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Leveraging Public Works for Sustainable and Resilient Livelihoods

Four Case Studies from India's Mahatma Gandhi National Rural Employment Guarantee Act

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EXECUTIVE SUMMARY

Despite significant improvements in poverty and standard of living over the last two decades, India continues to face challenges, including slow improvements in health and nutrition indicators and in aspects of women's empowerment and in generating opportunities for sustainable livelihoods. At the same time, climate-related events are increasing in frequency with associated risks. Women and other marginalized populations are often at greater risk from these events due to their relatively lower access to resources, lower mobility and greater dependence on common property resources. Social protection can be an effective instrument to promote resilience. One such large social protection program with significant potential is India's Mahatma Gandhi National Rural Employment Guarantee Act, or the MGNREGA, one of the largest public works programs in the world.

This report provides insights from four case studies linked to the MGNREGA and implemented under the Indo-German Enhancing Rural Resilience through Appropriate Development Actions, or ERADA project. ERADA was implemented in 8 blocks of 4 large Indian states, Rajasthan, Madhya Pradesh, Bihar and Jharkhand. The ERADA project had three broad objectives - of enhancing natural capital, green recovery through green enterprises, and convergence of resources and networks - and identified the MGNREGA as a critical social safety net on which to base its activities. While much has been written on the impact of the MGNREGA on "first-order" outcomes such as wages, employment, rural-urban distress migration and other household welfare outcomes, we know considerably less about the use of the assets created under the program, and even less about the potential of these assets to support and sustain value chain activities.

The International Food Policy Research Institute (IFPRI) partnered with Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) to study the use of MGNREGA assets in four of the eight ERADA blocks, each block representing a key value chain activity, and to assess the role of these assets in enhancing household income and resilience towards shocks. These included both covariate shocks, like climate change, as well as idiosyncratic household-specific shocks, such as health shocks. The four value chains were goat rearing in Sirohi, Rajasthan, moringa plantations in Khandwa, Madhya Pradesh, aquaculture in Araria, Bihar and mango plantations in Dumka, Jharkhand. The interventions in each block were led by different implementing NGOs. The four locations differed considerably in agroclimatic conditions and in MGNREGA indicators drawn from the MGNREGA MIS, as well as in scale of operations, duration of the interventions, and the type and number of converging government programs.

Our research activities had two key components. First, we used Process Influence Mapping (PIM), a collaborative hands-on exercise to map out the processes and actors involved in delivering the asset in question, and the relative influence of each actor. We conducted the PIM at both the block and village levels, to provide "top-down" and "bottom-up" perspectives of the same processes. Second, we conducted value chain analyses in each study area, with the goal of understanding the structure, conduct, and performance of the value chains developed around the specific MGNREGA assets. We interviewed key actors at different nodes along the value chain, including farmers, input dealers, retailers and processors, as well as government and civil society actors. We paid particular attention to potential transformation in value chains, "pain points" or challenges, and enabling factors.

The goat rearing in Sirohi built upon an existing value chain and focused on "upgrading" it, emphasizing the rearing of pure-bred Sirohi goats, a dual-purpose breed that exhibits fast weight gain, is hardy, and fetches a market premium. The focus here was on tribal households and women, and interventions centered on reducing goat mortality through improved extension and the training of a cadre of workers

(*Pashu Sakhis* or *Pashu Mitras)*, improving market linkages through a Farmer Producer Company (FPC), and improved feed and fodder systems. In contrast, the value chain in Khandwa was entirely new, and a lot of the initial work for the supporting NGO involved building community acceptance of a new product and developing the necessary market linkages. Moringa offered multiple opportunities: income as well as nutrition benefits, a backyard or plantation model depending on available space, and cultivation for pods or leaves or both. In Araria, the aquaculture activities leveraged many existing ponds that had been neglected or weren't being used to their full potential, while simultaneously supporting applications for new ponds. Much of the emphasis was on training and technical support, and the local JEEViKA self-help groups played a big role. Finally, in Dumka, mango plantations were also relatively new, but seemingly very lucrative. However, they required high fixed costs to establish, making the support from the MGNREGA invaluable. Here too there was a need for technical assistance and training.

Our research indicates that none of the four value chains were likely to have developed or upgraded organically in the absence of interventions, even where preconditions existed. For goats, for example, health care and market linkages needed to be established. For moringa, gaining community acceptance was a big initial challenge. In both aquaculture and mango, the high start-up costs prevented most potential beneficiaries from participating. However, the choice of each value chain was remarkably appropriate, and managed to balance both income generation and market development goals as well as environmental and other goals without any evident tradeoffs. For example, goat rearing does not require a lot of land, making it appropriate for women and poorer households, especially since goats can be grazed on public land. Both moringa and mango plantation models allowed for intercropping for short-term returns, and moringa addressed nutritional needs as well. Finally, the aquaculture model incorporated diversity in species, alternate uses of the ponds for growing *makhana*, and boundary plantations.

The value chains effectively bundled technological investments – pure-bred Sirohi goats, new varieties of moringa, strong focus on technical training, scientific pond and plantation management and so on – with social investments, thereby ensuring a greater chance of success and sustainability. There was a strong emphasis on local capacity creation, through the development of locally relevant training materials, the training of cadres and in developing networks of professionals who could support beneficiaries. There were also systematic efforts to involve or create local institutions. For example, the moringa community campaigns were run in collaboration with community institutions and line departments and women from self-help groups (SHGs) and Cluster Level Federations (CLFs) took ownership. Similarly, women's self-help groups (SHGs) were extensively used to identify community resource persons and beneficiaries in the case of aquaculture. Across value chains, a balance was maintained in focus on production and marketing: new buyers were located, as in the case of moringa, or existing relationships with traders were strengthened, as in the case of goats.

Importantly, all value chains embodied flexibility over fixity and encouraged adaptations that were suitable to both the local context and the individual beneficiaries' needs. The supporting NGOs developed low-cost goat shed models in Sirohi so that poorer households could benefit. Backyard cultivation of moringa allowed even those with limited space to participate; intercropping in moringa and mango and the integration of boundary plantations and *makhana* cultivation in the aquaculture ponds all supported multi-use flexible models. Local NGOs, GIZ leads, and other partners demonstrated a capacity and skill for innovative problem solving; for example, the use of GIZ's role as neutral outsider to catalyze convergence across government departments in Bihar and enable the wider appreciation and adoption of aquaculture. While the NGO partners and GIZ leads were certainly champions of the interventions they

were promoting, other champions and catalysts emerged organically, such as those in the KVK Khandwa who championed moringa and helped raise awareness of its benefits, as well as numerous women community resource persons and beneficiaries, some of whom persisted in these livelihood activities in the face of considerable resistance from community members.

The strength of the MGNREGA pathway varied across locations. In Sirohi, only about 5% of the goat sheds had been constructed using MGNREGA funds, given the long delays in material payments. In Khandwa, MGNREGA played a bigger role, with several schemes supporting plantations. Finally, the aquaculture and mango interventions were heavily reliant on MGNREGA assets. In addition to the MGNREGA, however, other partnerships mattered greatly: the careful selection of NGO partners who exhibited either prior experience or transferable skills, the use of existing institutions like women's groups and KVKs, and the strong role of CSR funding in Khandwa and Sirohi, all these came together to support the ERADA interventions. Interestingly, the relative influence and role of these actors as depicted in the PIM exercises differed depending on perspective. While the block level PIM tended to give more importance to those involved in giving technical sanctions, financial approvals and so on, the village level PIM emphasized the importance of the first-mile actors like the supporting NGO and local leaders.

Women were central to the processes in all locations. In part this was due to the commodity chosen or the partners identified. Goat-rearing, for example, was well-suited for women, as was backyard moringa plantation. SHGs, FPCs and Producer Groups were active in both Khandwa and Araria. In all locations, training and capacity building was delivered to women and marketing was often provided at the home/farmstead, thereby explicitly accounting and correcting for women's limited access to extension and limited mobility relative to their male counterparts.

In terms of resilience, a core component of our study, we study both climate resilience and income benefits. Climate resilience was built into the interventions in several ways, through the choice of context-appropriate commodities, the promotion of diverse activities on farm and diverse species in plantations and ponds, the use of low-cost durable designs using local materials, organic inputs for moringa and low-cost feed models for goat and fish. The estimated internal rates of return (IRR) to assets created with MGNREGA support range between 18 and 76%; our calculations suggest that the annual net present value (NPV) of each livelihood activity constitutes a 4-127% increase relative to the average 2019 income of an agricultural household within the state in question This suggests that MGNREGA-driven livelihoods can be an important pathway to doubling farmers' incomes, a stated goal of the Government of India.

There remain structural, implementation-related and longer-term challenges associated with both the value chain activities and with the MGNREGA program itself. We provide some specific recommendations in recognition of these challenges. There is a need to reduce delays in both material and wage payments, to prevent workers from being discouraged and turning away from the program. The MGNREGA can adapt its guidelines to allow for low-cost models using local materials, to develop different model estimates depending on the end use of the asset (e.g., clear guidelines for ponds for protective irrigation versus ponds for aquaculture), and to allow for the flexibility to repair and maintain existing individual-level assets. To build effective convergence, we propose the sharing of MGNREGA beneficiary information with other line departments, to enable inputs and training to be targeted towards these households. On this note, the NRLM-MGNREGA linkages seem to be working very well, and group-based assets, like those operated by SHGs or Producer Groups, can be explored more. Since

beneficiaries aspire to better, more fulfilling work beyond the MGNREGA, it would be useful to track them to see how many beneficiaries continue to remain dependent on the MGNREGA for income.

Lastly, our four state visits instilled in us a deep appreciation for the hard work and dedication of civil society partners. These partnerships must be nurtured and strengthened if interventions such as these are to have long-term sustained impacts.

Keywords: India, social protection, value chains, resilience, sustainable livelihoods, internal rate of return

ACRONYMS

AAO	Assistant Account Officer
ATM	Automated teller machine
ATMA	Agricultural Technology Management Agency
BCR	Benefit Cost Ratio
BDO	Block Development Officer
BHGY	Birsa Harit Gram Yojana
BMZ	*Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung* (German Federal Ministry for Economic Cooperation and Development)
BPIU	Block Programme Implementation Unit
BPO	Block Program Officer
BRLPS	Bihar Rural Livelihoods Promotion Society
BSLPS	Bihar State Livelihood Promotion Society
CEO	Chief Executive Officer
CFT	Cluster Facilitation Team
CLF	Cluster Level Federation
CmF	Centre for Microfinance
CM	Cluster Manager
CRP	Community Resource Person
CSR	Corporate Social Responsibility
DIC	District Industries Centre
DPO	District Project Officer
EDII	Entrepreneurship Development Institute of India
ECNRM	Environment, Climate Change, and Natural Resource
ERADA	Enhancing Resilience through Appropriate Development Actions
ESID	Effective States and Inclusive Development
FGD	Focus Group Discussion
FPC	Farmer Producer Company
FPO	Farmer Producer Organization
FRTC	Fishery Resource Technical Cell
FTO	Fund Transfer Order
FY	Fiscal Year
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmBH
GOI	Government of India

GP	Gram Panchayat
GRS	Gram Rozgar Sewak
ICRG	Infrastructure for Climate Resilient Growth
IFPRI	International Food Policy Research Institute
IGSSS	Indo-Global Social Service Society
IMC	Indian Major Carps
INR	Indian Rupee
IRR	Internal Rate of Return
JE	Junior Engineer
KVK	Krishi Vigyan Kendra
KG	Kilogram
MCP	Micro Credit Plan
MIS	Management Information System
MPOWER	Mitigation of Poverty in Western Rajasthan
MSME	Micro, Small and Medium Enterprises
MWC	Mission Water Conservation
NABARD	National Bank for Agriculture and Rural Development
NABCONS	NABARD Consultancy Services Private Limited
NGO	Non-Governmental Organization
NITI	National Institution for Transforming India
NPV	Net Present Value
NREGA	National Rural Employment Guarantee Act
NRM	Natural Resource Management
NRLM	National Rural Livelihoods Mission
NSS	National Statistical Survey
ODC-3	Oddanchathiran 3
PG	Producer Group
PIM	Process Influence Mapping
PKM-1	Periyakulam 1
PPR	Peste des petits ruminants
PRADAN	Professional Assistance for Development Action
PRS	Panchayat Rozgar Sevak
PTA	Panchayat Technical Assistant
RGB	Representative of General Body
ROI	Return on Investment
RSETI	Rural Self Employment Training Institute

SAFAL	Sustainable Aquaculture for Food and Livelihood
SC	Scheduled Caste
SHG	Self Help Group
SRLM	State Rural Livelihoods Mission
SSEVS	Samagra Shikshan Evam Vikas Sansthan
ST	Scheduled Tribe
TA	Technical Assistant
VLRP	Village Livelihoods Resource Person
VO	Village Organization

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1 INTRODUCTION

Despite the significant strides that India has made in moving millions out of abject poverty over the last two decades (Roy & Van der Weide, 2022), formidable challenges remain. These include improvements in health and nutrition, women's empowerment and establishing sustainable livelihoods, key components of the Sustainable Development Goals to which India is signatory. These challenges assume further salience given that extreme weather events in the Indian subcontinent are increasing in frequency (Roxy et al., 2017)[1], with associated impacts on agricultural productivity, household welfare, and health and nutrition (Carleton, 2017; Pandey et al., 2021; Zaveri & B. Lobell, 2019), posing significant challenges to millions of resource-poor households that depend on natural resources for their livelihoods.

In India, women are at greater risk of climate events than men due to lower ownership of resources, lower access to information and credit and lower decision-making ability (Desai & Joshi, 2014; GoI, 2019; Kanchi, 2010; Raabe, 2008). In addition, evidence suggests that adverse climate events can affect women disproportionately, increasing their vulnerability even further (Kosec et al., 2023; Mason & Agan, 2015). For example, climate events are linked to erosion of common property resources like forests and water bodies, many of which provide a means of livelihood to women and members of tribal and other marginalized groups. The adverse impacts of climate events on the viability of agriculture could also result in greater economic migration, both seasonal and otherwise, with impacts on women and children, the most vulnerable.

Several studies have noted that social protection policies in developing countries can be an effective instrument in global efforts for environmental action while at the same time promoting household resilience and climate adaptation (Jordan et al., 2021; Norton et al., 2020). Social protection policies and programs that explicitly enable greater voice and agency for women and other marginalized groups are especially important to ensure that their specific needs are addressed. One such large program is India's Mahatma Gandhi National Rural Employment Guarantee Act, or the MGNREGA, the largest public works program in the world. Not only is the creation of durable assets that strengthen the livelihood resource base of the poor a key objective of the MGNREGA, but the Act also mandates that at least one-third of its workers be women and that men and women be paid equal wages.

This paper provides insights from four case studies conducted by the International Food Policy Research Institute (IFPRI) within the three-year Indo-German **Enhancing Rural Resilience through Appropriate Development Actions (ERADA)** project, commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ), in partnership with the Indian Ministry of Rural Development, and implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) India. The objective of the four case studies was to document the process by which assets are created as part of the MGNREGA and used as the foundation for

[1] Climate Hazards and Vulnerability Atlas of India, Office of Climate Research and Services, India Meteorological Department, Ministry of Earth Sciences. https://imdpune.gov.in/hazardatlas/index.html. Accessed on July 9, 2024.

building value chains that can household income and resilience towards shocks. We further assess the potential impacts of these assets for beneficiaries. The overarching goal of this study is to highlight the potential of the MGNREGA but also to identify the constraints that need to be addressed to fulfil this promise.

The ERADA project was centered on enhancing rural resilience and promoting livelihood development of vulnerable households through the MGNREGA. In addition to its primary goal of providing a hundred days of work a year at minimum wage for every eligible rural household, the MGNREGA allows for the creation of rural assets that can be harnessed for livelihoods, such as canals, trenches, wells and farm ponds, rural infrastructure such as roads and community buildings, plantations, kitchen gardens for nutrition, and livestock sheds, among others. Yet, thus far, despite promising examples, MGNREGA assets have not been consistently leveraged for livelihoods activities, in part due to a lack of support and of complementary inputs. The ERADA project focused on providing the necessary inputs and training and creating linkages across government departments to allow for MGNREGA assets to be used to upgrade existing value chain activities or develop new ones, with the specific intent of improving incomes and resilience to climate and other shocks.

ERADA was implemented in one block in each of eight districts in four large Indian states, Rajasthan, Madhya Pradesh, Bihar and Jharkhand. In each block, several value chain activities were promoted and supported through the MGNREGA and other programs. We conducted our research in four locations where the MGNREGA was identified as having a particularly strong role in enabling the value chain in question. In our study location in Rajasthan, the value chain activity was goat rearing and the MGNREGA asset a goat shed; in Madhya Pradesh, the value chain activity was moringa cultivation and the moringa plantation was the MGNREGA asset; in Bihar the value chain activity was aquaculture, developed using MGNREGA farm ponds; and in Jharkhand, the MGNREGA supported the setting up of mango plantations for beneficiary households to cultivate and sell fruit from.

We used a case study approach to studying the assets created under the MGNREGA in each location, and the impact those assets have had on livelihoods and resilience. Our research had two key components. First, Process Influence Mapping (PIM), used to identify key actors involved in delivering these assets, their linkages to one another and to the beneficiary, and the relative influence of each. Second, value chain analyses, where we conducted key informant interviews and focus group discussions with several actors at various nodes of the value chain. As part of the value chain analyses, we collected cost and return information from beneficiaries, which we used to estimate the rates of return to the value chain activities associated with each MGNREGA asset.

The four case studies show that ensuring that MGNREGA assets form the basis of sustainable livelihoods demand significant investments in planning, design and implementation, on a sustained basis and purposeful coordination. We found that none of the four value chains was likely to have developed or upgraded in the absence of the ERADA interventions, even when preconditions existed. ERADA managed to bundle technological innovations with social investments, key to ensuring both initial uptake and longer-term sustainability. The innovations introduced pri-

oritized flexibility over fixity and encouraged adaptations tailored to the local context. Local champions and catalysts helped drive the ERADA interventions and ensure community buy-in, and NGO partners, local GIZ-leads and others demonstrated a capacity for innovative problem-solving that helped overcome several challenges.

We found that the processes involved with demanding an MGNREGA asset differed from asset to asset and across locations, but also within locations depending on whether the PIM was conducted at the block ("top-down") or village ("bottom-up") level. Block-level PIM exercises yielded more insight on payment and approval mechanisms, often unknown to beneficiaries, while village-level PIMs outlined both formal and informal pathways and the importance of NGO and government frontline staff.

Women were central to the processes in all locations, and where women's groups and their federations were involved—as was the case in Madhya Pradesh and Bihar—women took ownership of both the value chain activities and of encouraging broader community acceptance. Climate resilience was also built into the interventions very effectively, through choice of context-appropriate commodities and promotion of biodiversity. Lastly, we found that while the strength of the MGNREGA pathway varied across locations, our estimates of returns to the value chain activities supported by these assets are impressive regardless of the asset in question, with estimated internal rates of return (IRR) ranging from 18 to 76%.

Although there is widespread agreement that social protection programs can strengthen household resilience and climate adaptation, there is little systematic documentation of how this can be achieved. Our study contributes to redressing this gap by highlighting key ingredients of potentially successful interventions that can translate the creating of work under the MGNREGA into assets that strengthen the resilience of livelihoods of rural women.

The following sections describe the ERADA project and its implementation, the components of our research activities, and salient features of the MGNREGA program. We then present our findings and close with some clear policy recommendations.

2 THE ERADA PROJECT

The ERADA project had three broad objectives:

i. **Enhancing natural capital:** improving the wage work potential of the MGNREGA while simultaneously increasing the natural resource base.
ii. **Green recovery through green enterprises:** promoting long-term livelihoods development, capacity building support for improving livelihoods generation and promoting green enterprises.
iii. **Convergence of resources and networks:** promoting convergence and cooperation among multiple stakeholders.

The eight ERADA districts in Rajasthan, Madhya Pradesh, Bihar and Jharkhand—two districts in each state—were selected from among the set of aspirational districts in these states based on their ranking on a composite score of 22 indicators of both challenges and opportunities.

Blocks were selected from within the districts using similar criteria and in discussion with government partners. In each selected block, implementing organizations were identified and selected through a competitive process; these implementing organizations partnered with GIZ India to help fulfil the objectives of ERADA.

ERADA's focus was the MGNREGA, a public works guarantee program that has generated 44.2-billion-person days since its inception in 2006 and created 82.8 million assets as of July 14, 2024. The goal was to enable the realization of the potential of the MGNREGA to also generate sustainable and remunerative livelihoods. Its broad approach was to create platforms around this program for different stakeholders, including the implementing organizations, GIZ and government departments to coordinate and strengthen linkages between different programs. These include vertical linkages, as between the state, district, block level functionaries, as well as horizontal or lateral linkages, for example, those between various line departments.

Table 1 provides the details of each value chain in the four locations studied in this paper, including the specific MGNREGA asset being leveraged: goat sheds in Sirohi, Rajasthan, moringa plantations in Khandwa, Madhya Pradesh, farm ponds in Araria, Bihar and mango plantations in Dumka, Jharkhand.

Table 1: Value chains under ERADA

Livelihood/ value chain intervention	MGNREGA asset	Implementing NGO/ CSO Partner	Block, District, State	Approximate number of households involved at the time of our visit	Brief description of the activity	Converging Government programs
Goat	Goat shed	PRADAN and Centre for Microfinance (CmF)	Pindwara, Sirohi, Rajasthan	4000	Vet care services through Pashu Sakhis and Pashu Mitras (community paid model). Breed improvement trainings. Livelihood support. Asset creation (goat shed, marketing yard, livestock facility center). Marketing of livestock through the FPC. Feed and fodder management. Capacity building around livestock rearing practices. Convergence with Animal husbandry department	MGNREGA, Animal husbandry department, NRLM, NABCONS
Moringa (drumstick)	Moringa plantation	Indo-Global Social Service Society (IGSSS)	Khalwa, Khandwa, Madhya Pradesh	1500	Moringa plantation setup, seed and other input distribution (e.g., vermicompost, fencing etc.), setting-up community owned Bio-Inputs Resource Centers. Training of Trainers in coordination with Krishi Vigyan Kendras (KVK), Horticulture Department and other institutions on plant management (weeding, pruning, input provision and pest control), post-harvest management and business skills. Micro-enterprise Development Programme in partnership with Entrepreneurship Development Institute of India (EDII).	MGNREGA for Nursery and community plantation, MSME Department/DIC Enterprise Development Programs. Horticulture Department- Schemes for Plantation and Processing. NRLM for SHG members.

Livelihood/ value chain intervention	MGNREGA asset	Implementing NGO/ CSO Partner	Block, District, State	Approximate number of households involved at the time of our visit	Brief description of the activity	Converging Government programs
Aquaculture	Farm pond	Change Alliance and Samagra Shikshan Evam Vikas Sansthan (SSEVS)	Raniganj Block, Araria	500	Assistance in applying to MGNREGA for new farm ponds and rejuvenation of existing public/community ponds and bund plantations). Technical training of CRPs on sustainable aquaculture, types of fish, preparation of fish feed etc. Fishery Resource Technical Cell set up at District for coordination. Identification and training of community resource persons (CRPs) on preparation of the pond, technical components of package of practices, enterprise development (extension services). Linkages with Fishery department for training and schematic support. Fish production and marketing. Development of Integrated Fishery Resource Centre.	MGNREGA, BRLPS (Jeevika), Fisheries Department
Mango	Mango plantation	SUPPORT	Masaliya, Dumka, Jharkhand	200	Assistance with applications to MGNREGA for mango plantations. Training to beneficiaries on mango plantation maintenance, provision of inputs etc.	MGNREGA Dept, Jharkhand State Rural Livelihood Promotion Society, Department of agriculture.

Source: GIZ documents, information from implementing NGOs and own field visits.
Notes: The table reflects these projects at the time of our visit and may not be up to date or comprehensive.

