Photo Credit: Myanmar/Miguel Samper

CAN MARKET SYSTEMS DEVELOPMENT BUILD RESILIENCE IN FRAGILE CONTEXTS?

A Case Study of *Effective Seed Storage* in Timor-Leste

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MERCY CORPS

Executive Summary

Mercy Corps' Effective Seed Storage (ESS), funded by the United States Agency for International Development/ Office of Foreign Disaster Assistance (USAID/OFDA), seeks to increase food security in Timor-Leste through initiatives aimed at reducing seed and harvest storage losses and maintaining better access to quality seeds. Since August 2011, ESS has successfully developed a market system for a metal-based, customizable and locally manufactured seed storage system, branded as the "silo." ESS silos have reached 49% of all rural households in Timor-Leste, 71,613 in total. Compared to 2013 baseline measurements, these households have increased their food self-sufficiency—the number of months per year during which the food in a household comes from its own production—by 2.1 months, an 84% increase from baseline.

Against the backdrop of the 2015/2016 El Niño elongated drought and other shocks and stresses in Timor-Leste, ESS' experience of successfully implementing a market systems development (MSD) approach to achieving food security objectives in a weak market and fragile political environment, offers significant lessons for programs seeking to understand how market-based approaches can contribute to resilience. Based on the assessment, the following key recommendations emerged:

Assess stakeholder risks and needs holistically to inform MSD intervention design and partner selection

Because ESS was originally designed as a seed storage improvement program, it inherently focused on a sector that helped farmers address a key threat to food security, specifically seed and post-harvest losses. In addition, at the outset of the program, the ESS team conducted a more in-depth, participatory assessment of farmers' experiences and tolerance of risk, as well as their seed storage preferences, which helped inform program decisions around product design, private sector partner selection and market penetration approach. The current study found that contextualizing interventions based on a localized understanding of farmers' risk at the outset of implementation helped ESS contribute to resilience (see below). Specifically, ESS partnered with local blacksmiths for manufacturing a farmer-preferred silo to maximize local market outreach and penetration, and designed an appropriately-scaled transitional subsidy model that increased farmers' willingness to pay and ultimately led 49% of rural households in Timor-Leste to purchase and adopt the technology. The team's subsequent awareness and understanding of emerging risks allowed them to pivot during the 2015/2016 El Niño-induced drought to target farmers with additional resilience capacities—such as access to climate information—further highlighting how a holistic risk analysis can help inform supplementary interventions that strengthen farmers' resilience.

Harness market systems change to catalyze risk reduction and build resilience at scale

Mercy Corps' analysis found that MSD's central focus on catalyzing market systems change to bring benefits to the poor can foster relationships, ingenuity and open up unintended, but favorable, market opportunities that enable vulnerable households to better manage shocks and stresses in complex risk environments. The new connections between blacksmith manufacturers, transporters, retailers and farmers, which ESS facilitated to further a market for the silo technology, spurred new market innovations that contributed to resilience. These included a network for purchasing and selling-off of distressed livestock during the El Niño drought—reducing farmers' potential loses and providing them the cash critical to maintain food security—as well as the independent prototyping and sales of a new, local cooling system for fish, which helped households preserve food and increase incomes throughout lean seasons. Ultimately, by investing in the right sectors, actors and partnerships can enhance the performance of the market as a whole, catalyzing the provision of other resilience-building products and services and enhancing sustainability.

Build and leverage social networks to enhance markets' risk-reducing potential

Mercy Corps' analysis of ESS revealed that some contexts call for working with partners who possess or can generate high social capital with vulnerable target beneficiary groups even if they have lower capacity. The ESS team's decision to support and train blacksmiths as producers and central distributors of the silo leveraged existing relationships with farmers and market actors up the supply chain. These partnerships not only fostered the adoption of the risk-reducing technology by 71,613 households, they also catalyzed new product offerings for farmers to help them better manage shocks and stresses, as described above. Existing networks and social capital were integral to ensuring even the most vulnerable farmers could access and take advantage of these new markets. Mapping social networks, understanding how they support vulnerable households in the face of risk, and supporting the best positioned social networks and actors, can help market-focused programs ensure target beneficiary groups are equipped to better manage their risk environment.