3 RESEARCH STUDY DESIGN

Our overall objective was to assess the use and maintenance of existing MGNREGA assets and the role these assets play in enhancing household income and resilience towards shocks. Via this work, we hope to forward our understanding of whether public works programs, via creation of durable assets, can serve to improve and diversify rural livelihoods, to assess the strength and weaknesses of different approaches to improve the participation of the marginalized, especially women, and to provide tangible policy recommendations that can guide GIZ's future efforts to promote resilient development actions.

As mentioned above, our research activities were conducted in one block of one district in each state where the MGNREGA was identified to have a substantial role in supporting livelihoods and household resilience. These blocks and corresponding value chains are described in Table 1 above and in greater detail below, but include goat rearing in Sirohi, Rajasthan, moringa plantations in Khandwa, Madhya Pradesh, aquaculture in Araria, Bihar and mango plantations in Dumka, Jharkhand. While documenting ERADA's efforts in these four sites we focused on gleaning lessons from a comparative perspective. We were also particularly interested in the intersection of the MGNREGA, the role of women in the process and in the value chains that have been created, and in the potential of these activities to make women and their communities more resilient.

Our research activities had two main components, described in detail in the 5 Data and methods section below. First, we conducted a Process Influence Mapping (PIM) exercise for each value chain and in each location, detailing the people and processes involved in obtaining the assets in question (e.g., goat sheds in Sirohi, or plantations in Khandwa and Dumka). PIM is a collaboratively generated graphical means of depicting the interactions between actors and their relative influence over the processes in question and is particularly useful for complex processes with multiple stakeholders. Second, we conducted a value chain analysis for each value chain in question. For this, we conducted key informant interviews and focus group discussions with a variety of stakeholders at different nodes along the value chain and estimated a rough rate of return for each value chain activity[2].

Our goal was to use mixed methods to gain a systematic understanding of the process and potential of an intervention that seeks to strengthen an existing intervention. Our process, however, comes with caveats. First, the field sites and respondents were purposively selected in consultation with the stakeholders, including GIZ and its implementing partners. We opted to document and examine cases where the program was relatively successful to understand the ingredients of potential success in taking MGNREGA beyond public works. We felt this would be most useful, given that the challenges of MGNREGA implementation have already been documented widely. Second, given the short duration of ERADA activities, we were only able to assess the activities as they unfolded within that period. Many value chain interventions often span several years and

[2] Our original plan was to estimate the returns to the asset, i.e., the goat shed in the case of Sirohi, or the pond in the case of Araria. However, this proved very difficult to do. For example, it is hard to estimate the savings from reduced goat mortality or morbidity due to the goat shed. This report will, therefore, estimate the returns to goat rearing, plantations and aquaculture.

impacts can take a decade to materialize. Our research, therefore, can be seen as an early-stage documentation of value chains developed under ERADA. Third, we based our research on a small subset of source materials that exist as part of the project. For example, we did not incorporate project communications and information exchange or financial transactions amongst stakeholders. Nor did we take into consideration the costs incurred by the ERADA partners in fostering value chain activities. Our effort, consequently, is not an assessment of the ERADA program or indeed of the MGNREGA. Our focus was instead on gleaning insights into the challenges and opportunities associated with such an endeavor. To the extent that this paper relies on our expertise and subjective assessments, we hope that it will generate stimulating conversations and discussions about possibilities for the future.

Despite the promise of MGNREGA assets in supporting livelihoods and enhancing household income, significant challenges remain. Some of these are structural. For example, the MGNREGA's mandate ends with the creation of employment and assets, and developing value chain activities based on these assets requires the provision of additional inputs, training and capacity strengthening. Some challenges relate to implementation, such as delays in wages and material payments that serve to discourage workers from the program. Finally, longer-term challenges regarding sustainability of impacts once operations are scaled up or NGO support is withdrawn also need consideration. We conclude the paper with some concrete recommendations on how the MGNREGA can be strengthened and how learnings from these and other studies can be gathered and shared across states. We hope that these recommendations will be useful for policymakers, donor organizations and civil society organizations working with the MGNREGA and similar social safety net programs.

We now describe some salient features of the MGNREGA program.

4 THE MGNREGA

Rolled out in rural India in three phases between 2006 and 2008, the MGNREGA is a public works guarantee that entitles each rural household to a minimum of 100 days of manual unskilled work at stipulated wages. Men and women are paid equal wages, and the Act mandates a 33% reservation for women workers. Much has been written on the impact of the MGNREGA on employment, migration, and wages (Azam, 2012; Berg et al., 2012; Imbert & Papp, 2015, 2016; Zimmermann, 2023); on household welfare (Klonner & Oldiges, 2014); on crop choice and agricultural technologies (Bhargava, 2021; Gehrke, 2019); and on the role of the program as buffer against unanticipated shocks, including weather-related shocks and, more recently, the COVID-19 pandemic (Afridi et al., 2021; Johnson, 2009; Narayanan et al., 2020; Zimmermann, 2023).

Along with the primary guarantee of employment on demand, a secondary and far less-studied goal of the MGNREGA program is to create durable assets that can serve as the basis of sustainable rural livelihoods, that is, to create "durable assets" geared towards water conservation, drought proofing, irrigation, land development, water harvesting, flood control and rural connectivity. Schedule I of the 2005 Act provides a list of permissible works that have been amended since; these are categorized into 4 parts - natural resource management, individual and community assets, common infrastructure for women's groups, and rural infrastructure. Notably, the Act

mandates that 60% of the expenditure on works should focus on supporting agriculture and allied activities.[3]

The record of asset generation in the early years was far from inspiring, primarily because of the preoccupation with investing in institutional capacity to implement the complex program. Over time, however, thanks to specific initiatives, for example, to promote convergence across government departments, expanding the range of permissible assets, partnerships with civil society organizations, geotagging of assets created, etc., asset creation began to receive greater attention (Narayanan, 2016). Primary surveys since have shown that assets constructed under the program are viewed as useful and of good quality; demonstrate high rates of return; reduce the vulnerability of agricultural production, limit soil erosion and increase water availability, among other impacts (Aggarwal et al., 2012; Bhaskar & Yadav, 2015; Esteves et al., 2013; Indian Institute of Science, 2013; Narayanan, 2016; Ranaware et al., 2015; Tiwari et al., 2011; Verma & Shah, 2012). There is also some evidence that households that had MGNREGA assets built on their own land or lived near an asset cultivate more land, use more inputs (including own labor), and have higher agricultural output (Gehrke, 2015; Muralidharan et al., 2021).

Given the scale of the program and the nature of the assets being created, the MGNREGA has tremendous potential to enhance rural resilience against unexpected shocks, especially those related to climate change. Advocates have long been urging the government to treat MGNREGA as a "sharp policy instrument" to address the challenges of climate change (for example, Narayanan, 2014). Yet, several challenges exist, including appropriate choice, design and location of works, participatory planning, and the provision of complementary inputs such as training, credit, inputs, etc., for beneficiaries to better use the assets to pursue remunerative and sustainable livelihoods. Anecdotal evidence suggests that efforts to dovetail livelihoods programs of the government with the MGNREGA and skilling initiatives for MGNREGA workers have achieved variable success.

ERADA's focus on redressing some of these gaps offers opportunities for learning so that the MGNREGA program can fulfil its considerable promise.

5 DATA AND METHODS

Our research effort uses two analytical tools. The first component focusses on the process by which these assets are created, maintained, managed, and used by beneficiaries using a method called Process Influence Mapping or PIM. The second component maps the value chains for our select value chains to be able to understand the context and potential of the interventions under ERADA. A value chain approach is appropriate since these clusters were designed explicitly to establish, promote or strengthen specific value chains. We combine these two approaches to uncover insights into the process and ingredients that enable value chain transformation for promoting and strengthening resilience and sustainable livelihoods.

3 The proviso following Sub Para (2) of Para 4 of Schedule 1, Mahatma Gandhi NREGA, lays down that, "Provided that the District Programme Coordinator shall ensure that at least 60% of the works to be taken up in a district in terms of cost shall be for creation of productive assets directly linked to agriculture and allied activities through development of land, water and trees."

We undertook visits to each of the four field sites totaling approximately 70 person days spread over January-June 2024. Each visit was preceded by detailed interviews with the implementation partners and GIZ local teams. In each visit we undertook a set of activities common across sites (Table 2). The goal was to be able to capture any systematic differences in the perspectives and understanding of stakeholders who operate at different layers of governance.

5.1 Component 1: PIM

The Net-Map toolbox was developed as an interactive graphical way to depict the set of actors influential within a certain space, their relative degrees of power or influence and the nature of the connections between them (Schiffer, 2007). The Process Influence-Map (Raabe et al., 2010) extends the Net-Map methodology to focus also on the underlying processes (rather than just the actors), providing an excellent way to collaboratively develop and visualize the theory of change for the implementation of a complex intervention, outline how various steps in the process align sequentially, to identify the key actors at each stage, how much power they have and how they interact. This method can also be used to document how the actual process deviates from the formal process laid out in program guidelines. This is particularly useful for a project like the MGNREGA, since the complexity of its guidelines lends itself both to leakage and corruption, but also to the development of informal alternatives to formal processes.

In the context of the value chains described in Table 1, the Process Influence-Map is also useful in describing how different stakeholders understand the same process. For example, in the case of aquaculture in Bihar, the key stakeholders of SSEVS and Change Alliance (the two implementing NGOs), MGNREGA functionaries, district fishery departments and JEEViKA, the Bihar State Livelihood Promotion Society (BRLPS) functionaries and the beneficiaries themselves might each have a slightly different understanding of the processes, facilitators and barriers. Documenting these differences is a first step towards cultivating convergence.

The creation of a Process Influence-Map is a tactile, collaborative effort, using large sheets of paper, colored post-its and other physical markers to develop the flow of processes. Key informants are asked about the process of demanding MGNREGA assets in a series of steps. First, they are asked to describe these processes and how each is linked to the other; these will be depicted as boxes with arrows linking them. Second, for each stage of these processes, they are asked to list all the actors involved; these are represented by small tokens or figures. Third, the key informants provide a relative ranking of these actors in terms of their importance in the context of implementing the construction of the assets in question; this is depicted by building towers of varying heights for each actor, with the height of the tower representing the degree of influence. Finally, key informants help identify actors who pose barriers to these processes, depicted using red tokens.

These graphical representations of the processes and emerging actors are translated into a finished product, one per group of key informants. Doing this allows us to compare the resulting maps by informant type, highlighting where the largest gaps in knowledge about the formal processes lie or how the perceived relative influence of actors varies.

We conducted two PIM exercises in each field setting, one at the block level and one at the panchayat level. The types of participants differed across the two, with block-level representatives from the MGNREGA, associated line departments and the supporting NGO (among others) participating in the block level exercise, while the panchayat-level PIM included village level functionaries, those who had received the asset through the MGNREGA or another channel and those who had unsuccessfully applied for MGNREGA assets. As a result, the two PIMs differed in their perspective of the different pathways and the actors and processes involved in each. The block-level PIM provided a more top-down view, while the panchayat-level PIM built a picture from the ground up.

We draw on and describe the insights from the PIM exercise where relevant and present the results of each PIM in the Appendix.

5.2 Component 2: Value chain analysis

Value chains are generally defined as the full range of activities required to bring a product or service from conception through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers and final disposal after use (Kaplinsky & Morris, 2001). In general, value chain actors tend to be diverse (informal traders, large processors, etc., for example), spread across geographies depending on the location of the consumers and the extent of processing involved. Value chain actors may also have varying incentives that are sometimes symbiotic but at other times conflicting. A comprehensive understanding of these is key to assessing whether and how MGNREGA contributes to building sustainable livelihoods around the assets created.

In this second component, our goal was to understand the structure, conduct and performance of the value chains developed around these MGNREGA assets. We are particularly interested in capturing qualitatively two dimensions: the transformation, if any, in these value chains on account of the MGNREGA assets and a comparison of the MGNREGA-centric value chains relative to others that predate MGNREGA or have evolved independently in the region.

We followed established practice in value chain analysis and conducted key Informant Interviews with value chain actors including farmers, input dealers, traders, retailers, processors and any other actors relevant to the value chain (see (Baltenweck et al., 2019; Kruijssen et al., 2021) for examples). These include government actors and civil society actors who may not be directly involved in the value chain in the context of the MGNREGA but may have key roles as facilitators.

5.2.1 Estimating returns to the value chain activities

As part of the value chain analysis, we documented the costs and earnings for producers in each value chain. Owing to the relative immaturity of these value chains and some specific constraints, we estimate potential earnings for producers in the short run from pursuing goat rearing, moringa, mango plantations and aquaculture.

We compute three indicators, described in detail in the appendix:

(1) The net present value (NPV) of the stream of returns from the asset, and the annualized NPV as a percentage of agricultural household's income based on the 2019 Situation Assessment Survey of Agricultural Households in India (GoI, 2021). The NPV is the present value of the net benefits computed by deducting the total discounted costs from the total discounted returns, and a positive NPV indicates an investment is worth making;
(2) The Internal Rate of Return (IRR), which computes that discount rate such that the NPV=0;
(3) The Benefit Cost Ratio (BCR), which estimates benefits per unit of costs.

We drew on various sources for data to calculate returns. For investment costs, we used the Management Information System (MIS) of the MGNREGA and extracted data from the Table R.6.12 Dynamic, for the study blocks, Pindwara, Khalwa, Raniganj and Masaliya for the years 2020-21 through 2023-24. We computed the average total cost (including materials and labor) of the asset that most closely matched the asset in each of the value chains in terms of description and size. These were broadly in the same range as those mentioned in our field visit, but the MIS estimate was typically higher, likely because our respondents did not include or recall all the components of the costs in the MGNREGA.

For recurring expenses and any additional complementary investments, our estimates come from the respondents we interviewed in the field. In general, we tried to interview three beneficiaries to get estimates of the various costs. Unfortunately, since some value chains were at a very nascent stage and beneficiaries were unable to provide relevant cost estimates for later years, we resort to some assumptions around maintenance, repairs and replacement costs. These are described for each value chain in the appendix.

Where we were unable to obtain data, we refer to published literature for appropriate information. These assumptions can be influential and remain an important cautionary note when interpreting the results. We also draw on estimates from the Situation Assessment Survey of Agricultural households 2019, NSS Round 77 (GoI, 2021) to be able to compare estimate returns in current prices with incomes of agricultural households in the districts we study.

Other assumptions on the rate of interest and of inflation, the life of the assets, repair and maintenance costs, and on specific features of each individual asset (e.g., size and composition of the goat herd, the number of trees per acre of a plantation etc.) are detailed in the Appendix.

Table 2: Data collection and interactions

Data collection activities	Number	Details
Process Influence Mapping	**8**	
Block level	4 (1 in each state)	PIM exercise with representatives from MGNREGA (Gram Rozgar Sevak (GRS), Technical Assistant, etc.), representatives from relevant line departments, and the supporting NGOs.
GP level	4 (1 in each state)	PIM exercise with women beneficiaries and non-beneficiaries (including those who are SHG members), relevant community resource persons, and village-level representatives, as appropriate.
Focus Group Discussions (FGDs)	11	FGDs with Farmer Producer Company representatives, beneficiaries and community members engaged in value chain activities, MGNREGA labor group etc.
Stakeholder interviews	**30**	-
Government department functionaries	13	Key informant interviews with BDOs, relevant block-level line department representatives (department of animal husbandry, fisheries), representatives of other block- and district-level institutions, e.g., the Udyog Vibhag in Araria, ATMA in Dumka, KVK in Khandwa, JEEViKA block and district managers, JEEViKA Livestock State Program Manager etc.
MGNREGA functionaries	2	Interviews with MGNREGA Commissioner, Chief Operating Officer MGNREGA.
Value chain actors (traders, input dealers)	8	Interviews with input suppliers (e.g., feed for goats, fish feed and fish seed etc) and traders in local and state level markets, SHG members at the processing unit in Khandwa.
NGO Partner interviews	4	Meetings with members of each implementing NGO.
ERADA staff interviews	3	Meetings with GIZ staff overseeing the ERADA work in each block (all except Sirohi).

6 THE STUDY AREAS

The four sites - Sirohi (Rajasthan), Khandwa (Madhya Pradesh), Araria (Bihar) and Dumka (Jharkhand) – where we conducted our research activities are depicted in Figure 1 and represent some of the poorest regions in India (Table 3). All four are among the so-called 'aspirational districts', i.e., those districts where progress on social indicators has been particularly slow. Except for Araria, the proportion of Scheduled Tribes in the district population is higher than the all-India average in all districts; all four also have a lower sex ratio than the all-India average. The four districts also perform worse than the all-India average on female literacy, overall literacy and infant mortality.

Despite the shared context of backwardness, the districts are very distinct in terms of agroclimatic conditions, enabling lessons from diverse contexts. All of them are predominantly rural, but agriculture is of varying importance in the larger economy.

About half of the area of Pindwara block in Sirohi comprises dry deciduous forests, with remote, hilly settlements. With only a limited cultivable area, agriculture is restricted to specific tracts. The district is prone to drought, floods, heat waves, cold waves and frost. Landholdings are small and agriculture is not very lucrative. The main source of irrigation is wells (20.7%) followed by canals (1.7%). Groundwater is often saline. The main crops grown are maize, pearl millet, sesame, castor, green gram, fennel and cluster bean (kharif) and wheat, mustard, gram and cumin (rabi). Fennel, cumin and castor are key cash crops. In some tracts, lime, mango, amla, papaya, tomato, okra and other horticultural crops are popular.

Khalwa block in Khandwa too has large tracts of forests and is semi-arid with just half of the total area being cultivable. With a cropping intensity of 128%, there is one major growing season, kharif, when soybean, cotton, and sorghum are grown. In winter, i.e. rabi, wheat and gram are cultivated. The most owned livestock are cattle and buffaloes, followed by goats. Like Pindwara (Sirohi), Khalwa (Khandwa) too is dominated by tribals who live in remote settlements that are often difficult to reach. Soil conditions tend to be poor, and irrigation is limited, with less than 15% of the total population engaged in farming. Migration both within and outside the state is high and the region is known as a malnutrition hotspot.

The district of Dumka is part of a region known as the Santhal Paraganas and is home to the Santhal tribes. The region comprises gently sloped hills. Although net cultivated area is 40% of the land is suitable for agriculture, half of these are on uplands, 30% on medium lands and 20% are lowlands. The lowlands support paddy and maize, with the medium and uplands more likely to be undulated. Given low coverage of irrigation, in most areas the growing period is restricted to the rainy season and beyond 150 to 180 days. Most irrigated areas rely on open wells, tanks and occasionally canals or borewells. Rice, a staple food, and maize dominate the cropping pattern, with *arhar* (pigeon pea) and *urad* (black gram) in the kharif season, and gram, wheat and mustard in the winter.

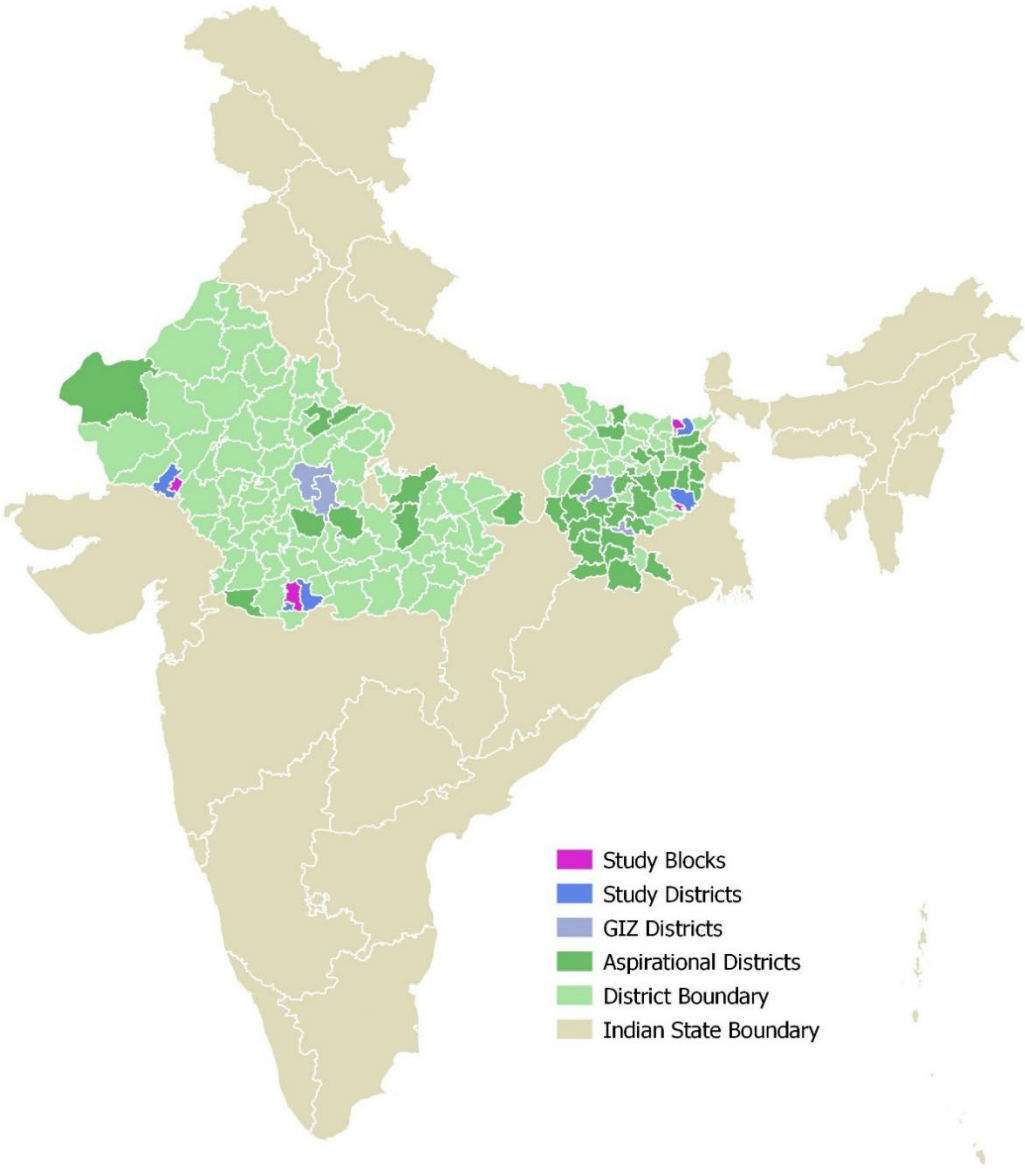
The fourth study area, Raniganj block in Araria district, is somewhat different. Unlike the semi-arid conditions in Sirohi and Khandwa, Araria is a region with plentiful water supplies thanks to the river Kosi, a perennial snow-fed river originating in the upper Himalayas. The economy of the

Araria district mainly depends on agriculture. The main cropping pattern is dominated by paddy, maize, and jute. The district is prone to floods each year in August, as the waters of the Kosi swell and submerge fields.

Each of the four districts is therefore somewhat vulnerable to climatic shocks and three of them are undulated with limited cultivable land and modest agricultural activity. While Sirohi has several industries locally, in the other three districts outmigration, especially of men is not uncommon.

All four districts received the MGNREGA program during Phase 1 of the rollout of the program in 2006. The MGNREGA was introduced in the poorest districts first. In terms of the relative performance of the MGNREGA program in these four districts in the most recent financial year, we find mixed results. The proportion of Scheduled Caste and Tribe person days as a percentage of total person days is highest in Sirohi. In Sirohi and Araria the percentage of women person days out of the total is higher than the all-India average, though the average number of days of employment exceeds the national average only in Sirohi. Dumka reports the highest number of completed works as of fiscal year (FY) 2023-24, as well as the highest proportion of Category B works (individual and community assets for vulnerable sections of the population) and the highest expenditure on agriculture and allied works as a percentage of total expenditure. While it is the case that data for a single year can be misleading on account of varying idiosyncratic issues, this provides a summary of the state of the program during the ERADA program.