Design smart subsidies to target immediate risks while building long-term resilience through market system change

MSD programs have long used smart subsidies to reduce investment risk. ESS's carefully-crafted, short-term silo subsidies constituted a facilitation tactic that addressed farmers' immediate financial and ecological risks, and ultimately provided the necessary stimulus and capital to spark a vibrant and sustainable market for the risk-reducing silo technology. The improved market efficiency spurred by amount and scale of the subsidy ultimately decreased silo prices by 40%, while increasing a manufacturers' profit. This transition—from managing short-term risks through subsidies to addressing long-term ones through sustained market access to risk-reducing technology—can be particularly challenging, but is even more essential, in environments where government and other development actors directly provide products they perceive farmers need but can never afford. ESS shared many of these challenges, and the subsidy design was a critical tool for ensuring the program could meet farmer demand and willingness to pay in the short term while building a self-sustaining market that supported resilience in the long term.

Understand and address gender-based vulnerabilities to build individual and household resilience more effectively

Aside from efforts through the Savings and Internal Lending Committees (SILCs) and keyhole gardens to increase women's capacity to earn "small money," ESS's failure to address several gender norms during markets intervention design may have limited the long-term resilience impacts. While well intentioned, complementary silo interventions, which helped women gain and manage small income streams during lean seasons through SILCs and keyhole gardens, only reinforced household decision-making norms favoring men's control over larger assets and expenditures. Though women eventually comprised 43% of silo voucher recipients, continued norms around household financial decision-making and the expectation that men typically interact with market actors limited women's ability to make future investments in agricultural input technology or to fully leverage the new market opportunities that the silo intervention supported. Given women's traditional role in seed storage, handling and sowing, failure to address these norms may have undermined resilience. Better understanding gender roles, rules and vulnerabilities should inform market systems development strategies to maximize resilience outcomes.

These findings underscore the potential of an MSD approach to yield significant resilience benefits, particularly where it builds wide-reaching market access for risk-reducing technologies. Investing in the right sectors, actors and partnerships can enhance the resilience of the market as a whole, catalyzing the provision of other resilience-building products and services and improving the long-term sustainability of interventions. At the same time, this analysis highlights the importance of focusing on household-and community-level social norms, particularly related to gender, within MSD programs to enhance the performance of market systems in meeting resilience outcomes.

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List of Acronyms

ESS	Effective Seed Storage
FDG	Focus group discussions
KII	Key informant interviews
MAF	Ministry of Agriculture and Fisheries
M-RED	Managing Risk through Economic Development
MSD	Market systems development
MVMW	Making Vegetable Markets Work for Smallholder Farmers in Southern Shan and Rakhine States
OFDA	Office of Foreign Disaster Assistance
SILC	Savings and internal lending committees
USAID	United States Agency for International Development

Why Study the Links Between Market Systems Development and Resilience?

Contextualizing This Case Within the Larger Assessment

Mercy Corps has traditionally worked to achieve lasting poverty reduction at scale in complex contexts through a market systems development (MSD) approach. MSD helps teams analyze supply and demand for goods and services—ranging from farm products to water supply systems—that can support economic growth and improve social outcomes. The approach guides teams to identify barriers that prevent this supply and demand exchange from working effectively on behalf of the poor, as well as specific market-based solutions. Finally, the process leads teams to identify and develop partnerships with the local, national and regional actors critical to addressing these constraints and creating the right conditions for markets to deliver improved products or services sustainably.