Figure 1: Map of the blocks in the study area



Source: Author's additions to Survey of India maps.

Table 3: Social indicators in the study districts

	Sirohi	Khandwa	Araria	Dumka	India
Aspirational district ranking [rank, score]	[53,35.19%]	[41,37.14%]	[91,30.16%]	[55,35.14%]	**-**
Population density (number of persons per square km)	202	178	992	300	**418**
Rural population (% of total population)	79.9%	80.2%	94%	93.2%	**68.8%**
Scheduled Tribes (% of total population)	28.2%	35.1%	1.4%	43.2%	**8.63%**
Scheduled Castes (% of total population)	19.5%	12.0%	13.6%	6.0%	**16.63%**
Sex ratio (number of females per 1000 males)	940	943	921	977	**1020**
Female literacy Rate	39.7%	55.9%	43.9%	48.8%	**69.1%**
Literacy rate	55.3%	66.4%	53.5%	61.0%	**76.32%**

Sources: Aspirational district ranking: NITI Aayog, https://www.niti.gov.in/sites/default/files/2018-12/AspirationalDistrictsBaselineRankingMarch2018.pdf. Population density, rural population, Scheduled Tribes and Caste proportions, sex ratio, female literacy rate, literacy rate, infant mortality: District Handbooks, Census of India 2011, https://censusindia.gov.in/census.website/data/handbooks#.

Table 4: MGNREGA indicators in the study districts

MGNREGA indicators	Sirohi	Khandwa	Araria	Dumka	INDIA
When was MGNREGA introduced?	2006	2006	2006	2006	**2006**
SC person days as % of total person days	24.46	7.72	11.48	4.52	**19.18**
ST person days as % of total person days	32.53	31.33	1.11	26.91	**17.63**
Women person days as % of total person days	84.22	43.48	59.37	47.09	**58.89**
Average days of employment provided per household	65.38	36.53	39.76	55.53	**52.09**
MGNREGA notified daily wage (Rs.)	255	221	228	228	**-**
Average wage rate per day per person (Rs.)	190.76	220.28	227.68	228	**235.63**
Number of Completed Works	2,921	14,498	23,712	25,803	**84.23 lakh**
% of NRM Exp. in MWC Blocks	48.81	-	-	19.89	**29.44**
% of Category B Works	52.31	61.17	68.41	80.32	**59.51**
% of Expenditure on Agriculture & Agriculture Allied Works	33.78	19.26	29.83	78.14	**35.67**

Source: Authors' compilations from MGNREGA At a Glance. https://nrega-narep.nic.in/netnrega/nrega_ataglance/At_a_glance.aspx All data are for FY 2023-24

7 THE FOUR VALUE CHAINS

7.1 Bringing in the MGNREGA: Goat rearing in Pindwara, Sirohi

In Sirohi, goat rearing is a traditional occupation in the remote, hilly parts of the district and is practiced by 80-90% of the households in Pindwara block. Pindwara is predominantly occupied by tribal households (specifically from the Garasi and Bhil Gameti tribes) with limited scope for agriculture due to the terrain and the preponderance of small landholdings. Most tribal households have small herds of 2-3 goats and rely on forest scrubland for grazing. Goat rearing is accessible to and manageable for poor households with small homesteads, requires low initial investments, generates regular returns, and women can be gainfully engaged in the activity. The main challenges therefore were around reaching and targeting women.

In Sirohi, ERADA supported PRADAN and Centre for Microfinance (CmF)'s ongoing efforts to promote goat value chains. The work under ERADA built on an earlier project called Mitigation of Poverty in Western Rajasthan (MPOWER), supported by the International Fund for Agricultural Development, which worked to strengthen goat-based livelihoods in the region and established a livestock Farmer Producer Company (FPC) in 2016. Since ERADA was building on a pre-existing value chain and ongoing NGO efforts, their main value add was in strengthening linkages to government schemes, Krishi Vigyan Kendras (KVKs), agricultural departments and universities, and facilitating the provision of technical information.

The focus of PRADAN and CmF's efforts in goat rearing was to promote the pure Sirohi breed, a high quality, dual purpose and rapid weight-gaining variety that is well-suited to the climatic conditions of the area and is resistant to major diseases. The Sirohi breed has a longer milking period and produces more milk than what is required for the goat kids (the extra can be consumed by the household or sold), however, at present there is no active market for milk. The main income comes from selling live goats for meat, in markets in Gujarat, Maharashtra and Ajmer in Rajasthan. Individual goat-rearing households interact only with the local traders, about ten in number, who visit their homesteads to purchase goats. Pure bred Sirohi goats not only fetch a premium in the meat market but also gain weight faster and can be sold at six months, generating income faster than the local *kaali peeli* variety that households used to keep for up to two years before selling.

Promoting Sirohi goats, therefore, provided a climate resilient income generating opportunity, with low entry barriers and widespread community acceptance. PRADAN and CmF followed a cluster approach, working first to identify areas where goats were already being reared, and focused their activities on three aspects: reducing goat mortality through improved veterinarian services delivered through the local cadre of *Pashu Sakhis*, improving market linkages by connecting women to the FPC for goat sales as well as increasing their awareness of going rates, the weighing process etc. to improve their bargaining power, and improved feed and fodder systems for better goat health. They also developed livestock facilitation centers with assured cold chain facilities to build entrepreneurial capacity to deliver all services, including vaccines. These

livestock facilitation centers were developed through collaboration between the Farmer Producer Company and NABARD. At the time of our visit, there were two clusters, covering 16 GPs and 2 FPCs, engaging 49 Pashu Sakhis and Pashu Mitras (F:28, M:21), and mobilizing close to 4000 households.

The MGNREGA enters the goat value chain through the provision of goat sheds, which help reduce goat mortality (due to foot and mouth disease in the rainy season and *peste des petits ruminants* or PPR during winter). PRADAN and CmF were supporting applications for goat sheds under the program – 216 applications had been submitted in 2023, more in 2022 – but delays in the release of payment for material meant that these goat sheds were yet to materialize. Several goat-rearing households had received sheds through the MPOWER project or through corporate CSR funds, others had constructed their own low-cost low-durability goat sheds. PRADAN and CmF had developed their own low-cost version at an estimated INR 18,000 per shed, in contrast to the INR 70,000 required for the one built under the MGNREGA.

In addition to their work to promote and support goat rearing, PRADAN and CmF also support two FPCs in the area; Samriddhi Mahila Producer Company Limited that has been operational for four years, has about 700 members and a turnover of INR 3 crore, and Abu Parvat Mahila Producer Company Limited that has been operational for 3-4 months and has about 300 members. A third FPC, Abu Swaroop Mahila Producer Company Limited, is supported by NABARD. Samriddhi FPC's main revenues come from their sales of castor and fennel, which constitute close to 70% of their business, with only about 30% coming from sale of goats.

7.2 Putting down strong roots: establishing moringa cultivation in Khalwa, Khandwa

Unlike goat rearing in Sirohi, which was focused on upgrading an existing value chain, the lead NGO in Khalwa block of Khandwa district for the ERADA project, Indo-Global Social Service Society (IGSSS), first had to revive and reestablish the cultivation of moringa in the face of considerable community resistance. Traditionally, moringa was grown in this area, but the variety that was cultivated produced bitter tasting pods so had been discontinued. Neither moringa pods nor leaves were commonly consumed, which added to the reluctance among households to grow the trees. And yet moringa is a great choice of value chain for this region: its high nutrient content is useful given high rates of malnutrition in Khandwa (IIPS, 2017, 2022), it requires little water and is heat resistant, it can be grown in a small space, and its "superfood" status suggest good market prospects, both in large regional markets like Indore, which has a big demand for herbal products, but also a high-value export-oriented market.

IGSSS started working on moringa in September-October 2021. To overcome the complaints about the bitter taste, they introduced two new varieties – Periyakulam 1 (PKM-1, mostly for leaves) and Oddanchathiran 3 (ODC-3, mostly for pods). They promoted several models: cultivation for pods, leaves or both, and small-scale backyard cultivation for self-consumption or larger-scale plantation style cultivation for sale. To generate community acceptance, IGSSS ran several awareness campaigns (See section on 8.1.5 Innovative solutions to barriers), with grad-

ual success and adoption among community members. These campaigns were run in collaboration with the KVK Khandwa, with whom IGSSS has a strong relationship, as well as representatives from the MGNREGA department and from the State Rural Livelihoods Mission (SRLM). In fact, the SRLM has played a strong role in supporting moringa work: the second more successful campaign around adoption of moringa was anchored by the Cluster-level Federation (CLF) and SHG members from within the SRLM fold. Technical training has been provided to the SHG members in coordination with KVK Khandwa to promote small enterprises for moringa-based value-added products, such as nutritious moringa *laddoos*.

IGSSS works with and supports the FPC Ona Mashi Producer Company Limited. In addition to producing and marketing a range of products – bamboo ornaments and decorative items, biscuits, and potato, banana and colocasia chips – the FPC also purchases moringa leaves from the women members, sorts and grades them and processes them into moringa leaf powder that is packaged and sold. The main markets for these products are local traders and regular (and popular) local *melas*, or community gatherings, where the FPC members set up their stalls. Recently the Bhopal Chamber of Commerce has purchased moringa leaves and there are a couple of export-oriented buyers in Indore and Bhopal who also have ties with Ona Mashi FPC.

Under the Synergy with Securing Nutrition, Enhancing Resilience (SENU) project in Khandwa, Madhya Pradesh, community nutrition gardens are being developed and maintained by SHG women, who are paid wages under the MGNREGA for performing different tasks on the nutrition garden. To ensure sustainability of these community nutrition gardens, SENU, along with the ERADA project, is looking to develop enterprise opportunities emerging from the surplus production of these gardens and to provide support for market linkages for the surplus produce. Furthermore, the supply of bio-inputs to the existing community nutrition gardens through small bioinput resource centers established by ERADA can be explored.

The role of MGNREGA in moringa plantations is three-fold. First, MGNREGA has a model for plantations with 300 plants per acre that includes costs of land development and labor charges. Under this, 70 applications for plantations have been successfully submitted and several individuals have established their plantations. Second, individuals with job cards can raise nurseries with MGNREGA funds and earn income through selling the saplings to farmers. Third, MGNREGA has played a strong role in rejuvenating vermicompost pits and bio input enterprises and centers. Individual women and SHGs can raise money through the selling of compost; indeed, the use of organic home-produced inputs is encouraged (including *jeevamrit*, a rather foul-smelling mixture of cow urine, manure, chickpea flour (*besan*) and jaggery (*gud*)). As in Sirohi, however, MGNREGA wage delays and delays in receiving the moringa plants are a major problem, especially since plantations are time-sensitive activities.

7.3 Teach a (wo)man to fish: Aquaculture in Raniganj, Araria

The work on aquaculture in Raniganj, Araria under the ERADA project proceeded in two phases. In the first exploratory phase, from July-August 2022 to November-December 2022, the focus was on vulnerable sections (SC, ST groups and women). A baseline assessment of differ-

ent stakeholders was conducted to understand the major gaps, what kind of work has been undertaken and what challenges were faced. In the second phase, from June 2023 onwards, five livelihood clusters were identified and selected for work – these included fisheries, groundnut, foxnut (*makhana*), goat rearing and MGNREGA for wage work. Pockets were identified for each based on where households were already engaged in large numbers. Aquaculture satisfied multiple criteria: it was an activity that was not already well-established and yet had cultural acceptability, it targeted natural resource management, it lent itself to convergence with government schemes, and it allowed for a focus on vulnerable groups.

Raniganj has a plentiful water supply and is a good candidate for developing aquaculture activities, but many of the existing farm ponds were in a state of disrepair at the start of the project and were not being utilized for fisheries. Sandy soils mean that ponds need regular desilting, or they tend to fill up. The focus of NGOs Change Alliance and Samagra Shikshan Evam Vikas Sansthan (SSEVS) – the lead NGOs in Araria under ERADA - was on using existing assets effectively to improve livelihoods.

In addition to desilting and rejuvenating existing ponds, the main challenges in encouraging fisheries were a lack of convergence across key line departments and a lack of training or knowledge. GIZ bypassed interdepartmental coordination issues creatively (See section on 8.1.5 Innovative solutions to barriers) and enabled state-level meetings that culminated in the formation of a fisheries technical resource cell using funds from the MGNREGA district contingency fund. This was a major win and a big step towards the expansion of fisheries work. The training component on fisheries was similarly creatively handled. The fisheries department did conduct one-time trainings on fisheries, but it limited its outreach to the Sahni-Malla community, who traditionally practiced aquaculture. Instead, GIZ adapted and repurposed fisheries manuals from the Indo-German Sustainable Aquaculture for Food and Livelihood (SAFAL) project in Assam that served as a model for Araria, with a focus on individual ponds.[4] Community resource persons (CRPs) for ERADA were selected by a committee of members from the fishery department, JEEViKA and NREGA. CRPs had to have been engaged in fisheries activities themselves, and these CRPs were trained by Kaling Kapoli, an Assam organization. The CRPs in turn provide extension services to community members who adopt fishery activities, in addition to the *matsya sakhi*, a JEEViKA cadre that has recently been established to support aquaculture activities.

At present, households engaged in aquaculture typically have ponds of around 1-5 *bighas*, surrounded by fruit and timber trees. They either purchase seeds (*jeera*) or fingerlings, and typically purchase three different varieties that include top, middle and bottom feeders to avoid competition for food. The feed itself is made at home from wheat flour, corn flour and mustard oil. Households have existing relationships with traders, who offer a flat rate for the fish (~INR 200-250/kg) once they have reached maturity.

The main challenges for further development of aquaculture activities are the need for quality seed and good local hatcheries, the regular draining of ponds every few years to remove the

[4] Under the SRLM, JEEViKA was already partnering with MicroSave Consulting and WorldFish to develop community models of aquaculture that could be seamlessly adopted by Producer Groups.

silt, and the provision of credit and technical inputs. Despite the lack of a fish FPO, which would be beneficial to scaling up this work, markets are not viewed as an issue – there are daily *haats* (local wet markets) in Raniganj and Araria, weddings and other festivals generate high demand, and there are also local traders who visit farmers directly.

The role of the MGNREGA in Raniganj is limited to the construction and maintenance of the farm ponds. According to the fisheries department data, there are about 5000-5500 farm ponds in Araria of which 70% are MGNREGA ponds. However, while the MGNREGA guidelines differentiate between ponds for protective irrigation, for water conservation or for fish at the community level, they do not do so for individual assets. There is also a need for clear construction guidelines to be developed keeping in mind the end use of the pond. For example, ponds designed for aquaculture need to have the correct slope to allow fish to rest periodically – these design elements can be integrated into MGNREGA guidelines.

7.4 Green shoots: Introducing mango plantations in Masaliya, Dumka

Although part of a belt that grows mangoes, Dumka district in general, and Masaliya block, in particular, does not have well-established mango plantations. ERADA's partners in Dumka, SUPPORT, had been working to establish mango plantations since 2006, partnering with the National Horticulture Mission, NABARD and the Cluster Facilitation Team (CFT) to set up 2000 or more acres of mango plantations in Ramgarh and now in Dumka, with a focus on improving marketing linkages and enhancing income opportunities for farmers. The Harit Gram Yojana, a program of the horticulture department and MGNREGA, supports mango orchards in the state.

SUPPORT conducted outreach programs with job card holders and SHGs to persuade them to take up mango orchards, conducted field verification of the suitability of farmers' lands for mango plantations, assisted with formal applications to the MGNREGA program and coordinated with block officers to solve farmer issues. The three main activities were capacity building, training and on-field support. To apply for a MGNREGA mango plantation, the beneficiary must have at least 1 acre of land with appropriate slope and a source of water close by. The guidelines then allow for 122 mango saplings in 1 acre, or, if they go for mixed plantations, 56 mango, 56 guava and 80 timber trees. GIZ and SUPPORT are actively promoting intercropping in the mango plantation – this serves the dual purpose of ensuring the farmer visits the plantation site regularly and monitors tree health and growth, while also providing short-term returns even as the mango trees are maturing.

Though the Malda mango variety is preferred by farmers for its high demand, it is the Amrapali and Mallika varieties that are being provided under the MGNREGA, both because they have thicker skins and damage less easily during transportation, and because the trees don't grow as tall, making harvesting easier. Another advantage of the Amrapali is that it ripens later in the season, so does not compete for attention with other varieties.[5] However, the marketing of the mangoes appears to be a bit of a weak link - since this is not traditionally a mango producing area, there are not a lot of local traders, and the market will have to grow alongside the value

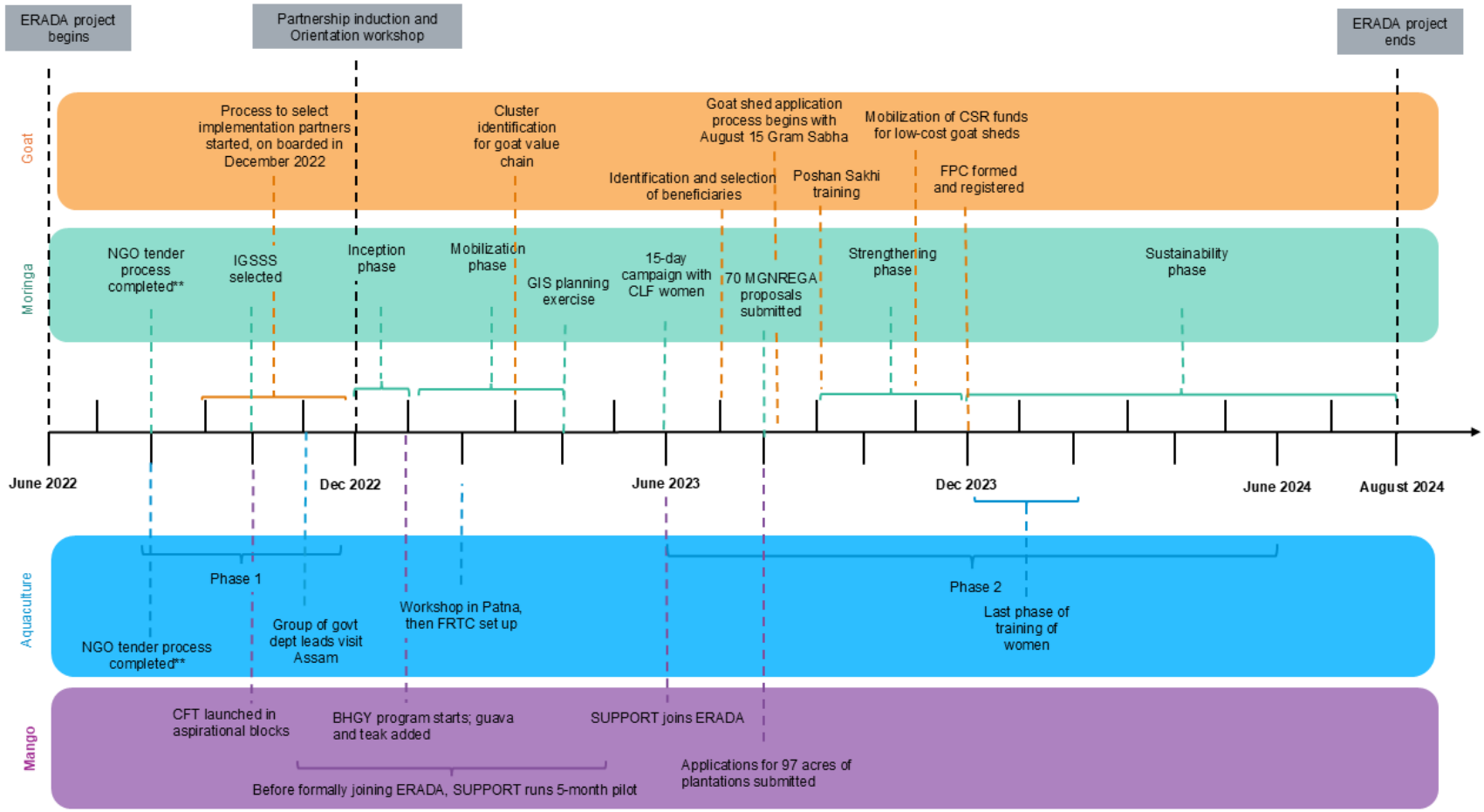
[5] In our field visit, we found that farmers had flexibility in choosing the variety they preferred, with some growing Malda and others adopting the recommended varieties.

chain. Our visit to the local markets and to the Dumka *mandi* informed us that mangoes still come from West Bengal or neighboring regions, with traders exhibiting limited supply or awareness of locally grown mangoes. So far, there is also no provision for training on postharvest practices as none of the plantations have reached that level. There is a need to identify solutions for both marketing and training on post-harvest practices, which could include cooperatives of mango farmers as have been set up elsewhere in the state.

Since many of the beneficiaries are new to mango plantations, the training and capacity building component is crucial. Here we saw a role also of GramVaani advisories, which SUPPORT members (and some beneficiaries) said worked well, and on occasion even faster than the CRP or the Gram Rozgaar Sewak.

MGNREGA plays a very big role in supporting mango plantations – not only does it provide for the costs of labor to prepare the land, fill the holes and plant the saplings, it also covers all other costs of maintenance for three (now five!) years, including the cost of bio-fencing, cattle trenches etc. This is crucial, as while the returns to mango plantations are impressive, the upfront costs of setting up a 1-acre mango plantation are extremely high at INR 3,77,000. This is unlike goat rearing or even moringa plantations, where entry barriers were far lower. Only the richest beneficiaries would be able to afford to set up their own mango plantations without support.

Figure 2: A timeline of ERADA interventions



Source: Authors' elaborations based on field data and conversations with NGO and other partners.

8 RESEARCH FINDINGS

8.1 Value chain formation strategies and lessons: A synthesis

The case for interventions in value chains usually rests on the fact that despite the requisite preconditions, certain missing ingredients prevent these value chains from developing. These may be gaps in technology, lack of strong institutions, missing markets, and so on, thereby justifying interventions to enable value chain formation. In other cases, value chains may have developed but are not sustained or upgraded on account of certain "pain points", stemming from many potential constraints. We now synthesize our observations from the four case studies from a value chain perspective.

8.1.1 Interventions for value chain formation

Our key question is whether these value chains would have evolved without external animators or catalysts. All four cases represent value chains that either did not exist or did not have a commercial orientation, i.e., households' pursuit of the activity was multi-functional and devoid of scientific or systematic practices, rather than an enterprise model motivated by profits and focused on productivity. In all four cases, the value chains of interest are unlikely to have developed or upgraded organically even when the preconditions existed.

In Sirohi, the key issues identified as potential intervention entry points were better herd management practices and health care that would lower goat mortality and increase live weight for the market, along with collective marketing of live animals. Most farmers here sold goats sporadically and did not explicitly "grow for the market". To do so involves the establishment of an ecosystem of supporting actors and institutions such as veterinary care at the doorstep and a coordinating mechanism for aggregating goats for sale.

In Khandwa, too, the double-duty potential of moringa to tackle malnutrition among the community and generate income as a cash crop, remained unexplored, despite the suitability of the crop and the proximity to large markets such as Indore city. The perception that moringa pods were bitter and the lack of awareness of the potential of a market for moringa leaves were key barriers for the evolution of a moringa value chain.

In Araria and Dumka, the high fixed costs of establishing fishponds and mango plantations offer significant entry barriers to marginal farmers; another barrier was the lack of technical training or knowledge. In both contexts, market linkages do not (at present) constrain uptake. Yet, farmers were not taking up these activities due to limited awareness of these opportunities and the formidable investments upfront. In each case, therefore, value chains were unlikely to have emerged organically, and the impetus provided by the NGO partners and ERADA was critical.

8.1.2 Tackling tradeoffs, aligning incentives in value chain selection and development

Often promoting value chains and market development can come at a cost. There are instances globally of value chain development leading to adverse environmental consequences, including deterioration in soil health and water depletion, loss of biodiversity. In others, market development can undermine nutrition when growing for markets crowds out home consumption. These can be particularly damaging in fragile ecological contexts where malnutrition is a problem.

In general, it seems that in each of the value chains promoted under ERADA, the set of interventions were eminently appropriate for the context.

In Sirohi, goat rearing catered to the low landholdings and limited capital of the target population, especially using common property resources for grazing. Initially, we were concerned that goat rearing for sale (rather than consumption) would threaten local food security. However, goat rearing households seldom consume meat from the goats they raise and would instead buy locally. It seemed that this would continue to be the practice, with sales in the market being conditioned on the availability of animals. By some accounts, lower mortality and morbidity, expansion of herd size, faster weight gain and frequent twin births of the Sirohi breeds ensured that market sales would not crowd out local consumption. One stakeholder noted that *"goats are ATMs: Any time milk, any time money".*

In the case of both plantation models, the varieties being promoted were the result of thoughtful deliberation: PKM-1 and ODC-3 to permit the dual leaf-pod model for income generation as well as overcome taste barriers in the case of moringa, and the selection of Amrapali and Mallika varieties of mango in Dumka to account for spoilage and for the timing of mangos in the market. Moringa in Khandwa was also an excellent choice given the level of malnutrition in Khandwa.

In both aquaculture and mango orchard cultivation, intensification has not come at the cost of diversity. In aquaculture, not only are multiple species encouraged, but models also combine aquaculture with *makhana* and encourage the growing of trees on pond boundaries. In mango, apart from promoting mixed orchards, agroforestry (including boundary plantations of Indian rosewood (*sheesham*), among others) was also one approach. Further, to ensure that beneficiaries were still able to earn incomes in the short run during the gestation period of the plantation, the ERADA partners encouraged farmers to intercrop horticultural crops in the moringa and mango orchards.

In Araria, a noteworthy decision the ERADA partners took early on was the choice of fishponds on private lands. In their preliminary exploration, they noted the substantial challenges that the Government of Bihar was facing in reviving community ponds and handing them over to women's SHGs for aquaculture activities. By all accounts, barring a few exceptions, disputes over control of ponds and usufruct rights, the presence of encroachments made this effort a non-starter. ERADA's partners sidestepped these apparently insurmountable challenges by opting for a path that had a higher probability of success.

Finally, across the four sites, ERADA partners were able to leverage pre-existing or new government schemes that aimed to support the specific value chain, Nandan *Falodyan Yojana, Devaran Yojana*, Pradan Mantri Matsya Sampada Yojana, Birsa Harit Gram Yojana, etc., to name a few.

8.1.3 Combining technology with social and institutional investments

Successful value chain interventions often involve a combination of inputs or socio-technical bundles, that combine technological with institutional innovations, and the fact that interventions that focus on one without the other are unlikely to work. ERADA's interventions across the value chains offer useful examples of such innovation bundling.

At least two of the value chains center on specific breeds or varieties. In Sirohi, a key focus was on the replacement of the local *kaali peeli* breed with the pure bred Sirohi that is hardier and has greater commercial value. In Khandwa, the introduction of new varieties of moringa – ODC-3 and PKM-1 - was pivotal. These varieties allowed for cultivation of both pods and leaves and importantly the pods were more palatable than the earlier variety, contributing to community acceptance. In the case of both aquaculture and mango, scientific pond and farm management and production practices were the route to transitioning to intensive commercial farming.

These technological inputs were, however, not provided in isolation. In each value chain, the ERADA partners focused on two broad types of social and institutional investments as well. First, they emphasized the **creation of local capacity through formal and informal training and building networks within communities**. The training component varies greatly in each but shares common goals. In Sirohi, a cadre of "barefoot" extension workers, the *Pashu Sakhis* or *Pashu Mitras*, most of them women from the community, function as the first point of contact for goat rearers, providing vaccination services and ethnoveterinary advice for a small fee. In Araria, CRPs selected by an interdepartmental committee receive training on fish rearing but also specifically on home-based feed production, fish care and treatment, and serve as a support system for new adopters of aquaculture. They work alongside existing institutional cadres established by JEEViKA, the Bihar Rural Livelihoods Promotion Society (BRLPS). In Khandwa, strong partnerships with the KVK have enabled training both on moringa plantations as well as on nutritional aspects, while the SHGs and their federations play an active role in community mobilization. Finally, in Dumka too the provision of training on technical aspects of mango cultivation is key, with GramVaani playing a strong role alongside the CRPs and the GRS. In most cases, efforts have been made to ensure that these workers have the monetary incentive to continue undertaking these tasks via the fees they can charge for their services. In other cases, fostering linkages with local entrepreneurs and the proposed establishment of learning or resource centers enable support to producers. In Araria for instance, a progressive aquaculturist and makhana processor has been identified as a potential focal point for an aquaculture producer group. Importantly, he has shown himself to be willing to act as a community resource.

Second, in virtually all cases, ERADA partners made **a systematic effort to use, strengthen and/or create institutions** such as FPCs, SHGs, and their federations, such as the CLFs. These are important complementary investments to ensure that the value chains formed have entities

that take on the roles of representing and strengthening producer interests, expanding participation and scale of operations, and sustaining momentum in the medium and long term. In some cases, these institutions also undertake value chain activities, such as input retail and aggregation, grading, sorting, processing and marketing, to ensure that there are no missing links in the value chain. For example, in Khandwa's moringa intervention, the Ona Mashi FPC established processing activities for moringa leaf powder, centers for producing bio-inputs such as vermicompost, and a platform for the sale of these products.

8.1.4 Adopting flexible models

A key feature across the four cases is the adoption of a pragmatic approach that privileges flexibility over fixity/formula. This is evident in the following instances.

Across value chains, notwithstanding the focus areas for intervention, the ERADA partners have maintained a balance in focus on production versus marketing. The possible exception is mango, where the value chain is in a nascent stage, but here too the ERADA partners are aware of the need to develop a marketing strategy. In some cases, such as moringa, buyers have been found because none existed. In others, the ERADA partners have sought to align value chain activities with the existing system, forging and strengthening relationships with local traders rather than trying to start over. For fledgling value chains, this is a useful starting point for learning how the markets work and grow, before seeking other midstream buyers or embarking on direct marketing, for example.

Another noteworthy feature is the relative flexibility of models. In goat rearing, for example, the herd size can vary significantly based on household resources, and the use of common property resources for grazing allows for great flexibility. In the case of moringa, models were adapted to allow for backyard cultivation in small spaces as well as larger scale cultivation on a plantation basis; yet even in the plantations, trees were spaced to allow for intercropping with horticultural crops. In the case of aquaculture, ponds that silted up could continue to be used for *makhana* cultivation, which permits also the cultivation of local *desi* varieties of fish, which can coexist with the *makhana* plants. The sides of the pond could also be productively used to grow fruit and timber trees, yielding additional returns. Even though the MGNREGA guidelines do not provide for ponds for aquaculture, including the slope and the provision of inlet/outlet pipes, GIZ and its partners had successfully adapted these models using FarmHub's input. Only mango plantations were somewhat strict in scope and exclusionary due to their high start-up costs and multiple requirements for acreage, irrigation source and so on; yet even here, the models were adapted to accommodation intercropping with horticultural crops for short-term returns. Mixed plantations allowed beneficiaries to grow different varieties of fruit trees alongside timber (teak), though most beneficiaries preferred mango orchards.

8.1.5 Innovative solutions to barriers

As mentioned earlier, one motivation for an interventionist approach for value chain development is on account of certain entrenched barriers that prevent these value chains from emerging and thriving organically. Even if these "pain points" are addressed, other challenges could thwart their sustenance.

In Sirohi, where ERADA partners were keen to strengthen the goat rearing FPC that would ensure the continuity and sustainability of goat rearing, a key barrier was that beneficiaries, predominantly women, could not become members of the FPC. Membership in FPCs by law required women to be farmers, evidence of which was land in their own name. Thus, FPC membership for goat rearing women was contingent on several documents: bank details, aadhar card, passport photos and most of all the *jamadaani*, or land record. However, it is extremely rare for poor tribal women in the block to own land. To overcome the formal regulations on land titles (and to ensure that no one person or organization was held responsible for circumventing the formal processes), an ad-hoc committee was formed with members from the departments of agriculture, animal husbandry, formal sector banks, NABARD and others. This committee would provide a document vouching for their status as farmers, and thus enable FPC membership.

In Khandwa, community acceptance of moringa was a big initial challenge to improving take-up. Earlier varieties of moringa had proved bitter and community members were reluctant to grow the trees. The lead NGO in Khandwa, IGSSS, ran a campaign, *Moringa Mahotsav*, to bring together KVK Khandwa, MGNREGA, SRLM and other stakeholders and to improve take-up. When this campaign was only moderately successful, they realized more had to be done, and ran a second more successful campaign some six months later. This second campaign, *Har Ghar Moringa,* directly involved community members and leaders through the local cluster-level federations and SHG members and led to widespread community acceptance.

In Araria, there was a lot of scope for interdepartmental coordination on aquaculture – between the BSLPS and Jeevika, the MGNREGA, the department of fisheries and so on. However, it proved very difficult to overcome coordination challenges between these government organizations. As a relative outsider, the state GIZ lead, Mr. Vivek Anand, was in a unique position to facilitate convergence. He did so by issuing invitations to key state stakeholders to a trip to Assam to study and learn from the SAFAL model, which they believed could work well in Araria as well. This trip brought officials together very effectively. The convergence was sustained through a follow-up workshop in Patna, after which a fisheries technical resource cell was set up with resources from the MGNREGA district contingency fund.

Other barriers were also discussed, some remained without resolution.

In Dumka, for example, GIZ and the lead NGO acknowledged that being the first mango plantation cluster in an area that did not traditionally have mango orchards, established buyers did not exist. However, the system of pre-harvest contractors and retailers already existed in neighboring areas and Dumka city, respectively, who were potential buyers, who could absorb all that was produced in the cluster.

A longstanding feature countrywide is that line departments do not coordinate well with the fisheries department. Convergence initiatives as part of the reformed MGNREGA 2.0 in the 2010s were promoted to address this issue. Reflecting a continued divide, in Araria, the fisheries department did not speak to MGNREGA and had their own target beneficiaries – members of the Sahni-Malla community, owners of much larger ponds and so on. ERADA's priority was poorer beneficiaries, so they essentially created a parallel system to that of the fisheries department.

Another interesting barrier was articulated by the members of the Jalpari producer's group in Araria, who complained that they did not make any profit because so much money went towards the biofloc that kept malfunctioning. This seemed to be an instance where a top-down effort to promote biofloc stood at odds with the sustainable value chain development. Here the beneficiaries had independently resolved not to invest in a biofloc in the future. They had also agreed collectively to opt for lower cost alternatives to fencing and to disengage from the relatively less profitable duck rearing that had been integrated into their aquaculture activities.

The PIM exercise in Sirohi and in Khandwa highlighted that it was community members themselves who erected barriers. In Sirohi, participants said that initially others in the village would try to demotivate them by saying that their land will be taken away or they and their future generations will be in debt because of the help they are receiving presently, though this changed once they saw the returns to goat rearing and the usefulness of the goat sheds. In Khandwa, community members discouraged beneficiaries from participating in moringa, which was a new activity, saying that this was a waste of time and would not be profitable.

In Sirohi**,** participants said the Central government was one such figure who could erect barriers, explaining that the delays in payments constituted the single biggest hurdle to the construction of goat sheds under the MGNREGA. The block-level PIM was very helpful in shedding light on informal workarounds to roadblocks in the formal processes. Here the discussion on actors and processes suggested that each panchayat had a fixed private contractor who supplies material to individual beneficiaries. The beneficiaries get the manual work done by labor that is paid a wage from the MGNREGA, but the payment for materials (cement, sand, tin sheet for the roof and so on) goes to the contractor's account.

Box 1: Champions and catalysts

In many resource-constrained contexts, development projects rely heavily on champions – actors whose commitment to project's goals are not tied to their own returns from the effort – and catalysts, whose presence animates the value chain. Across the four sites, we witnessed individuals and organizations who served as champions and catalysts.

In Sirohi, for example, the NABARD representative was instrumental in establishing the ad-hoc committee that waived the land ownership requirement to become FPC members (see the section above on *Innovative solutions to barriers)*. He noted that such barriers are more easily solved via concerted action by a group, since individuals may be reluctant to act on their own. A livestock scientist himself, his commitment to building institutions that would sustain the intervention beyond his term in office at Sirohi, is noteworthy.

In Khandwa, Dr. D. K. Vaani and Dr. Rashmi Shukla of the KVK Khandwa were strong proponents and supporters of the new moringa value chain. Dr. Rashmi Shukla, trained in Home Science, was an advocate for the nutritive properties of moringa. Through the KVK's efforts, *laddoos* fortified with moringa powder were produced in Anganwadis and distributed to children, with positive impacts. The trials on moringa at the KVK were initiated by Dr. Shukla out of her own interest.

In Araria, Besra Pradhan was the ideal catalyst for community adoption of aquaculture. His ponds were large and well-maintained, and his operations were on an impressive scale. He had also invented labor-saving machines such as the *makhana* harvester, that can do the work of 50 laborers at about 25-30% of the cost. Besra ji has expressed his willingness to act as the fulcrum for a producer's group and to provide technical advice and assistance to members of his community.

All the NGO staff we met are themselves both champions and catalysts, driving these interventions with their enthusiasm and dedication. For example, in the case of mango plantations in Dumka, the BPO in Masaliya was very clear that it was because of SUPPORT and ERADA's work that mango plantations had emerged as a viable livelihood alternative. He urged them to continue building capacity and providing their support.

(continued): Champions and catalysts

There are many everyday champions as well, such as the women trained to be community resource persons. Not only do they provide assistance to their communities on a daily basis, but they also have to battle community resistance to their participation in the value chain activities, as Khushi Devi, the Pashu Sakhi in Kalabol village in Sirohi articulated. Similarly, women like Leela bai and Kesar bai in Khandwa also provide inspiration for their fellow women community members.

These are but a few examples of champions and catalysts we encountered. There are likely many more. Ultimately, the presence of such individuals can alter the fortunes of an intervention. A key lesson is therefore to ensure that interventions such as this proactively identify and engage such champions rather than leave their emergence to luck.

Thus far, we have focused on specific aspects of value chain formation and strengthening. We now focus on programming and processes. ERADA's premise was twofold that the MGNREGA works can be the foundation for building livelihoods by community-based organizations and that this is best achieved in partnership with and cooperation of the state and via better convergence across state departments.

8.2 The MGNREGA pathway

Given that the overarching goal of ERADA was to build on MGNREGA's foundational work of creating assets, what do these four case studies reveal about the potential of this approach?

Our PIM exercise revealed that the strength of the MGNREGA pathway relative to other ways of requesting assets varied across value chains. Recall that in Sirohi, PRADAN and CMF had already been working on goat value chains before the ERADA project, largely disconnected from the MGNREGA. For goat sheds in Sirohi, for example, participants of the PIM we conducted at the block level estimated that only 5% of all applications for assets are made via MGNREGA, while more than 90% come from CSR funds, facilitated by the supporting NGO. Goat sheds, they noted, have a considerable material component and material payments via the MGNREGA program have been very delayed. Here, ERADA's efforts were to animate the link between the MGNREGA and goat rearing. Several new applications for MGNREGA goat sheds had been made in 2023 in addition to the pending applications from 2022, but with no success at the time of our visit.

MGNREGA played a much larger role in enabling moringa plantations in Khandwa. There were two schemes under which beneficiaries could apply for plantations – the MGNREGA *Nandan Falodyan Yojana*, which supports individual plantations with priority to SC and ST households, widows and the disabled, and the *Devaran Yojana*, that supports community plantations. The

Devaran Yojana is linked to the Ayush department and aims to revive forest medicines and crops. In Khandwa, the MGNREGA successfully converged with the horticulture department to ensure the provision of seedlings and other inputs. Though the CSR pathway was acknowledged, participants said CSR funds were mostly used for backyard cultivation and not for larger scale plantation work.

In the case of aquaculture in Araria, most farm ponds used to raise fish were acquired via the MGNREGA – this included both newly constructed ponds as well as older ponds that had been revived. ERADA partners estimated that approximately 70% of the 5000-5500 ponds in 211 GPs of Araria had been acquired through the MGNREGA channel; the remaining 30% being a mix of older preexisting ponds, fisheries department ponds and ponds constructed using beneficiaries' own money. As noted before, though, the designs of MGNREGA farm ponds in the block were not specifically tailored for aquaculture and therefore did not allow for an inlet and outlet pipe. GIZ and its partners modified the materials from the Assam SAFAL model with the input of FarmHub, including these aspects while simultaneously contextualizing the advice to Araria.

In Dumka, the cost of setting up a mango plantation is between INR 3,00,000-4,00,000, an amount that none but the wealthiest farmers can afford, rendering the MGNREGA the only viable pathway through which mango plantations could be acquired. The MGNREGA is a very significant help on this front, heavily subsidizing the cost of the mango plantation for the first three years (now increased to five years), the period when the bulk of the expenditure on the plantation is incurred. The MGNREGA covers the cost of the saplings, of fertilizers and other inputs, of fencing and cattle-proof trenching, and of land preparation and planting. In our PIM, the BPO observed *"The MGNREGA has made mango plantations possible for small farmers"*. The BPO added that in turn it was because of SUPPORT that this was possible.

It is worth noting here contrasting experiences with MGNREGA construction norms. In Sirohi, where the reliance on the MGNREGA was low, ERADA partners designed and constructed low-cost goat sheds. Those prescribed by the MGNREGA were high-cost models that could ostensibly accommodate both cattle and goats, though their designs were on occasion even deemed suitable for homes for the beneficiaries.[6] The high implicit subsidies offered by MGNREGA in goat sheds is less preferred to affordable goat sheds. In contrast, in aquaculture and mango plantations, the MGNREGA represents a large implicit transfer, and few alternatives/ outside options exist for lower cost fishponds or plantation establishment.

8.3 Navigating partnerships- operationalizing the project

In many developing country contexts, institutional and capacity constraints thwart development, and competition over scarce resources precludes effective partnerships and coordination across departments and organizations. A rich literature notes the many problems with implementation. This failure to fully take advantage of partnerships is also the case with the MGNREGA, where

[6] The Mahatma Gandhi NREGA guidelines allowed for the construction of a concrete four-walled structure with one small window relatively high up in the wall. The flooring is also made of concrete. Not only does this design not allow for ventilation, but the hard surface of the floor also wears down goat hooves. Instead, the low-cost model developed by ERADA partners has a beaten earth floor, which is better for the goats, and is open on three sides for plenty of cross-movement of air.

all too often, different departments operate in silos and remain reluctant to come together to collaborate. A network of vested interests often impede the implementation (ESID, n.d.). Given the complexity of the value chains being studied and the need to effect coordination across a diverse set of interests and interest groups, we need to understand how stakeholders navigated this complex terrain.

8.3.1 Partner selection and presence

The process begins with careful selection of NGO partners in each area, and here, ERADA really excelled. In Araria, even though aquaculture was a relatively new area, and partners did not always have prior experience in fisheries, they brought with them a wealth of other relevant experiences and skills in livelihoods development. For example, one NGO member mentioned their past work with an Infrastructure for Climate Resilient Growth (ICRG) project that focused on strengthening the Gram Sabha and linkages to the MGNREGA, including the design and function of MGNREGA assets. ERADA provided the obvious next step, of linking these assets to livelihoods. The learnings from the ICRG project were integrated at the state level and imbibed into asset selection and construction. In both Khandwa and Dumka, ERADA partnered with strong organizations that had been working in the select value chains already, raising awareness, improving community acceptance and building individual capacities to manage the assets, always with a strong emphasis on livelihoods. The same is also true of Sirohi, where the partners had been present for almost a decade and had been engaged in the goat value chain already.

8.3.2 Prior investment in institutions

A lot of the work across sites is built on prior investment in institutions. The MGNREGA has been in place in the study areas since the first phase of the program in 2006, almost 20 years ago, and is a well-established social safety net. Of course, the utilization and performance of the MGNREGA was not uniform across these locations either over this 20-year period or in the more recent histories (as Table 4 above shows), but the fact remains that the program provided an excellent platform through which to provide assets that could complement other investments in these select value chains.

Similarly, in Khandwa and Araria especially, the National Rural Livelihoods Mission (NRLM) and its state counterparts under the various State Rural Livelihoods Missions (SRLMs) were the obvious partners to this work, greatly enabling the targeting of rural women. The NRLM was established in 2011 as a restructured version of an earlier program, and is implemented in each state, with contextual variations, by the different SRLMs. The strength of the SRLMs also varies. JEEViKA, the program in Bihar that anchored much of the work on fisheries, is a particularly strong rural institution. However, even in Khandwa, where the SHGs and their federations are perhaps not quite as strong, the ERADA partners made full use of linkages to the SHG women in establishing the Ona Mashi FPC and enhancing community uptake of interventions.

8.3.3 Actors, their interactions and influence

We draw on the PIM exercises described above to generate insights into the types of actors involved in each value chain and their relative influence in the process of acquiring assets. The graphical representations of all the PIMs are in the Appendix Figures 1-8.

There was considerable variation across field sites in the set of actors named in the PIM exercises and the role of line departments in supporting asset construction. In Sirohi, as mentioned above, there was a strong role of private CSR funds routed through and facilitated by PRADAN and CmF. The role of collective organizations like the SHGs and their federations was less prominent in comparison, and the department of animal husbandry did not feature explicitly. In contrast, for moringa plantations in Khandwa, the horticultural department and KVK Khandwa were identified as key actors.

In aquaculture in Araria, the fisheries department had a role, but it was not as central as that of the women's SHGs and their federations. In Dumka, convergence between the department of horticulture and the MGNREGA was limited to the provision of drip irrigation in select cases; for the most part the provision of saplings came via a state-selected registered vendor and not from the horticulture department. Much of the training on mango plantations was led by the supporting NGO, SUPPORT as part of the Cluster Facilitation Project. While there was scope for greater convergence with the department of agriculture for support in training and inputs for intercropping in the plantations, this had not materialized in any significant way at the time of our visit.

The differing role of actors across intervention sites appears to be a combination of several factors: (1) the supporting NGO's relationship with the line department and the initiative they have taken to design effective collaborations, (2) pre-existing strong institutions, such as the SHG movement in Bihar, and (3) the feasibility with which line departments can function within the MGNREGA processes. For example, the delays in material payments have rendered the MGNREGA pathway almost non-functional in Sirohi, limiting opportunities for effective convergence; similarly, the use of a state chosen registered vendor for saplings in Dumka bypasses the horticulture department altogether.

Box 2: Process of pond construction for aquaculture in Raniganj, Araria

This box illustrates a single PIM exercise, taking as an example the block-level mapping of the processes involved in constructing an aquaculture pond, as conducted with members of the supporting NGO and VLRPs in the block office. The corresponding PIM is depicted graphically in Appendix Figure 5.

Participants identified four main pathways: through the Mahatma Gandhi NREGA, through own funds, through JEEViKA, and through the fisheries department. Each of these pathways are discussed in detail below.

I. Mahatma Gandhi NREGA pathway

Any woman who wants to get a fishpond built will first express her interest in fish farming to the SHG and ask the SHG to help her with a formal application. The SHG Community Mobilizer puts the woman in touch with the VLRP, who gives her the information on the set of documents needed and the eligibility criteria for a pond (mainly the land requirement) and helps her prepare a formal application.

The VLRP then takes the application to the JEEViKA Block Programme Implementation Unit which verifies everything is in order and passes the application to the Mahatma Gandhi NREGA office. The Mahatma Gandhi NREGA Junior Engineer, Panchayat Technical Assistant and the Panchayat Rozgar Sevak (known as the GRS in other states) visit the potential beneficiary's homestead to verify the availability of land of the correct slope and kind of soil. They have the power to reject the application at this stage if the eligibility criteria are not met. After the full inspection, they report back to the Mahatma Gandhi NREGA.

If amount required is greater than INR 500,000, then permission is needed from District Program Officer. If not, the project is approved by the Mahatma Gandhi NREGA, and this approval is forwarded to the District Program Officer. Once official sanction is received, the muster roll (worksite attendance sheet) is prepared, laborers are informed about the opening of the worksite, and work begins. The Panchayat Rozgar Sevak and the Junior Engineer inspect the work at regular intervals. Payment is released to workers as the work progresses.

(continued): Processes of pond construction for aquaculture in Raniganj, Araria

II. Own funds

There are two channels for training and extension services: one via the *Matsya Sakhi*, who provides information about land size, pond construction and maintenance. The other is the Rural Self Employment Training Institute, an initiative of the Ministry of Rural Development with dedicated infrastructure in each district of the country to impart training and skill upgradation of rural youth geared towards entrepreneurship development. This Institute can also provide information about fish farming. Once the farmer has the technical information this pathway is straightforward: a beneficiary who has the resources can pay for labor or machines to dig their own pond for aquaculture.

Side note: An interesting nugget that came up during discussion of this pathway was that farmers using their own funds will sell the and are thus able to recover some of their cost. It is unclear what happens to the mud during the construction of Mahatma Gandhi NREGA ponds.

III. JEEViKA

This pathway begins in much the same way as the Mahatma Gandhi NREGA pathway: women interested in pursuing aquaculture inform their SHG and the Village Organization. At the CLF level, there is a Representative of General Body meeting where each VO is represented by two members, and which deliberates on the applications received. One week after this, the Board of Directors meets and approves the applications recommended by the General Body. Once approved, beneficiaries are sanctioned an amount of money to construct the pond from existing JEEViKA funds such as the Micro Credit Plan. If the need is up to INR 100,000, the money comes from the Village Organization, anything more than that amount comes via the CLF. VLRPs provide an overview of the number of women they have assisted in this process and overall work progress at the monthly CLF level review meeting. While about 100 applications have been made via this channel, only 10-15 have received RGB approval. In addition to women expressing interest, JEEViKA also identifies women who can generate income of at least INR 100,000; these women are provided training and handheld support.

(continued): Processes involved with constructing a pond for aquaculture in Raniganj, Araria

IV. Fishery department

The last pathway outlined was to receive the ponds through the fisheries department. Under this route, SC and ST households receive a 50-60% subsidy on the cost of the fishpond. All documentation of eligibility based on the guidelines are submitted to the fishery department, following which there is a verification by the bank, which sends representatives to visit the household. If the verification is without issues, the money is deposited into their bank accounts in instalments. Each instalment is accompanied by a monitoring visit to ensure the money has been used for the purpose it was provided. Technical training on how to manage and maintain the fishpond for aquaculture is provided first by SSEVS to the CRP and VLRPs, and then through them to the SHG women.

8.3.4 Differences between block and panchayat level perceptions of processes

There were three ways in which the block and panchayat level views of the processes involved in demanding assets differed, due both to their respective vantage points and to an asymmetry of information between those at the block and the panchayat level.

First, the number of pathways delineated differed: the block-level PIM exercise typically resulted in the articulation of a larger number of pathways, while the panchayat level exercise was heavily centered on the most common pathway, usually MGNREGA (except in the case of Sirohi). In some cases, those at the panchayat level were not aware that a particular pathway was available, let alone what processes were involved in accessing it. This insight was not restricted to “ordinary” beneficiaries, where one might expect a lack of information. In Araria, for example, a group of women JEEViKA SHG members who held CRP positions, as well as the position of the MGNREGA mate, did not know that funds to construct a fishpond could be requested through the fisheries department.

Second, there were clear differences in the articulation of formal processes beyond the block level. The block PIM typically contained a large amount of detail on technical measurement, formal sanction, and the release of funds, including on complex systems such as those instituted for the geo-tagging of MGNREGA assets. Unsurprisingly, much of this is a black box for respondents at the panchayat level, who usually described the chain of decisions till the level of the block office.

Third, the reported relative influence of actors also differed in interesting ways depending on whether the PIM was conducted at the block or the panchayat. From the block perspective, the centers of influence were the gram panchayat/gram sabha and block level officials like the BDO (or CEO in the case of Madhya Pradesh); reflecting an understanding of the way in which the act was envisioned and how formal sanctions operate. There were two exceptions to this: first, in Araria, where block-level PIM participants

agreed that the supporting NGOs, SSEVS and Change Alliance, had played a big role in raising awareness among women. Second, in Dumka, where the GRS was identified as playing an instrumental role, described as the mediator between the families of two people getting married.

In contrast, the PIMs at the panchayat level reflected to a large degree the role of "power brokers", individuals and collectives that helped beneficiaries negotiate the complex processes of application and approval. These typically included the supporting NGO and the SHG and its federations. In the case of Araria, the PRS was mentioned as being influential as he is responsible for preparing and forwarding NREGA applications. In Dumka, the panchayat was also identified as having a considerable amount of influence over the process.

8.4 Women-centricity

We noted at the outset that we are particularly interested in the place of women in these interventions. What are the ingredients of the four interventions that enable women to be included or excluded? How are women incorporated in these value chains and in which segments? To some extent the choice of commodities and the model of farming adopted make some value chains more inclusive of women than others; in other cases, the nature of the linkages (training, marketing) provided enables the inclusion of women.

As an example of the appropriate selection of value chain, goat rearing is traditionally undertaken by women who care for the animals and graze them. The choice of value chain and goat rearing in Sirohi therefore puts women at the heart of the intervention. In contrast, for the aquaculture value chain, while women care for ponds and feed the fish traditionally, many of the pond management practices or harvesting are undertaken by men, generally hired labor. The ERADA intervention, however, targeted women from within the SHG-fold, providing them with training on the technical aspects of fisheries. As a result of the interventions, women may have an enhanced role in decision making or higher executive agency, even if the existing gendered patterns of tasks does not change.[7] Indeed, an interesting example of women, asserting their preferences came in the Jalpari community fishery, mentioned earlier. In this case, women were provided with a farm pond, with ducks and fingerlings along with a biofloc facility. Though women were direct beneficiaries they had had little say in the design of the model. At the time of our visit, they had resolved to focus on fishery and abandon the biofloc facility and duckery. The moringa plantations in Khandwa also deliberately targeted women and engaged actively with women's SHGs. Lastly, for mango orchards in Dumka, beneficiaries of mango plantations had to show ownership of the land. Since women are not customarily landowners, the beneficiaries that we met with on our visit were predominantly male. However, these are early days. The fact that there is high outmigration of men and the requirement that orchards are proximate to the residence of the beneficiary are features that might enable the participation of women in the value chain as time progresses. Here, as in aquaculture, women are likely to retain executive agency or take on supervisory roles rather than engage actively in plantation maintenance such as pruning, etc.

As an example of the latter approach to enhancing women's roles, training and capacity building is often delivered to women, as mentioned above, and further extension is made available on or near the homestead through CRPs, often themselves female (*Pashu Sakhis, Matsya Sakhis, Bagwani Sakhis,* the GRS, Village Level Resource Persons (VLRPs) and others), limiting barriers that women could face

[7] Indeed, there is no need to assume that women taking on more of the tasks related to pond cleaning and harvesting of fish is an agency enhancing move, since women we spoke to did not seem keen to engage in these tasks. Being able to manage a business and outsource unsavory tasks is itself an exercise in agency.

due to mobility restrictions or domestic obligations. In a context where male farmers tend to benefit from extension and training (for example, fisheries department efforts in Araria), both selecting women farmers for training and the choice of women as extension workers explicitly creates a platform for women to participate as producers and as value chain actors. The same is true also for marketing, where linkages in all four value chains rely on farmgate sale and/or doorstep collection, an arrangement that is particularly suitable for women who typically are unlikely to engage in marketing activities outside the village.

Our PIM exercise further shed light on women as beneficiaries of assets as well as the larger role played by women and women's organizations in supporting ERADA activities, and indeed the value chains themselves. The prioritization of women beneficiaries was apparent only in the context of the moringa plantations in Khandwa. The *Devaran* scheme mentioned above explicitly prioritizes widows. Participants in the block-level PIM exercise in Khandwa also reported that the GP worked to identify women beneficiaries at the village level, rather than simply relying on women to submit applications of interest.

While the explicit prioritization of women beneficiaries was limited, the role and centrality of women was not, with women's collectives playing a key role in facilitating the asset demand process in all locations, with the possible exception of Dumka. In Sirohi and Araria, women's SHGs were explicitly listed as a separate pathway (though in Sirohi, only an estimated 2% of demand came via these collectives). In all locations, SHGs and their higher order federations (Village Organizations (VOs) and Cluster-level Federations (CLFs)) were identified as playing an instrumental role in consolidating demand from their members, representing this demand to the relevant functionaries and facilitating both the flow of information and the preparation of individual applications. In Khandwa, participants in the panchayat level PIM said that many women outside the SHG-fold had expressed an interest in joining SHGs or in enlisting the help of SHG members in submitting applications for moringa plantations, in recognition of the power of the collective in demanding entitlements. In Araria, too, participants in the panchayat PIM said women would not have been successful in registering their demand for farm ponds if the SHG had not supported their applications.

In Dumka, however, the role of women and of women's collectives is less prominent, for two reasons: first, as mentioned above, the beneficiaries of the mango plantation must be owners of the land, and women are typically not the listed landowners. Second, the women's collectives under the Jharkhand State Livelihoods Promotion Society (JSLPS) are not as strong as JEEViKA collectives in Bihar. Even here, though, the panchayat level PIM identified the SHG and the VO as strong actors in the MGNREGA pathway.

This section should not be taken to suggest that the ERADA interventions have successfully overcome all barriers to women's participation in value chains but should be viewed as indicative of GIZ and the partners' commitment to reaching and benefitting women (see Box 1 for more examples).

8.5 Resilience

One of the key concerns of the ERADA project was to build household resilience and enable households to earn a living income. Consequently, our research effort, at its core, had the goal of assessing the potential of the four value chains and associated ERADA interventions to deliver on this aspect. In this section, we discuss our findings. First, given the extraordinary challenges that climate change poses, we reflect on whether the value chains are themselves climate-resilient, and hence likely to support household ability to withstand climatic shocks. Second, we explore whether participation in these

value chains build household resilience by augmenting incomes and assets over the longer term in ways that reduce household vulnerability. As mentioned earlier, given the relatively short duration of ERADA activities and the nascency of some of the value chains promoted, our effort is to highlight the potential rather than assess impacts.

8.5.1 Climate resilience

Three features stand out amongst these interventions. First, the choice of commodities for value chain formation and development in some of these cases lend themselves naturally to forwarding the goal of resilience. For example, the Sirohi breed of goat is known to withstand climate extremes and thrive even in difficult conditions. It is also resilient to a variety of care practices. Moringa likewise is heat resistant and requires less water than other trees. Both are appropriate for the contexts for which they were selected.

Second, a critical component that promotes resilience is diversity in species or varieties both in pond or on farm and across landscapes, with greater biodiversity being linked to greater ecosystem stability, including resistance against disease and climatic shocks (Cardinale et al., 2012; Loreau & De Mazancourt, 2013; Sgrò et al., 2011; Yachi & Loreau, 1999). In the case of the mango and aquaculture value chains, both of which may be susceptible to climate shocks, the specific species chosen - Amrapali mango for the former; Indian Major Carps (IMCs), rohu, katla etc. for the latter - are not exotic, but hardy, and in the case of fish, diverse.

Third, each of these interventions allow the possibility for sustainable intensification at scale. In most of these cases, the model promoted by ERADA relies on sustainable intensification, selecting low-cost designs where possible, using local materials and low external input systems. In the aquaculture intervention, some beneficiaries no longer relied on store bought feed, instead preparing their own. So too with goat rearing. Even if there are high startup costs, animal care practices include a low-cost model that reduces feed costs; goats rely on pastures, not stall fed, local materials. In the case of moringa, the emphasis on the use of organic inputs that are homegrown (vermicompost, *jeevamrit*, five-leaf fertilizer etc.) also ensures greater climate friendliness.

8.5.2 Income/ Living income – Livelihoods – Returns /Cost-Benefit analysis

A key goal of the ERADA project was to establish sustainable livelihoods that can generate a stream of earnings that constitute living incomes, while strengthening household resilience. There are many conceptions of resilience and for the purpose of this paper, we focus on an intuitive definition of the term, avoiding the more ambitious definitions that support measurement.

We have already discussed elements of the intervention that are likely to reduce vulnerability of the beneficiary households. These include limiting household exposure to risk associated with the commercial enterprise through species or varietal diversity. A careful balancing of potential tradeoffs, for instance, in the case of malnutrition versus cash incomes for moringa, further contributes to supporting household resilience. To the extent that household resilience is also bolstered by the development of institutions, notably collectives such as SHGs and FPOs, ERADA activities contribute to what is now a well-recognized ingredient of resilience (Narayanan et al., 2023).

Despite these elements, the proof lies in the pudding. To what extent do these livelihoods generate incomes for beneficiary households that can serve to strengthen their asset base and invest in social and

economic capital? To answer this, we attempt to obtain ballpark estimates of the earning potential of each livelihood activity for the beneficiaries.

For each of the four cases we study, we compute three measures: (1) the Net present value (NPV) of the stream of returns from the asset, and the annualized NPV as a percentage of agricultural household's income based on the 2019 Situation Assessment Survey of Agricultural Households in India (GoI, 2021); (2) the Internal Rate of Return (IRR); and (3) the Benefit Cost Ratio (BCR), which estimates benefits per unit of costs. There are several limitations of this exercise, described in detail later in this paper.

Each of these assets has distinct features that merit attention. For example, mango orchards involve large initial investments and a long-life cycle of an estimated 30 years or more, with production peaking between 10 years and 18 years and declining thereafter. Here the initial costs outstrip the cost of routine maintenance and replanting.

For goat rearing, the dynamics of herd size due to the natural breeding cycle implies that, unlike other activities, given a fixed mortality and culling rate, and rates of self-use and gifting, the herd size expands over time. The female often has two births per year and a high proportion of these births result in twins. Yet, capacity constraints in terms of grazing land, size of the shed and women's time constraints might mean that many strive to maintain, rather than expand, their herd size. Our premise, based on our field visits, is that a typical goat rearer may wish to hold about ten goats

In the case of moringa, the choice of whether to grow in the backyard or as a plantation makes a significant difference to the stream of income it generates for the beneficiaries.

In aquaculture, in contrast to the other activities, the recurrent costs of maintenance can be very high. These include emptying out the pond, drying and undertaking repairs of the structure, including desilting and bunding. Yields and returns from the pond therefore depend crucially on pond management practices.

Despite the high fixed costs of entering these value chains, the fact that MGNREGA subsidizes these ensures that beneficiaries are not left indebted, a significant problem with smallholder commercialization. Beneficiaries need only to bear the comparatively low production costs. Figure 3 shows the program allocation for the closest match to our selected livelihood activities in these four blocks, using data from the MGNREGA MIS for the year 2023-24.

Box 3: Mahatma Gandhi NREGA asset designs

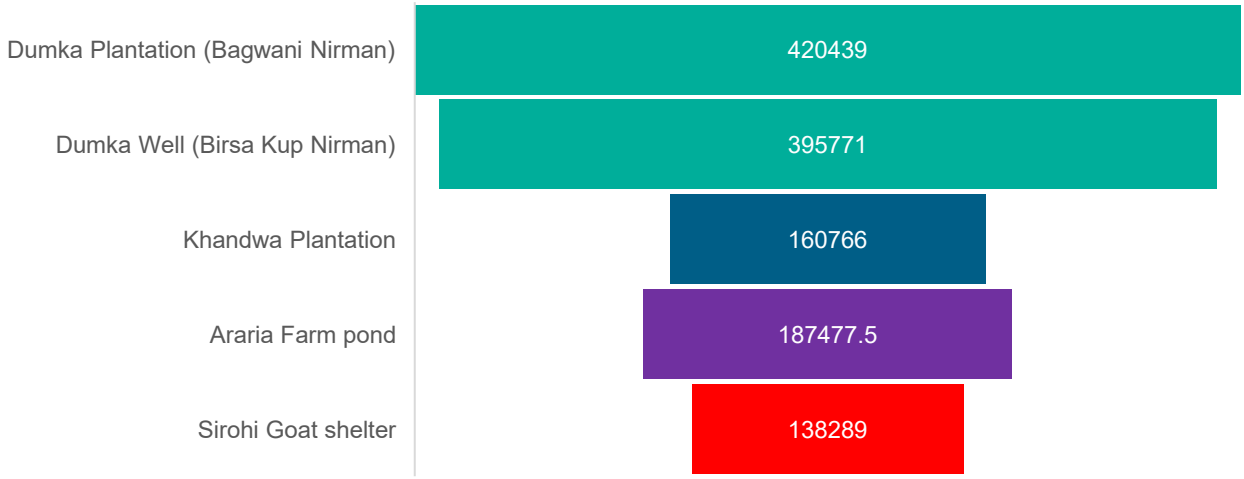
The Mahatma Gandhi NREGA has well established guidelines for the design and construction of assets, with inputs from experts. At the same time, it has been recognized that in some contexts there is significant scope to improve upon existing designs to either lower the costs associated with the asset or in terms of developing designs fit for purpose.

Across the four cases we found such instances. In goat rearing, we found that the guidelines for goat sheds are for dual purpose cattle and goat sheds, so they are larger and more expensive than the low-cost goat shed blueprints that the NGOs had developed. The materials used and preferred by most in these low-cost models were locally available. The guidelines are also in need of review: for the goat sheds, for example, the structure does not have adequate ventilation and has a concrete floor, which is not ideal for goat hoof health. Low-cost goat shed models with adequate specifications for animal comfort would greatly increase the useability of the structures.

In Araria's Raniganj, the inexperience of many beneficiaries was evident when they discussed some crucial mistakes they made when designing the pond. First, it did not slope to the pond and had vertical rise instead; the Mahatma Gandhi NREGA design did not have an inlet and outlet. It seemed that the Mahatma Gandhi NREGA did not make a distinction between a fishpond and a farm pond, a difference that new fisher(wo)men did not know either. It emerged that farm ponds under the Mahatma Gandhi NREGA are not explicitly designed for aquaculture. In that context, clear distinctions in design of farm ponds tailored to the purpose – for protective irrigation, groundwater recharge or commercial aquaculture – would be useful. Some training on the appropriate site /location for each of these ponds would also be useful to ensure that the investments are used well.

The experience with mango and moringa also suggests interesting possibilities for explicitly bundling Mahatma Gandhi NREGA assets as livelihood "start-up" package (for example, an irrigation facility with mango plantation, cattle proof trench and fencing or fish pond with community hatcheries and fish drying units) or differentiating plantations for nutrition versus for commercial development These would render Mahatma Gandhi NREGA more amenable to convergence and CSR initiatives or civil society action to strengthen livelihoods.

Figure 3: Estimate of MGNREGA allocation per asset for select livelihood activities in the study blocks, 2023-24 (in INR)



Source: MGNREGA MIS Table R.6.12, 2023-24

Table 5 presents the IRR, NPV and Benefit Cost ratios of the assets considered under different production models.[8] Given that each is tailored specifically for a context, it does not make sense to compare these numbers across value chains. In other words, these estimates should not be viewed as a head-to-head race for the winning value chain activity. Note too that these estimates are very sensitive to the many assumptions underpinning the analysis. Despite these caveats, the IRR, NPV and Benefit-Cost Ratio however shed light on some important aspects of leveraging the MGNREGA for value chain development.

First, all the value chains show a positive IRR for one or more models, suggesting that these investments are worth undertaking (column 3 of Table 5). The IRR ranges between 18 and 76%, where estimates are available. Further, in many cases, the IRRs are so large that they far outstrip those that might be considered impressive for any business undertaking. These impressive returns have been pointed out in other studies as well although those estimates come from other contexts within India and pertain to other times. For example, studies have reported rates of return for moringa of around 25 and 27.66% (Balasubramaniam & Easwaran, 2019), for mango of around 31.4% , going up to 49.4% in some scenarios (Dreze & Nair, 2023; Nair, 2023), as well as an output value 2.57 times the input in some parts of India and an IRR of 27.13% in Bhagalpur, Bihar (Datarkar et al., 2014; Vijay et al., 2019). For aquaculture, the IRR for intensive farming in irrigated systems for similar species are in the range of 69.55 and 82.86% (Bag et al., 2014), for example). Returns to goat rearing thus far focus more on milk rather than those sold by liveweight (Kumar et al., 2006; D. Singh & Ramachandran, 2007; K. P. Singh et al., 2009), making it difficult to find estimates that offer a comparative perspective.

[8] Appendix A.2 “Appendix A.3 Estimating the costs and returns to four value chain activities” describes the data sources and methods used. The detailed computations are available from the authors on request.

Second, these estimates provide a validation of some of ERADA's choices. This is especially striking for goatery, where the low-cost goat shed promoted by PRADAN-CmF consistently generates comparable if not larger returns for a much lower cost than the high-cost MGNREGA goat shed. The Benefit Cost ratios (column 4 of Table 5) suggest consistently higher benefits per INR spent. The approach of using home-based feed rather than commercial feed makes a big difference to the returns, turning a potentially unprofitable venture into a lucrative one. In aquaculture too, although high stocking density with commercial feed holds high returns, the low-density low-cost-feed model, more likely to be adopted by beneficiary households, appears to be a remunerative approach.

Third, a comparison with 2019 incomes of a typical agricultural household within the state in question suggest that MGNREGA-driven livelihoods can be an important pathway to doubling farmers' incomes, a stated goal of the Government of India.

As elaborated in the Appendix, these estimates offer guidance for thinking through the different elements of the production and marketing system to inform decisions on possible models that are fit for the context. As such, these should not be construed as a verdict on the performance of either ERADA or on the prospects of a value chain in each area but instead used to better understand the parameters that drive the observed returns.

The multiple aspects of the four value chains we studied are summarized in Table 6 as the "5Rs" of the ERADA project.

Table 5: Estimates of Internal Rate of Return and Net Present Value

Value Chain	Model	Internal Rate of Return	Benefit cost ratio	Net Present Value (without MGNREGA support)	Net Present Value (with MGNREGA support for main asset)	Annual NPV (without MGNREGA support) (% of annual agricultural household income in the state)	Annual NPV (with MGNREGA support for main asset) (% of annual agricultural household income in the state)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Goat	MGNREGA- home feed	68%	1.70	657293	741237	21.9	26.8
	MGNREGA-Commercial feed		0.51	-1547772	-1408660	-51.5	-63.1
	MGNREGA-supplemental feed	19%	1.07	105610	217138	3.5	4.3
	PRADAN-CmF- home feed		1.92	764759	737914	25.5	31.2
	PRADAN-CmF Commercial feed		0.53	-1440307	-1411983	-47.9	-58.7
	PRADAN-CmF supplemental feed		1.15	213076	213815	7.1	8.7
Moringa	Plantation model	30%	1.97	908336	1192712	30.2	37.0
Aquaculture	High intensity model	76%	1.44	3127312	3503248	104.1	127.5
	Low intensity model	18%	1.14	641802	1189063	21.4	26.2
Mango		20%	2.20	2024514	2862050	44.9	55.0

Source: Authors' computations based on field visits and secondary data sources. **Notes**: (1) Where IRR is not presented, the stream of income is always positive and hence there is no rate of return that sets NPV=0. (2) Detailed worksheets for these estimates are available on request. (3) The annual agricultural household income for the state and for India are from (GoI, 2021). (4) For goatery, “without MGNREGA support” should be read as “without PRADAN support for goat shed construction” when PRADAN-CmF model is being evaluated. (5) "With MGNREGA support" implies that the net earnings are computed excluding the cost of establishment of plantation, farm pond or goat shelter. We include complementary support as costs (for example, trenches and fencing, maintenance). (7) We assume a goat herd size of 10 females and one buck. For aquaculture, the high intensity model assumes a high stocking density of 400 fingerlings per acre pond and the use of commercial feed, while the low intensity model assumes 300 fingerlings per acre pond and home-produced feed. For all other assumptions and details on these calculations, please refer to the Appendix.

Table 6: The 5Rs: Key outcomes of ERADA activities

	Reach	Rural women	Internal Rate of Return*	Resilience	Retreat
Goatery in Sirohi (PRADAN, CmF)	4000 HHs	• Tribal women traditionally goat-rearers • Women FPOs for inputs and marketing. • Local cadre of mostly women extension workers – *pashu sakhis.*	68% (Home feed) 19% (Supplemental Feed)	• Sirohi goat breed resilient in the climatic context of the region. • Low-cost sheds promoted using local materials and low external inputs.	• FPC confident about taking over activities. NGO partners plan to withdraw by 2026.
Moringa in Khandwa (IGSSS)	1500 HHs	• Women SHGs and FPCs growing and processing moringa leaves for markets. • Women extension agents to support production.	30%	• Moringa heat resistant and appropriate for the regional climate • Has nutritional benefits • Organic inputs used in cultivation • Intercropping with horticultural crops for short-term returns	• NGO partners working towards strengthening FPCs to be able to eventually withdraw.
Aquaculture in Araria (Change Alliance, SSEVS)	500 HHs	• SHG members trained in technical aspects of fisheries which might enhance their role in decision-making. • Strong role of JEEViKA SHGs and other groups	76% (High Intensity Model) 18% (Low Intensity Model)	• Diverse species of fish promote local biodiversity. • Use of homemade feed to reduce cost. • Can grow *makhana* in the pond if it gets silted up; cultivate boundary plantations	• NGO partners plan to hand over activities to JEEViKA and help establish a fish FPO to strengthen the value chain.
Mango plantation in Dumka (SUPPORT)	200 HHs	• Women SHGs as a pathway to demand mango plantations. • Coordination with *Bagwani Sakhis* in management of mango plantations.	20%	• Mango species resilient in the local context. • Intercropping with horticultural crops for short-term returns	• Beneficiaries are heavily reliant on technical support from NGO partners due to the nascency of the value chain.

Source: Authors' summary. Notes: Returns are reported as the net present value as a percentage of the average annual income of agricultural households in the same state (GoI, 2021), assuming MGNREGA support for the asset.

9 CHALLENGES

In this section, we reflect on the challenges that emerge from our four case studies. These challenges can be structural, e.g., related to the formal guidelines of the MGNREGA, or those of other government programs, governance structures and state capacity for implementation, or they could relate to bigger picture concerns such as sustainability of impacts.

9.1 Structural challenges

A key challenge in using MGNREGA for value chain development is that the MGNREGA, by design, the mandate of the MGNREGA ends with the creation of employment and assets. It cannot help form or strengthen value chain activities beyond playing an enabling role of asset provision. The formation of new value chains (or the revival/upgrading of existing ones) requires the provision of additional inputs like credit, technical assistance and training and so on which are necessarily outside the purview of the MGNREGA, thereby necessitating convergence with other actors in the system. Despite efforts across states to enable convergence, it is apparent that non-governmental organizations have played a critical role in facilitating such convergence in many instances.

Creating or streamlining inbuilt mechanisms for information sharing and convergence across line departments. For example, the fisheries department in Araria both conducts trainings and selects farm pond beneficiaries. Rather than create an entirely parallel system, it would be cost-effective to combine efforts: hold joint trainings that are adapted to the context, while sharing lists of MGNREGA or fisheries beneficiaries across departments to make sure that assets reach the most deserving. The Araria case study showed us that often it requires an external “neutral” party to help facilitate convergence, but that it can be done very effectively.

One key structural challenge that emerged was in the formal guidelines around certain assets. MGNREGA guidelines, partly because MGNREGA is not responsible for developing specific value chains. For example, the MGNREGA could explicitly differentiate between pond designs based on purpose, i.e., farm ponds used for protective irrigation, for water conservation or for aquaculture or for goat sheds (see Box 3).

Such challenges extend beyond the MGNREGA. Guidelines for membership in FPOs apparently tend to exclude women farmers on account of the condition that they own land. This is connected to the broader issue in India on lack of recognition of women as farmers. A review of programs and policies for eligibility criteria for subsidies, grants and memberships in producer organizations is essential to ensure that they do not undermine the ability of women or marginal farmers from accessing programs.

9.2 Implementation related challenges

Related to implementation of the MGNREGA, a consistent story across all four scenarios was the delays in wage and material payments (of up to six months in the latter). Delays in material

payments effectively destroy incentives for creating durable assets. For poor unskilled workers, the need for immediate cash in hand meant that they were willing to work for a lower wage in construction and other sectors rather than wait indefinitely for the slightly higher MGNREGA wages. Despite recent revisions, MGNREGA wages are also very low, especially in Madhya Pradesh, where workers prefer working in the sculpture sector instead.

A second challenge related to implementation of the ERADA interventions across the four value chains was the need for technical assistance, as mentioned above. In the case of goats, this was provided by the *Pashu Sakhi/Pashu Mitras*, in the case of aquaculture it was the CRP women trained by the ERADA team as well as the VLRPs and the *Matsya Sakhi*, in the case of mango plantations it was the *Bagwani mitras* as well as the CRPs and the GRS. Some new resource persons had to be trained, while other existing resource persons, such as the GRS, had to take on additional duties for no additional pay. A more sustainable solution in the longer term would be to instead train one cadre of workers on a range of different livelihood activities, minimizing the need for coordination between households and these workers and streamlining the training and technical assistance component of these value chain activities.

9.3 Longer-term challenges

There are several longer-term challenges that a follow-up to the ERADA project or similar efforts in other sites should consider.

First, all four value chains were profitable because they were heavily subsidized (e.g., provision of subsidized fencing through CSR for the moringa plantations, subsidies for low-cost goat sheds and so on). As such this is the argument for intervention in value chain development, that in the absence of such subsidies, smallholders would be unable to participate in potentially lucrative value chains. At the same time, in some cases the assets may involve significant recurring expenditure for maintenance (such as pond repairs). These could continue to be barriers for small and marginal farmers, given the credit constraints they face.

Further, most of the beneficiaries currently have semi-intensive operations on a small scale. Once these value chain activities are scaled up – both in terms of breadth (number of beneficiaries) as well as depth (herd size, plantation size, stocking density of fish for an individual beneficiary), there may be limits to sustainable intensification. Pressure on grazing land or availability of low-cost feed for fish may prompt them to switch to greater reliance on external inputs that cost more (for example, stall feeding of goats or commercial feed for fish, pesticides for plantations). Likewise, if the models are scaled up successfully, whether the current markets can absorb the additional production deserves consideration (for example, a danger of market saturation in the case of mango production in Dumka. Should these come to pass, it remains an open question whether profitability will also scale in the same way.

It is also unclear the extent to which the ERADA activities are sustainable once the project ends, and the implementing partner NGOs move on to other projects. Beneficiaries have mixed reactions: in Sirohi, the FPC women were confident of being able to sustain their activities even if PRADAN and CmF were to withdraw. In Dumka, on the other hand, beneficiaries still relied

heavily on SUPPORT for technical assistance and troubleshooting. As one NGO partner in Sirohi said, *“ERADA’s plan was more to demonstrate the feasibility of the model, not to scale it up PRADAN and CmF have the goal of making this model sustainable”*. But NGO activities are also fund dependent, and as new projects and priorities emerge, it will be difficult to sustain the same level of engagement and support.

A longer-term sustainable model must engage with existing institutions, often governmental, such as the widespread SRLM platforms. Where these platforms are strong, as in Bihar, there is lots of scope to hand over core activities to them. The implementing NGO partners in Araria have a clear plan of handing over their activities to JEEViKA and eventually hopefully ensure the establishment of a fish FPO; similarly, PRADAN in Sirohi was clear that they will exit the district by 2026 and need to hand over their activities by that time. On the one hand, it is true that NGO and external partners should not plan to remain in a supportive role indefinitely; on the other hand, sustaining the benefits of the work they have undertaken requires a careful exit strategy. Across the four value chains, FPOs and FPCs are often viewed as a sustainable vehicle for value chain development. Yet, FPOs/FPCs are themselves quite vulnerable. The short history of FPCs in India suggest that only a few thrive. Much therefore depends on policies and regulations that may govern FPOs and SHGs.

Appendix Figure 9 presents the theory of change for the MGNREGA, the set of entry points for ERADA, and the challenges or “pain points” described above.

Box 4: Policy recommendations for a more effective Mahatma Gandhi NREGA

- Prioritize asset creation over daily targets to generate employment.
- Delays in material payments hinder the creation of assets. This needs to be addressed.
- Current Mahatma Gandhi NREGA designs for assets (for e.g. goat sheds, etc.) are high cost and sometimes not adequately designed (for example, goat shed that resemble rooms with a small window). Low cost appropriately designed models can be considered, using durable local materials.
- Convergence: best practices in states Mahatma Gandhi NREGA beneficiaries' lists are shared with line departments so that complementary inputs and training are targeted to the beneficiaries. The reverse is also useful, though less so, where line departments share their beneficiaries lists with the Block office to verify if Mahatma Gandhi NREGA assets can be provided.
- Some flexibility to repair and maintain individual-level assets with appropriate checks and balances. Existing guidelines allow this for community assets only.
- NRLM-SHG linkage with Mahatma Gandhi seems to work well and systematize demand generation for assets via SHGs.
- In the Mahatma Gandhi NREGA list of works, a clear set of construction guidelines that distinguish types of works based on purpose, example farm ponds for protective irrigation, groundwater recharge ponds or fishponds, etc.
- Foster civil society partnerships to take forward asset-based livelihoods with longer term engagement of actors, since it is a slow process.
- Explore group assets - community goat/cow sheds, farm ponds, - Mahatma Gandhi NREGA already allows these, but they can be strengthened.
- Strengthen the focus on natural resource management and on building climate resilience.
- Track asset beneficiaries to see if they continue dependence on Mahatma Gandhi NREGA

10 RECOMMENDATIONS AND CONCLUSIONS

10.1 Recommendations

Our consideration of the challenges outlined above points to a concise but clear list of policy recommendations.

Value chain interventions of the sort envisaged under ERADA demand several years of engagement. In general, therefore, planning for such interventions deserves a longer period of support, both financial and technical. This would ensure that when partners exit the value chain, the various actors in the ecosystem are strong enough to be self-reliant.

It would be useful for stakeholders to convene common platforms for cross-initiative and inter-state learning. At present, those engaged in implementation use limited resources to device solutions to problems. Across states and contexts, there are potentially many instances that have led to diverse solutions. A common platform would ensure that these lessons are captured and shared.

Since ERADA is anchored in the MGNREGA, there are small changes with potentially large benefits that the MGNREGA can adopt. These are listed in Box 4. The MGNREGA can enable vigorous value chain activities without necessarily detracting from its central purpose of employment guarantee and creation of durable assets. There is also a clear opportunity for the NRLM to more explicitly support value chain development, via systematizing requests for assets, especially community assets, for livelihoods, for enabling credit and lending to FPCs and farmers and to access government programs that provide rural infrastructure, farm equipment, etc. There are some examples of this already and these can be absorbed more explicitly into guidelines to enable best practices.

Last, but not least, to understand fully the impacts of these various approaches, a systematic approach to evaluation is essential. This paper focuses on some stylized features of these interventions and some prospects. However, we know little about whether these interventions fulfil the goals they purport to fulfil.

10.2 Concluding remarks

In the introduction to this paper, we pointed to the evidence that social protection policies and programs in developing countries have tremendous potential to enhance climate action and promote household resilience and climate adaptation. However, there are often important tradeoffs to be considered between climate resilience, remunerative livelihoods and the targeting and inclusion of marginalized communities (including women) who are most in need of both income support and protection from climate shocks.

India presents an interesting case study in this regard. Not only is it at increasing risk of more extreme climate events – heatwaves, droughts, erosion of natural resources – it also has a

strong network of social protection programs that explicitly target vulnerable populations. As we noted earlier, and as has been reiterated throughout this paper, India's MGNREGA lies squarely at the intersection of these oft-competing interests. It provides work and income support, it has inbuilt targeting mechanisms for women, small landholders, marginalized caste and other groups, and it can support climate resilience through the creation of durable assets that rejuvenate, protect or strengthen the existing natural resource base. Other public works programs with an emphasis on creating durable infrastructure to promote welfare, such as the Productive Safety Net Program in Ethiopia, achieve similar goals.

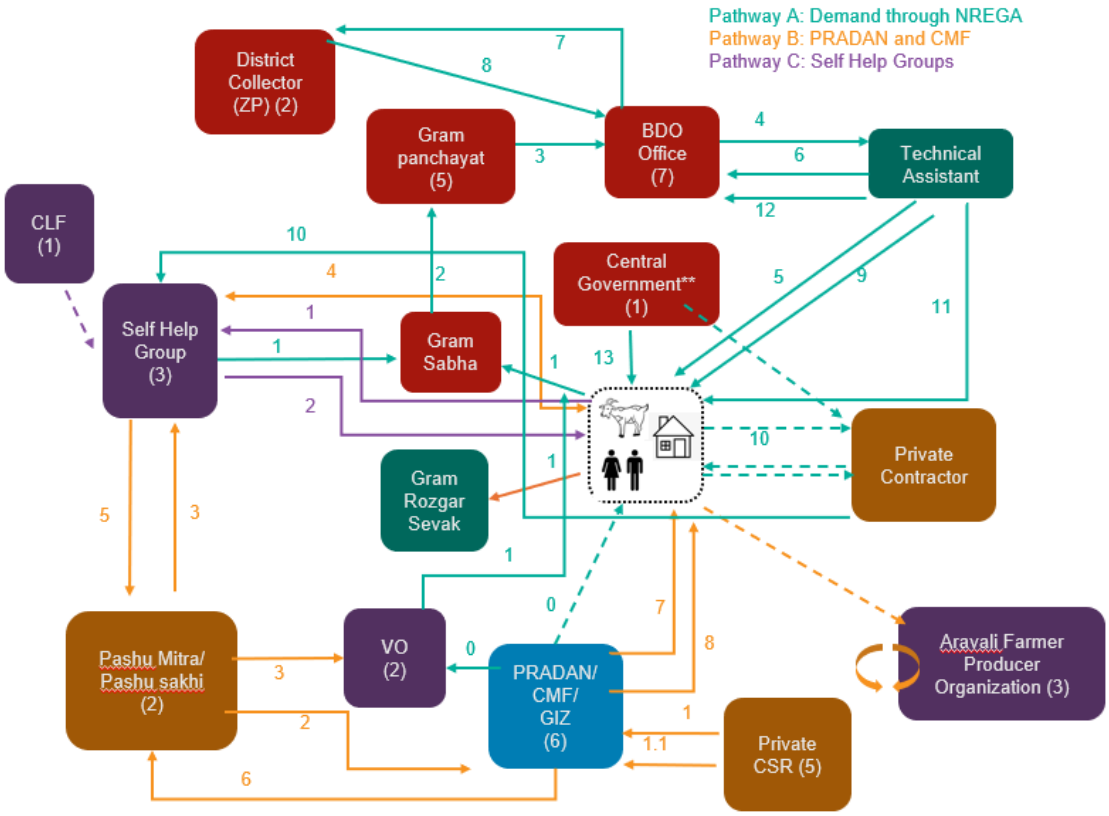
What is compelling about the MGNREGA is the unique set of possibilities it offers. It is the largest public works program of its kind in the world, and it is entirely publicly funded. Yet this public investment has a potential multiplier effect – by building on the foundation that the MGNREGA assets provide, public, private and civil society players can generate sizeable returns through additional investments in value chain formation and strengthening, upgradation through market linkages, input provision and technical support. Thus, the public investment catalyzes and crowds in additional private investments. This paper is a testament to the way in which this process can bring together national and local governments, non-governmental organizations and the private sector to deliver impact.

MGNREGA is a powerful program. The four case studies of the ERADA program presented in this paper serve to showcase just how transformative MGNREGA can be when combined with innovative, solution-oriented, context appropriate and thoughtful investments. It is our hope that the concrete recommendations outlined above can guide policymakers with regard to possible improvements to the program, and encourage donors, researchers and policymakers alike to convene platforms where inter-state and inter-project evidence and experiences can be shared regularly.

APPENDIX

Appendix A.1 Process Influence Maps

Appendix Figure 1: Goat shed block-level PIM



Pathway A [Demand through MGNREGA]

1. [Information] Beneficiary requests goat shed at Gram Sabha.
2. [Official Sanction] The approved documents are sent to Gram Panchayat.
3. [Official Sanction] GP approves and sends to BDO.
4. [Information] BDO asks the technical assistant to see if the beneficiary has land.
5. [Training/Measurement] Technical assistant visits the beneficiary's house to check the land, space, and minimum requirements.
6. [Information] Technical Assistant scans documents and estimates, then forwards them to the BDO.
7. [Information] BDO reviews and forwards documents/estimates to the district collector's office for sanction.
8. [Official Sanction] Zila Parishad verifies SC/ST categories and BPL number (2002 census) and sanctions within 4-7 days.
9. [Training/Measurement] Technical Assistant (TA) then goes to the beneficiaries' house and does marking.
10. [Input/Services] The household may hire or may not hire a private contractor to do the construction.

11. [Training/Measurement] Technical Assistant visits the household for measurement post-construction.
12. [Information] TA reports back to the BDO office about the measurement details.
13. [Money] Central Government pays labor and karigars/contractors directly 15 days after Goat Shed construction.

Pathway B [PRADAN and CMF]

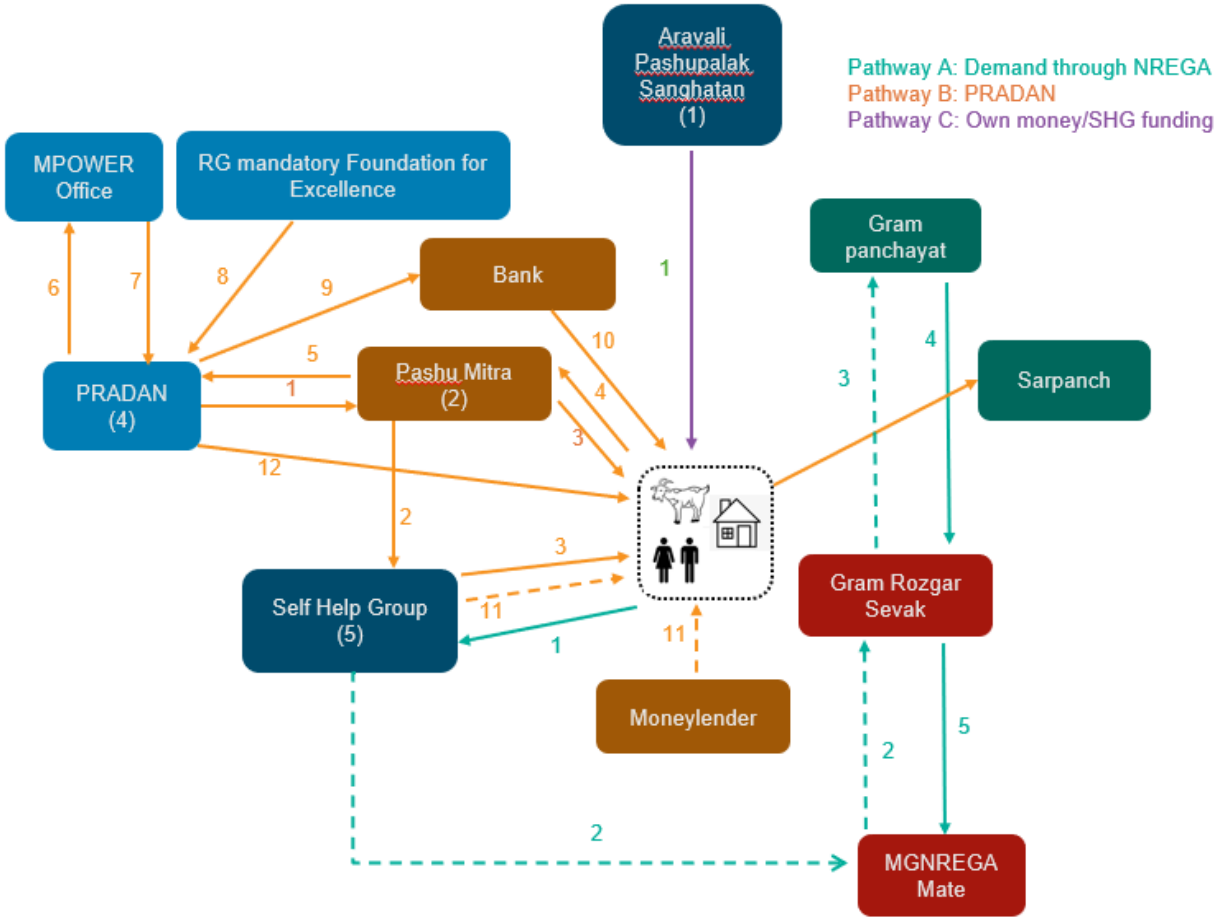
1. [Money] Inform households about goat shed via CSR funding.
2. [Information] Pashu Sakhi/Mitra conveys information to beneficiaries.
3. [Information] Information passes to SHG and VO.
4. [Information] SHGs inform and collect interest from beneficiaries.
5. [Information] SHG provides and fills the 'Sahmati Patra' form.
6. [Information] Pashumitra submits the form to CMF/PRADAN.
7. [Training/Measurement] PRADAN verifies construction and takes geo-tagged photos.
8. [Money] CMF transfers funds to beneficiaries' accounts.

Pathway C [Self-Help Groups]

1. [Information] Household informed about goat shed by SHG.
2. [Money] Household takes SHG loan for goat shed.

**: individual/organization can create barriers to acquiring the asset.

Appendix Figure 2: Goat shed GP-level PIM



Pathway A: Demand through MGNREGA

[Note: This pathway was hypothetical as no one had received assets through this channel. We explored it for completeness.]

1. [Information] Households discuss in SHGs regarding goat shed construction.
2. [Information] SHG informs the Mate regarding the application, and they take the application to GRS.
3. [Information] GRS gives the application to Gram Panchayat.
4. [Information] GP returns the application to GRS.
5. [Information] GRS gives back the application to Mate.

Pathway B: PRADAN (EMPOWER Office)

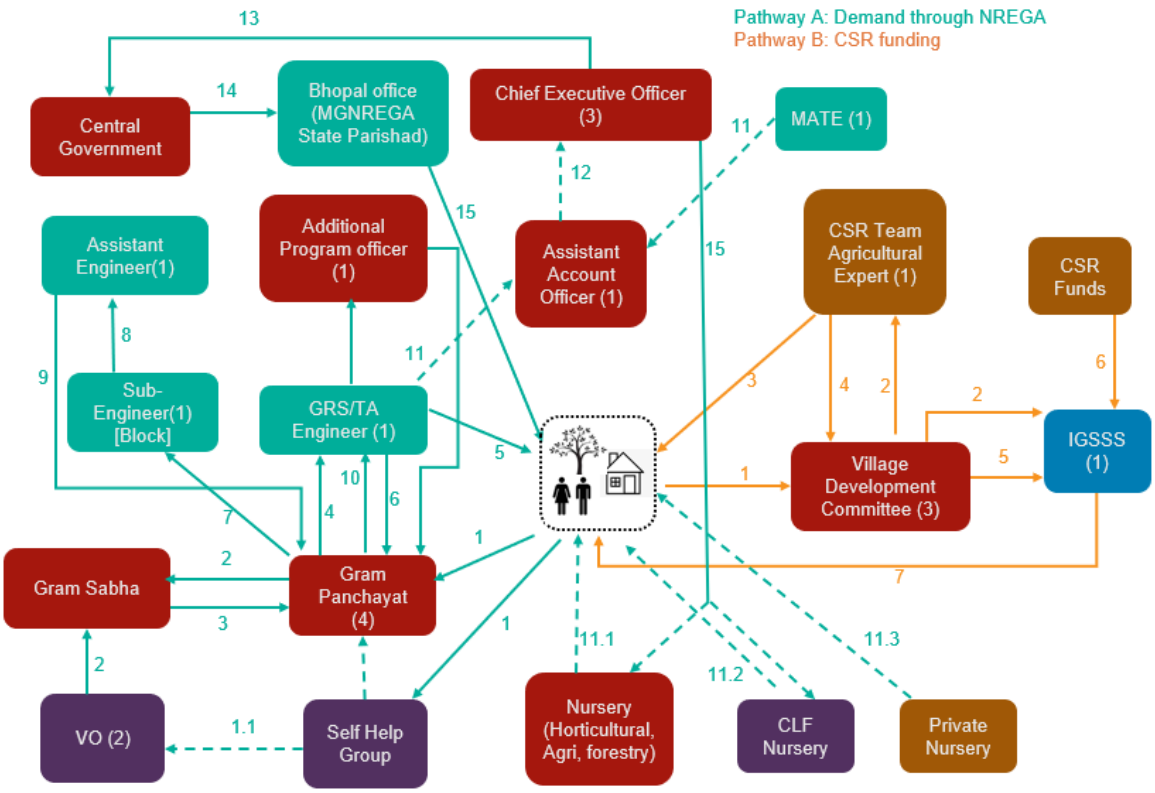
1. [Information] PRADAN gives information to Pashu Sakhi.
2. [Information] Pashu Sakhi passes this information to members of the Self-Help Group.
3. [Information] Individuals learned about the possibility of obtaining a goat shed through the SHG.
4. [Information] The women get the documents ready with the help of Pashu sakhi.
5. [Information] The Pashu sakhi deposits the application and documents at the PRADAN office.
6. [Information] PRADAN forwards the documents to the EMPOWER office.
7. [Official Sanction] The EMPOWER office approves the application and sends it back to PRADAN.

8. [Money] PRADAN receives money from RG Manudhane Foundation for Excellence.
9. [Money] PRADAN then transfers the amount directly into the beneficiary's bank account.
10. [Money] Beneficiary can take the transferred money out of the bank.
11. [Money] For goat sheds constructed under EMPOWER, some borrow from SHG, some from money lenders.
12. [Training/Measurement] PRADAN comes for training and measurement at the Goat shed.

Pathway C: Self-Funded Model (or Borrowings from groups)

1. [Money] Many pay for their own goat shed. Some borrow from Aravali Pashupalak Sangathan.

Appendix Figure 3: Moringa plantation block-level PIM



Pathway A: Demand through NREGA

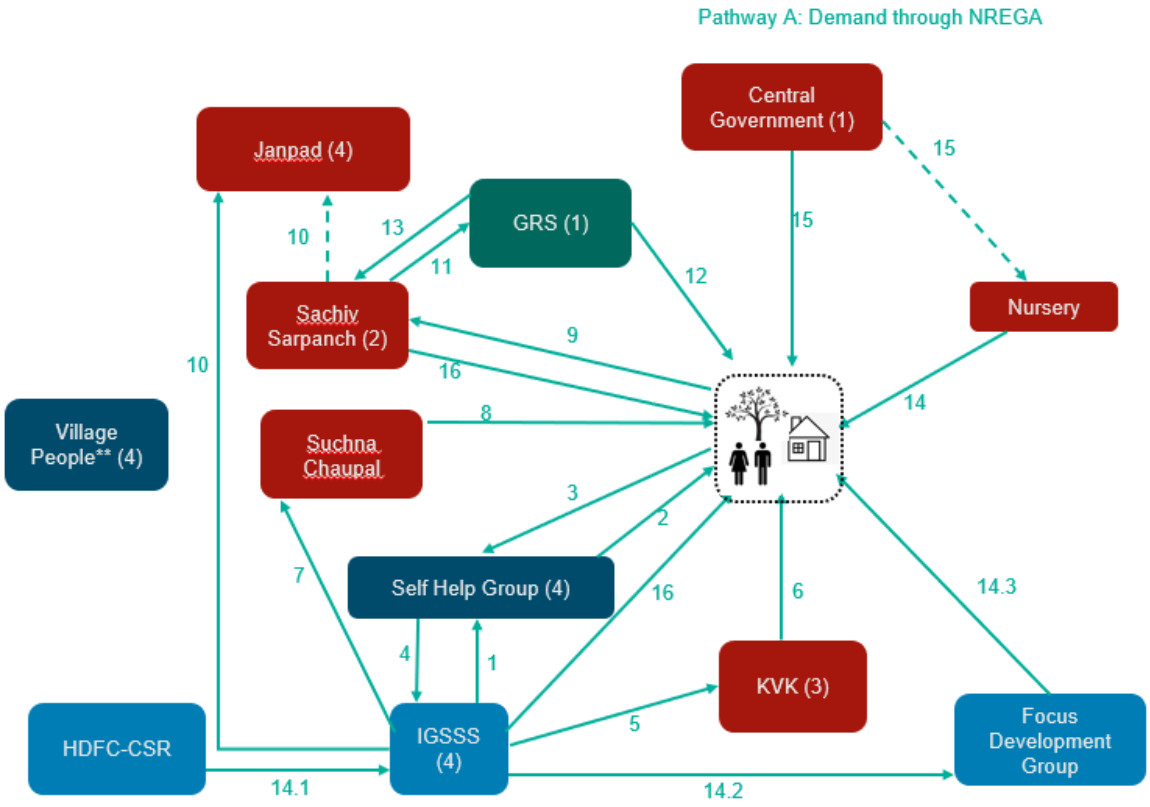
1. [Information] Beneficiary submits the application to Gram Panchayat for moringa support.
2. [Information] Information is given to Gram Sabha by GP; a priority list is prepared.
3. [Information] Priority list shared by Gram Sabha with Gram Panchayat.
4. [Information] GP informs GRS and Technical Assistant for field visit.
5. [Training and Measurement] GRS and TA conduct necessary field verification.
6. [Information] Verification form and work ID generated, shared with GP.
7. [Information] GP forwards the file to the Sub-Engineer for estimation.
8. [Information] Sub-Engineer sends file to Assistant Engineer.
9. [Official Approval] The Assistant Engineer sends the approved file back to GP.
10. [Information] GP sends the file to GRS/TA for geo-tagging.
    11. [Information] GRS and MATE sends the Muster roll to the Assistant Account Officer. After GRS sends to AAO, the beneficiary gets saplings from either CLF nursery (11.2), private nursery (11.3), or government nursery horticulture, agriculture, and forest nursery (11.1).
12. [Information] File sent to Chief Executive Officer for signature.
13. [Official Approval] The Chief executive waits for approval from the Central government.
14. [Money] Central Government transfers money to the Bhopal Office.
15. [Money] Payments transferred to beneficiaries' and nurseries' accounts.

Pathway B: CSR support for funds

1. [Information] The household sends the application to the village development committee.
2. [Information] A copy of the file is sent to IGSSS.
3. [Training and Measurement] The CSR team sends the technical experts to the plantations to take technical measurements.

4. [Information] The technical experts send the report back to the village development committee.
5. [Official Approval] The village development committee then gives official approval to the IGSSS.
6. [Money] IGSSS then gets funds from CSR.
7. [Inputs/Services] IGSSS buys inputs and provides resources to households, not cash.

Appendix Figure 4: Moringa plantation GP-level PIM



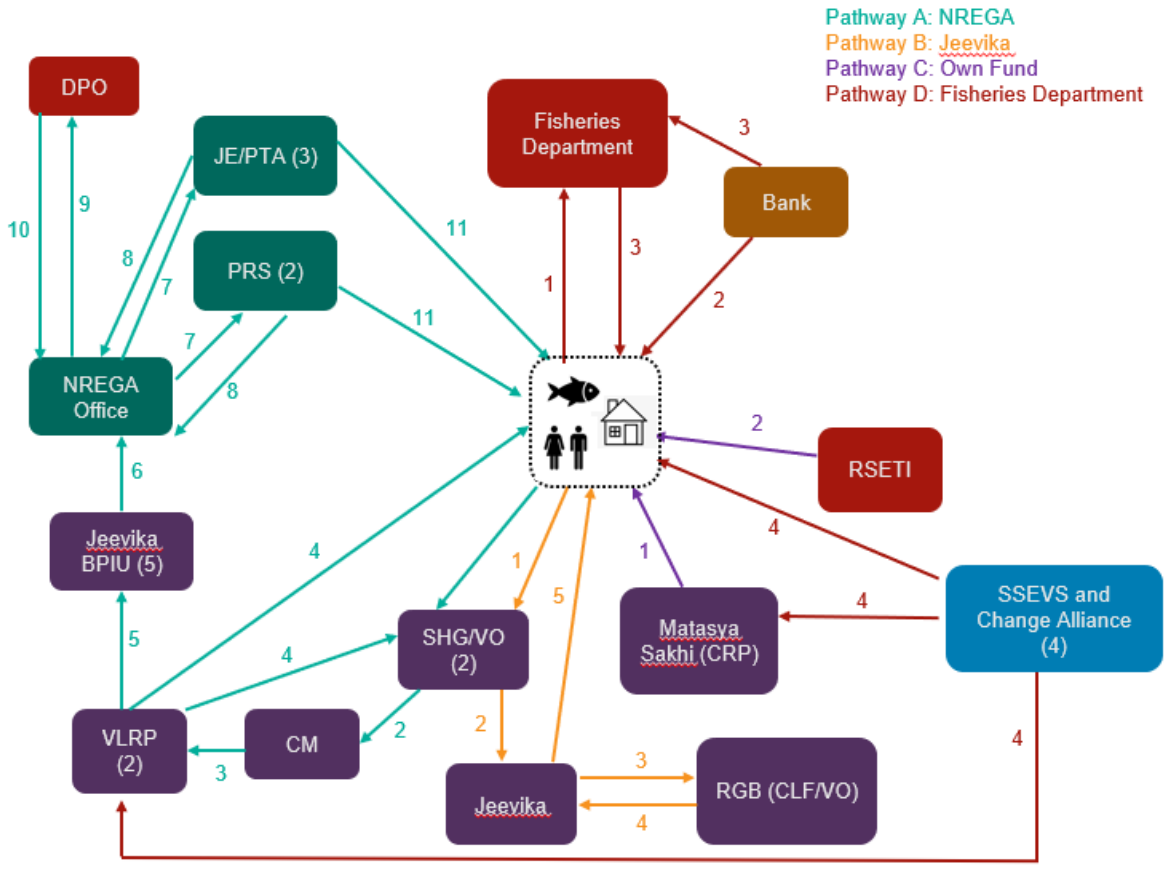
Pathway A: Demand through MGNREGA

1. [Information] IGSSS informs SHG about Moringa uses.
2. [Information] SHG conveys this information to women.
3. [Information] Women discuss in the SHG meeting that they want to go for training to grow Moringa.
4. [Information] SHG informs IGSSS about women interested in training for moringa.
5. [Information] IGSSS requests KVK to train women.
6. [Training/Measurement] Women receive training at KVK (how to grow moringa and how to apply for NREGA).
7. [Information] IGSSS lists interested women in 'Suchna Chaupal'.
8. [Information] Application forms are given to women.
9. [Information] Women prepare details which are then shared with 'Sachiv/ Sarpanch' for signature.
10. [Information] The application forms are forwarded by the 'Sachiv Sarpanch' along with IGSSS to 'Janpad' .
11. [Information] 'Sachiv/ Sarpanch' then forwards the document to GRS.
12. [Training/Measurement] GRS verifies land and application details.
13. [Information] GRS does Geo-tagging, and the form is sent to Sachiv.
14. [Inputs and Services] SHG gets saplings from the nursery and digs holes and plants. [Farmers can get support for fencing from the Focus Development Program (FDP) (14.3). The FDP program is implemented by IGSSS (14.2), for which the funds come via HDFC-CSR (14.1)]
15. [Money] The Central Government transfers payments to women's accounts and the money for saplings to the nursery.

16. [Training and Measurement] Sachiv and GRS inspect farms regularly.
[Note: Since village people can create hindrance in this process by discouraging others, they have been rated as 4 and in red]

**: individual/organization can create barriers to acquiring the asset.

Appendix Figure 5: Aquaculture pond block-level PIM



Pathway A: MGNREGA

1. [Information] Any woman who wants to get a fishpond built will 1st raise this demand in SHG.
2. [Information] SHG head then goes to CM, and then CM phones to VLRP.
3. [Information] VLRP could be present in the meeting of SHG and CM.
4. [Information] VLRP then goes to SHG and talks to the women who want a pond and writes an application for them.
5. [Information] VLRP then takes the application to the BPIU (Block Programme Implementation Unit) of Jeevika to check if everything is okay.
6. [Information] BPIU takes the application to NREGA.
7. [Information] NREGA takes the application to Junior Engineer (JE)/ Panchayat Technical Assistance (PTA)/ PRS (Panchayat Rozgar Sevak).
8. [Information] After a full inspection, PRS and PTA report back to NREGA.
9. [Information] Once NREGA approves, it forwards to the DPO.
10. [Official Sanction] DPO gives official sanction to NREGA, after which the muster is rolled out.
11. [Training/Measurement] PRS and JE come for inspection in intervals to monitor the progress of work under NREGA.

Pathway B: Jeevika

1. [Information] Women first tell SHG/VO that they are interested in pond construction.
2. [Information] SHG/VO takes the application to Jeevika.

3. [Information] At the CLF level, there is an RGB (Representative of General Body) meeting in which there are 2 members from each VO.
4. [Official Approval] Then there will be a meeting of the Board of Directors, and the application will be approved.
5. [Money] Women get funding from Jeevika funds such as MCP (Micro Credit Plan) and other funds.

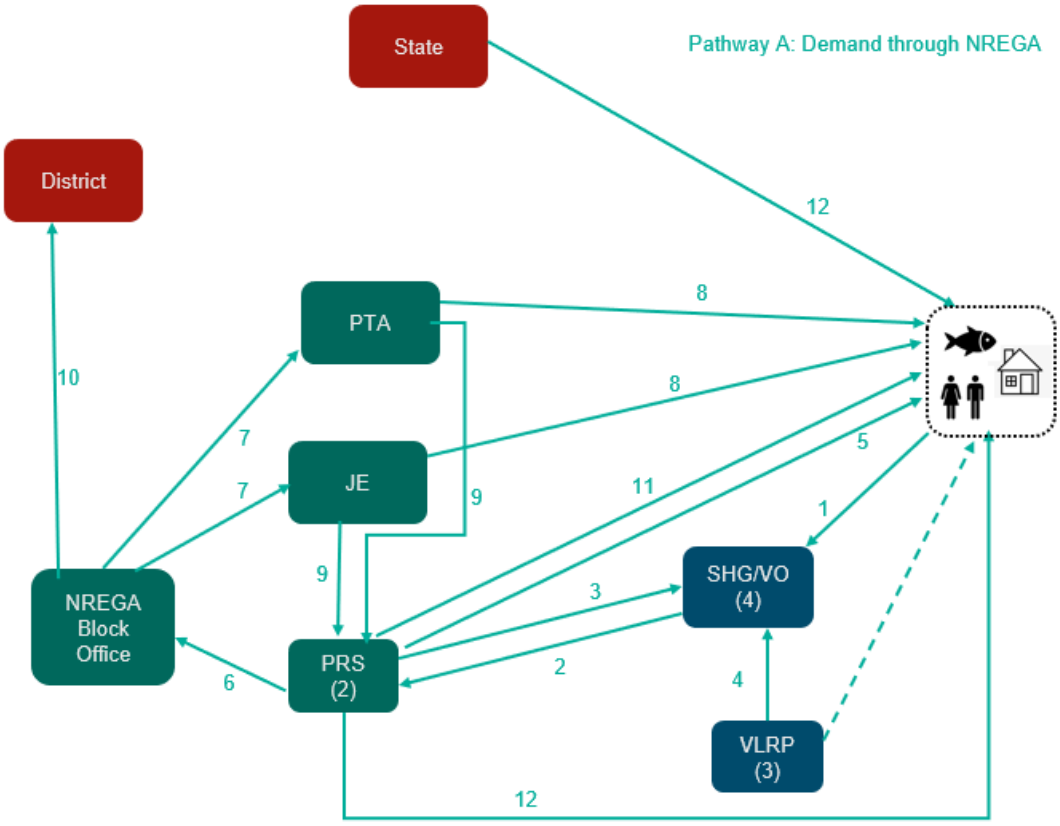
Pathway C: Own Fund

1. [Information] Matasya Sakhi gives information about the land size (and info about what is required for pond construction and maintenance).
2. [Information] RSETI (Rural Self Employment Training Institute) provides information about fish farming.

Pathway D: Fisheries Department

1. [Information] All the documents regarding eligibility for ponds are given to the fishery department.
2. [Information] Then, there is verification by the bank by visiting the household.
3. [Money] Money (subsidy) comes from the fisheries department via the bank.
4. [Training][Information] Samagra Sikchhan Evam Vikas Sansthan (SSEVS): gives training to CRP and also to VLRP and give information to SHG women.

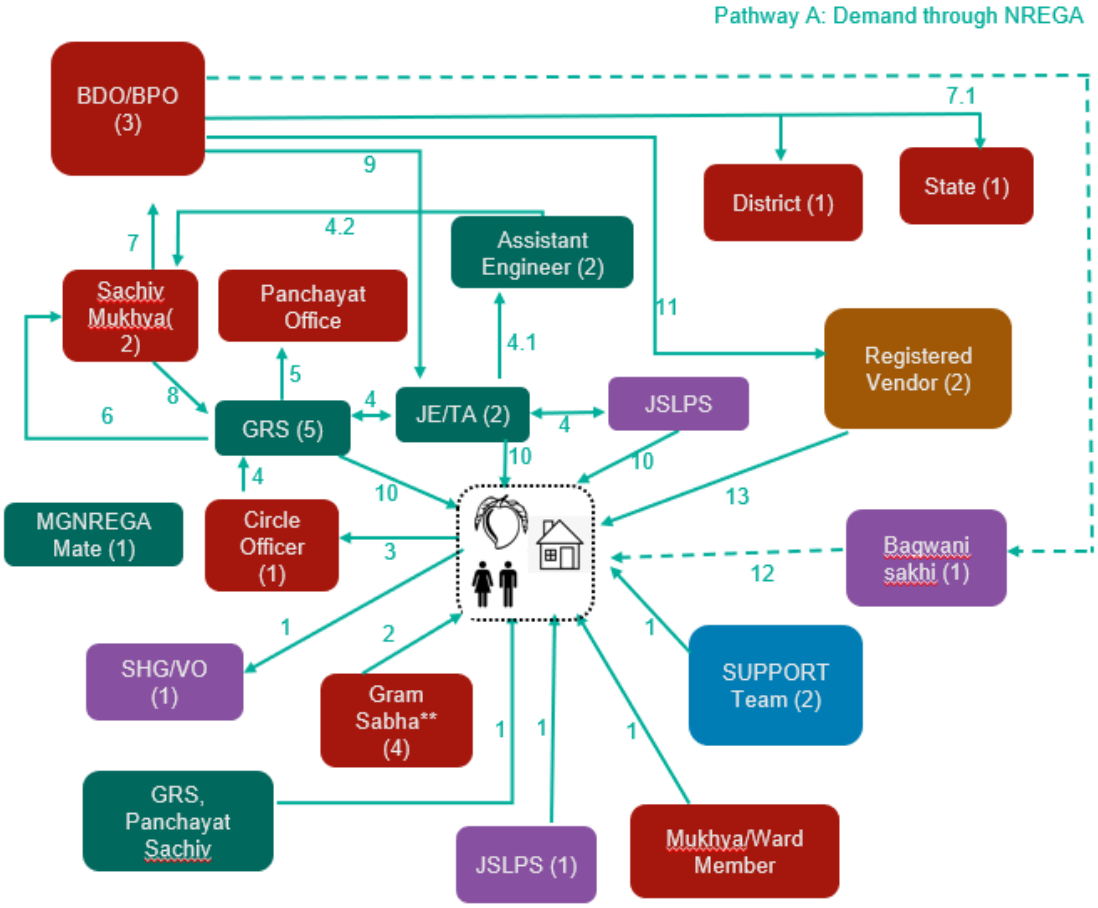
Appendix Figure 6: Aquaculture pond GP-level PIM



Pathway A: Demand through NREGA

1. [Information] The beneficiary goes to the VO/SHG meeting and says she wants 'Pokhar'.
2. [Information] VO connects the woman to PRS.
3. [Information] PRS goes to an SHG meeting in which a woman (beneficiary) is present.
4. [Information] VLRP also comes to the same meeting.
5. [Information] PRS then meets the woman at her home to collect the required documents.
6. [Information] PRS deposits the document in the NREGA office.
7. [Information] The NREGA block office asks the PTA and JE to inspect it carefully.
8. [Training/Measurement] JE and PTA come to inspect the land (all measurements are done).
9. [Information] PTA/JE verifies land details and conveys the same to PRS.
10. [Information] Then, from the NREGA block office, it goes to the district for approval.
11. [Information] PRS then tells the woman that the application has been passed, and the work can begin.
12. [Money] PRS then sends the money to the woman's account and into the account of all laborers who worked on the pond. According to beneficiaries, money comes from the state.

Appendix Figure 7: Mango plantation block-level PIM



Pathway A: Demand through NREGA

1.[Information] GRS, Panchayat Sachiv, JSLPS, Mukhya/Ward Member, SUPPORT create awareness about mango plantations and the Beneficiary submits their demand at the SHG and VO.

2.[Information] Information is shared through the Gram Sabha by the various actors involved and requests for plantations are placed there.

3.[Information] Households gets a “prativedan” which is proof of land title/possession, from the Circle Officer at the Revenue Department of the BDO office. GRS/SUPPORT/CFPT assist them with this.

4.[Information] The household submits the “prativedan” to sachiv secretary, mukhiya and GRS sanction this work in the prescribed format and work code is generated with block approval. The JE/TA inspect the land physically, assisted by JSLPS.

4.1. [Information] JE/TA sends their report to the Assistant Engineer.

4.2. [Information] Assistant Engineer sends the verified applications to Sachiv and Mukhiya.

5.[Information] GRS sends the verified applications to Panchayat office.

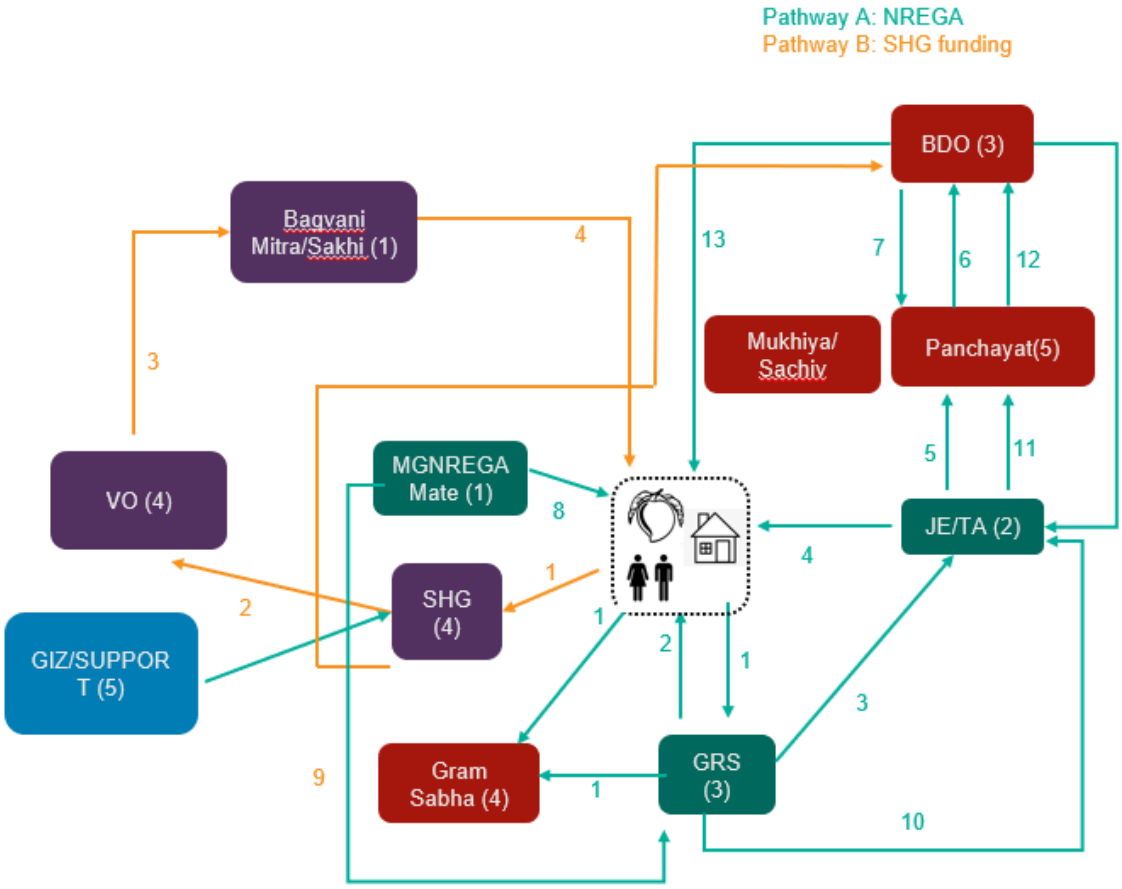
6.[Information] GRS also shares the verified applications to Sachiv/Mukhiya.

7.[Information] Sachiv/Mukhiya shares the applications with BDO/BPO.

7.1. [Information] BDO sends the demands to the District and State office.

8.[Official Approval] After receiving approval from Sachiv/Mukhiya, GRS geotags the work and e-muster roll is created.
9.[Information] BDO sends the approved applications to JE/TA to start the construction of the plantation.
10.[Information] JSLPS, GRS, and JE/TA all facilitate the construction of the mango plantation.
11.[Money] BDO/BPO transfer funds to registered vendor for saplings.
12.[Training/Extension] Bagwani Sakhis (who are paid by the BDO's office) support beneficiaries by providing training and extension.
13.[Inputs] Registered vendors provide saplings to the beneficiary.

Appendix Figure 8: Mango plantation GP-level PIM



Pathway A: Demand through NREGA

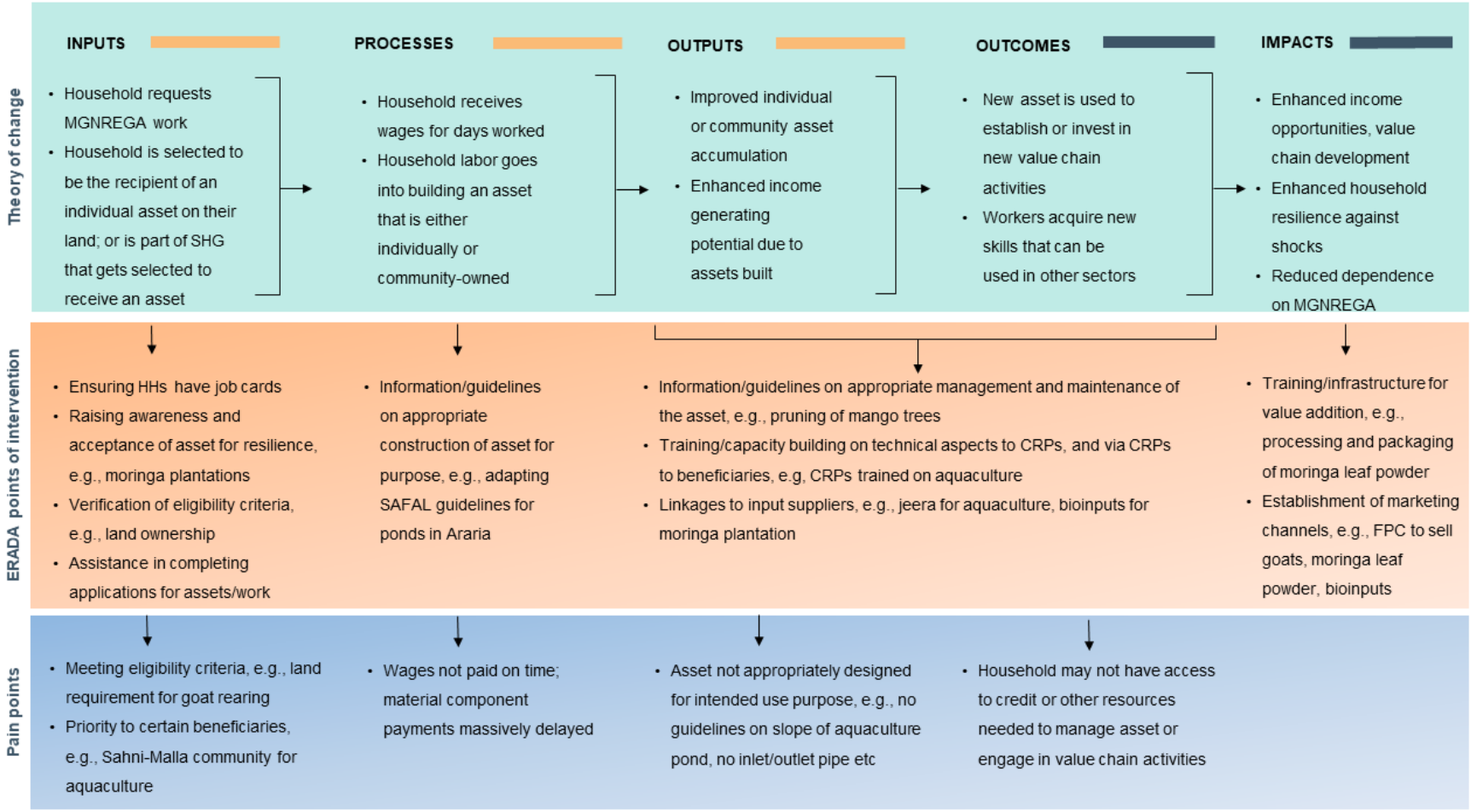
1. [Information] Beneficiaries approach the Gram Sabha directly or through Rozgar Sevak to demand a plantation.
2. [Information] Rozgar Sevak physically assesses the suitability of the beneficiary's land and water sources.
3. [Information] After inspection GRS informs JE/TA.
4. [Information] JE/TA confirms this and then draws up the cost estimate.
5. [Information] JE/TA passes the cost estimate to Panchayat.
6. [Information] Panchayat passes it to the BDO office for sanction.
7. [Official Approval] BDO sanctions the work and sends the information to Panchayat.
8. [Information] Panchayat sends the Mate to geotag the plot and e-muster roll.
9. [Information] Mate shares the attendance based on the muster roll with the Rozgar Sevak.
10. [Information] Rozgar Sevak shares the attendance with JE.
11. [Information] JE shares it with Panchayat office.
12. [Information] Panchayat office shares it with Block Office where the Fund Transfer Order (FTO) is generated.
13. [Money] BDO pays the labor directly.

Pathway B: Demand through JSLPS (under NREGA)

1. [Information] The household approaches the SHG with the demand for a plantation.
2. [Information] SHG passes the demand to Gram Sangathan and to the BDO.
3. [Information] Gram Sangathan passes the demand to the Bagwani Mitra/Sakhi.
4. [Training/Extension] Bagwani Mitra/Sakhi provide training and extension to the beneficiaries.

Appendix A.2 A theory of change for ERADA

Appendix Figure 9: Theory of change, ERADA entry points and pain points



Appendix A.3 Estimating the costs and returns to four value chain activities

The computation of costs and returns to value chain activities is typically complicated and the results can vary greatly depending on the context and assumptions underpinning the exercise. In this Appendix, we lay out the methods we use for the estimates presented in this paper, along with cautionary notes on the many limitations of our effort.

We compute three indicators: (1) Net present value (NPV) of the stream of returns from the asset, and the annualized NPV as a percentage of agricultural household's income based on the 2019 Situation Assessment Survey of Agricultural Households in India (GoI, 2021); (2) The Internal Rate of Return (IRR); and (3) the Benefit Cost Ratio (BCR) which estimates benefits per unit of costs. These indicators are described in detail later.

The four value chain activities - goatery, moringa and mango cultivation and aquaculture - are quite different from one another and as such the estimates we generate are not comparable across value chains. For example, it does not make sense to note that one activity has a higher IRR and is therefore "better" since each IRR is driven by specific assumptions and models. Our approach and estimates may also depart significantly from existing studies on account of the specificity of location and context of our work.

The following caveats are worth keeping in mind:

First, both moringa and mango plantations have a fixed life span (typically assumed as 30 years for mango and 20 years for moringa) after which senescence and mortality rates necessitate replanting. For goatery and aquaculture, the asset (goat shed or farm pond) might demand repair or replacement but, like field crops, the activities can potentially be undertaken in perpetuity. For parity with moringa, we calculate net returns for goatery and aquaculture for a span of 20 years as well, with just mango cultivation spanning a 30-year period.

Second, our estimates focus on the models promoted under ERADA. These tend to be low-cost in the sense of relying on home-prepared feed, compost, other bioinputs etc. rather than heavy use of external inputs, depending more on family labor than hired labor, and with herd sizes and stocking intensity that align with extensive or semi-intensive cultivation/rearing household operation with a commercial orientation rather than large scale, intensive commercial farming.

Third, since the MGNREGA is at the core of ERADA efforts, we treat the MGNREGA costs of provisioning a goat shelter, fishpond, mango and moringa plantations as the investment costs respectively for each value chain. We note in this paper that lower cost alternatives exist and ERADA partners have recommended these on occasions (for example, lower cost goat sheds). Our estimates vary depending on which models we choose. We opt here to estimate returns on the MGNREGA investment, noting therefore that our estimates are conservative and on the lower side. We also do not include complementary MGNREGA support such as for irrigation, cattle proof trenches or maintenance costs when we compare the NPV with MGNREGA support to the NPV without MGNREGA support. This implies that in the former, we don't account for the *full* extent of MGNREGA support, again leading to a more conservative estimate of net returns. Importantly, we do not account for the costs of the ERADA program itself. Given that we find that the four value chains are unlikely to have developed without the support and intensive engagement of civil society actors, these costs are likely to reduce the returns significantly if accounted for.

Fourth, as the sections that follow note, since we rely almost fully on the data we obtained from our respondents during our field visits to the four sites, these estimates are not representative of all beneficiaries of the ERADA program. Nor are they consistently estimated. For example, in goatery, our respondents had borrowed money to buy goats, but in aquaculture, no respondent had borrowed money. Interest payments may therefore appear in the former value chain but not in the latter.

Fifth, the ERADA program itself may be considered atypical. Beneficiaries we interacted with were supported in different ways: financially, and via technical training and organizational support that ensured that the asset was well designed and used. For example, SUPPORT's role in ensuring that the same beneficiary obtained a mango plantation as well as the complementary inputs of fencing, cattle proof trenches and irrigation, combined with close monitoring of tree growth and health, allows the plantation to thrive with a high survival rate of saplings. The moringa plantation that ERADA supports also includes financial assistance for fencing via IGSSS; similarly, the FPCs supporting goatery in Sirohi benefit from support of the promoters.

These are examples of ways in which the estimates we present are neither representative of all beneficiaries in a value chain, nor comparable across value chains. We offer a fuller account of our assumptions below.

Methods

The data we use are described in Section 5.2.1 above.

Here we describe the three measures we estimate, Net Present Value (NPV), the Internal Rate of Return (IRR), and the Benefit Cost Ratio.

The NPV represents a present worth of the stream of returns net of costs. It is thus the present value of the net benefits computed by deducting the total discounted costs from the total discounted returns. This number is typically used to assess whether an investment is worth undertaking; a positive NPV indicates the worthiness, so to speak, of the investment. It is computed as follows:

$$NPV = \sum_{t=1}^{T} \frac{B_t - C_t}{(1+i)^t}$$

where B_t refers to the monetary value of earnings per year for a fixed model (e.g. a given herd size, acre of pond, plantation, etc.), C_t refers to the costs associated with the activity per year, including fixed and variable costs, T is the total number of years considered, this is 30 for mango plantations and 20 for all other assets, i is the discount rate used to value the present value of future returns. We use 5% as the discount rate to value the stream of net earnings.

We present two estimates of NPV, one where we include all costs, and another in which we exclude the cost of establishing the plantation, fishpond or goat shelter, as the case may be. The latter is akin to the stream of returns with MGNREGA support for the specific asset and reflects the boost to NPV since the beneficiary does not bear these costs. As noted previously, beneficiaries often receive more by way of financial (and technical or managerial) support, such as for complementary inputs like trenches, irrigation, fencing and maintenance. We exclude these to highlight the implications of MGNREGA support to the main asset.

Whereas we apply an assumed discount rate to compute the present value in the NPV calculations, the IRR instead computes that discount rate such that the NPV=0. The IRR estimates the annualized yield on a rupee of investment. For both these numbers, the higher the number, the greater the returns to investments. The IRR has some limitations. It cannot be computed if the net returns are positive each year, and multiple discount rates are possible when positive and negative returns alternate over the span of period considered.

Finally, we compute a third indicator, the Benefit Cost Ratio (BCR), defined as

$$BCR = \frac{\sum_{t=1}^{T} \frac{B_t}{(1+i)^t}}{\sum_{t=1}^{T} \frac{C_t}{(1+i)^t}}$$

The BCR indicates the INR value of benefits deriving from an INR of costs incurred for the duration considered, discounted by an appropriate rate i. A BCR greater than 1 suggests that the benefits outstrip the costs of the activity.

Interest rates and inflation

Across all value chains, we assume that input prices, including those of labor, increase at the rate of 5% per annum while the value of outputs increases by 3% per annum. These assumptions would tend to reduce the net returns per year over the period considered. These assumptions broadly reflect that the terms of trade of farmers in recent years have worsened or remained unchanged, this is also the perception articulated by farmers that output prices barely improve while input prices keep rising. The differential rates applied also reflect our concern that the upscaling of the models might lead to a rapid increase in supply that will prevent output prices from increasing at the same pace as input prices. Our estimates of NPV and IRR are contingent on these choices. For specific cases, such as goatery, respondents mentioned obtaining loans for buying goats or funding investments relating to goat shelters (e.g. a water tank) at 6%.

Establishment costs

For all the value chains, we assign the costs of establishing a farm pond, goat shed and plantations (i.e. the establishment costs or investment) to the first year, reflecting the way these are incurred. We do not apportion these across the lifetime of the asset. For goat, we assume that households have a herd to start with, as was the case in Sirohi. In other cases, the moringa and mango saplings as well as the fingerlings are part of the establishment costs.

Repairs, maintenance and replacement costs

Due to the nascency of many of the value chains, we estimate the costs of repairs and maintenance as a fraction of the value of the asset evenly distributed over the life of the asset or the period considered. These assumptions are discussed in detail for each value chain. We also assume that the asset (or complementary investment, such as a fence) is replaced periodically. In most cases, these are assumed to be replaced every 5 years, sometimes 10 years depending on the nature of these additional assets.

Imputed value

For some items we impute the value of inputs. Family labor, for example, is valued at MGNREGA wages. These are, however, applied differently across value chains based on our understanding of each value chain. We also impute the value of milk in goatery even if such milk is not sold in the market (as yet).

Another imputation is for the opportunity cost of land. For goatery, since these are often small spaces attached to the house and do not replace homestead gardens or fields, we assume that there are no opportunity costs. For all the other value chains, we assume INR 25,000 per acre and apply this throughout the period considered. These may or may not be justified in specific cases. In several instances, fallow uplands had been brought into cultivation for the first time. In other cases, plantations permit intercropping so that there is no substantial loss of income from converting land to plantations. In the case of fishponds, many were in a state of disrepair and were revived so that the opportunity cost is similarly 0. However, allowing for a modest imputed cost here also ensures that our NPV, IRR and BCR estimates are conservative.

Mango

For mango we assume a 1-acre plantation with 122 mango trees, i.e., the model adopted by the MGNREGA in Masaliya block, Dumka, Jharkhand. We assume, based on our field visit, that 112 trees survive. In general, it seems that the saplings that don't survive are replaced under the program, but we assume that they are not. We assume that all the yields and production practices and costs associated are when complementary investments such as irrigation, cattle proof trenches and fencing are available, without which both survival rates and yields would be much lower. Due to the presence of the ERADA partners, the layer of extension workers and MGNREGA support, the choice of mortality rates is justified. We also assume that the orchard has only mangoes, no intercropping and no boundary plantation.

The trees start yielding fruit in Year 3, and as per respondent accounts, we assume that yield In Year 3 is 10 kgs/tree, 40 kgs in Years 4-6, 70kgs in Years 7-16, and 10 kgs thereafter to Year 30. We assume that the mangoes will be marketed via pre-harvest contractors who harvest the fruit and collect it at farmgate, so that costs of harvesting, sorting, packing and transport to the market are not borne by the beneficiaries.

We assume that the market price of Amrapali is Rs.50/kg and this price increases in nominal terms by 3% each year throughout the period for which we compute the returns. This reflects a conservative stand – but also possibly realistic, given the expanding mango production locally and the fact that prices of mangoes have not seen a secular upward trend in India.

As per our field work, the main recurring costs are fertilizer, pesticides, weeding, pruning and lopping of trees. We have accounted for DAP, MOP, potash, chuna (lime), gobar (manure) and have built in transportation costs for purchasing these and prices of these in Dumka at wholesale rates. Retail rates are generally 25% higher based on our interviews with input dealers in Dumka. We have chosen not to use retail rates since we believe that not all of these inputs are used or applied consistently by all beneficiaries over the life cycle of the plantation.

MGNREGA used to pay for 3 years' maintenance, and this has now increased to 5 years. This has not been accounted for as a transfer.

We assume 1% of the costs of irrigation, trenching and fencing is spent each year on repairs and maintenance and that these fences are replaced every sixth year, the price of which increases by 5% per annym.

The fences are net /wires made of synthetic materials. In the estimates presented, we exclude the imputed value of family labor but include hired labor costs and account for the opportunity cost of land. This is even though SUPPORT promotes intercropping in the initial years when the mango trees are still immature and not fruiting.

Moringa

As we note, there are two models of moringa, backyard and plantation. We estimate the returns only for the plantation. We assume that 300 out of 350 trees survive. As with the mango plantations, the extensive support provided by the ecosystem of ERADA players justifies the survival rates we assume.

We include in the costs the imputed value of labor since there is limited use of hired labor on the farms thus far. We assume that the opportunity cost of 1 acre is INR 25,000 and apply a fixed value for the full period considered.

Costs include metal-wired fences, that are assumed to not require replacement frequently, so we assume these are replaced every 10 years. Beneficiaries currently pay only a part of these costs, with most of the costs funded by CSR funds channeled via IGSSS. We assume the full costs of the fences.

We assume that 1% of the costs of the fence and plantation establishment are spent on maintenance and 5% of the irrigation investments are incurred each year as costs of repair, maintenance and irrigation itself.

We assume that earnings come from the sale of dry leaves for power and direct sale of pods. We value the dry leaves in equivalent value of powder, ignoring processing costs. Thus, it is modelled as if dry leaves cost nothing to process and the benefits accrue to farmers.

Aquaculture

We set the fishpond size to be 1 acre in size and 8 ft in depth at its deepest point. In reality, pond sizes vary and there could be economies of scale that we neglect. We also ignore the possibility of additional livelihood activities such as *makhana* (which may be possible for shallow ponds, i.e. once these ponds silt up) or trees on the perimeter.

We cost two models – a high and a low intensity model. The former involves higher stocking density of 400 kgs of fingerlings of mixed species, including Indian Major Carps, rohu, katla, etc. and the use of commercial feed. The latter uses 300 kgs of fingerlings and relies on home-made fish feed. The yields for the former are assumed to be 10-fold and for the latter 7-fold. These reflect the fact that high intensity models with higher feed and with comparable care would yield larger fish, given comparable mortality rates, which are factored into the yield estimates. Note that this return on fingerlings depends on pond management, feeding practices and biosecurity. In this instance, the yields suggested by respondents obtain if the practices recommended by ERADA partners are followed.

We estimate the costs of home-made feed (these are imputed) and commercial feed from the accounts of our respondents. We price hired labor for feeding although some use family labor. We exclude the cost of imputed family labor for feeding fish and acknowledge here that these could be considerable. Like grazing goats, beneficiary households often spend all day checking the ponds for feeding requirements and to maintain biosecurity.

We include the opportunity costs of land (of INR 25,000 per year) in the total costs. We also include pond netting costs and costs of aerators, although these may be used by just a few of the beneficiaries.

We assume that 1% of the pond development and preparation costs, including netting and aerator costs, is spent each year on maintenance. This is a ballpark based on our understanding from field visits. We assume that 10% of total production is either retained for home consumption, shared within the village or stolen, a problem in some areas, even if uncommon. We do not account for catastrophic years when potentially the entire stock in the fishpond might die of disease.

For marketing, the current arrangement follows traditional practice where traders come with their nets and labor to harvest from the ponds, with the price adjusted for these costs, so we assume that the price reflects the absorption of transactions costs of various kinds.

Goats

In goatery, the herd size is typically dynamic and whether households grow their herd size depends on their preference and resources, especially in terms of family labor availability and availability of space to keep the goats. We make some restrictive assumptions that we believe reflect the preferences of the respondents we met. While many had just 2-4 goats and a few had very large herds, ranging from 40 to 100, it seemed that 10 goats were both an aspiration and preference. A herd size of 10 seemed to fit both the current model of production and the goat shelters that were designed (about 200 sq ft). We therefore assume a “steady state” herd size of 10 females and 1 buck, year on year, and abstract from herd size dynamics. By all accounts, households sell males and keep females. These would necessitate hiring in buck breeding services or occasionally buying a buck for breeding. It may also lead to an expansion in herd size.

For our estimates we assume that each year, only 7 of the 10 females survive, of which 6 give birth to 9 kids (assuming a twinning rate of 1.5). We assume these births are in the first quarter and these are raised and sold in the market at the end of each year. We assume that each year, 8 kids survive, of the rest, 2 female kids are retained and hence 6 are sold as adults. The assumption is therefore that there are at least 2 female kids to keep and also that the 6 that are sold are all males. The buck cannot live forever, and we include a buck purchase expense of INR 10,000 every 5 years, without adjustment for inflation, to account for buck mortality, so that the breeding buck is replaced every 5 years. We further assume that of the 6 that give birth, five produce milk that can be sold or consumed by the household. These provide the parameters we hold as fixed for our estimates.

Further, the semi-intensive/extensive model of rearing goats has different implications for feed costs. We assume, as we witnessed from our interactions with the field, that the main feeding pattern is based on grazing. Stall feeding is limited to dry and green fodder collected locally and whatever prepared feed is used supplements these.

We present three goatery models, where given herd size of 10+1 adults, beneficiaries rely on commercial feed, homemade feed or a hybrid with commercial feed for half the year supplemented with homemade feed for the rest of the year. Grazing is assumed under all models.

We include the cost of imputed family labor for cleaning the shed, obtaining fodder etc. but do not account for the full costs of grazing that can be as much as 8 hours per day throughout the year. We also assume that the land for the goat shelter would not have been put to alternate use, and the opportunity cost is therefore 0. These reflect field conditions in Pindwara.

For goatery alone, we include interest costs annually, since many beneficiaries noted having borrowed money for goat shelters or to buy goats themselves. However, in the version presented in this paper, we exclude these for consistency.

In addition, we also present alternative IRR, NPV and BCR for two types of goat shelters. The MGNREGA's cost of goat shelters is substantially higher than that developed by PRADAN-CmF. These would result in vastly different estimates of returns. Indeed, we note that for the low-cost alternative, as long as beneficiaries use home feed or the supplemental home feed model, even if these sheds were not subsidized, with a herd size of 11 adults, they would make modest profits or barely any loss from the first year itself. We present NPV and BCR for these cases, but IRR is not computable.

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