Foundational to the MSD approach is the tenet that project implementers should adopt a light-touch role, creating linkages between market actors and stimulating market systems to deliver the selected product or service over the long-term, rather than having the project team deliver these directly within its short lifespan. MSD has evolved into a well-established, impactful model for achieving transformational change in economic systems that has led to sustained income growth and improved economic well-being among poor and marginalized populations in many cases.

More recently, Mercy Corps has developed a resilience approach to project design and implementation. The approach evolved in response to growing concerns that frequent and often cyclical shocks and stresses have reversed development gains—particularly in more politically and ecologically fragile geographies. The resilience approach draws on the systems thinking embedded in MSD, but provides a broader lens for understanding the social, economic and ecological systems within which communities live and identify shocks and stresses that contribute to fragility and unpredictability in these systems. The resilience approach also seeks to understand who is most vulnerable to these impacts, and what resilience capacities are required to prevent risk from undermining progress toward development goals.

While both MSD and resilience take a systems perspective—focusing on how to improve system performance for the benefit of marginalized or underserviced communities—recent research and

Two Systems-Based Approaches

Systems-based approaches draw on systems thinking to unpack complex systems elements and form a greater understanding around their interconnectedness and interdependencies. Mercy Corps defines market systems development and resilience—two systems-based approaches—as follows:

Market Systems Development: An approach to working through public and private sector actors to address the underlying systemic constraints that hinder target populations' access to, and participation in, the market. Because locally embedded actors have wide-reaching connections with local populations, they can reach more people and change norms in market systems well beyond the life of the program.

Resilience: The capacity of households and communities in complex socio-ecological systems to learn, cope, adapt and transform in the face of shocks and stresses. Mercy Corps takes a systems approach to identifying which shocks and stresses pose the biggest threats to relief, recovery or development goals in a given context; who is most vulnerable and how; and what capacities households and communities need to stay on track and get ahead.

programmatic learning suggest they are not synonymous, or even automatically reinforcing.[1] MSD traditionally focuses on improved economic outcomes for the poor (e.g., increased income among a target population), more recently under the assumption that these outcomes can the help the poor improve social well-being. On the other hand, resilience building is a means or pathway to sustaining and enhancing a broad range of development goals (e.g., income, social empowerment, health, food security) in a given complex risk environment—even in the face of intensifying shocks and stresses. For Mercy Corps, introducing the resilience approach into a relatively well-established MSD approach provides opportunities to enhance program impact for the poor, but the requirements of considering multiple systems and risks can be challenging, as they introduce a new level of complexity into a relatively high-performing and bounded MSD model. To better understand where and how practitioners can better apply resilience and MSD approaches together in a way that is mutually reinforcing, this research set out to assess the relationship between them in three unique contexts. Over a period of six months, Mercy Corps asked the following questions aimed at better understanding the synergies, challenges and tradeoffs that emerge when attempting to build resilience and achieve market systems outcomes:

- **Can MSD—with a primary focus on increasing market access and incomes—help build resilience in fragile contexts? If so, which elements of an MSD approach support resilience?**
- **What are the risks of applying an MSD approach to poverty alleviation in fragile contexts without considering resilience?**
- **Can applying a resilience approach to MSD programs implemented in fragile contexts help ensure their long-term success and sustainability?**
- **Can the principles of MSD strengthen Mercy Corps' resilience approach?**

Mercy Corps explored these questions through three MSD-oriented programs in its South and Southeast Asia portfolio, each of which integrated resilience theory in their design to varying degrees: 1) Making Vegetable Markets Work for Smallholder Farmers (MVMW), an MSD program in Myanmar with no explicit resilience analysis or component in its design; 2) Effective Seed Storage (ESS), a food security program in East Timor with a central intervention focused on developing markets for seed silos to help address food security risks, and the subject of this case study; and 3) Managing Risk through Economic Development (M-RED), a program in Nepal's Far West Region designed to build resilience to natural disasters using a market-based approach. This set of programs provides three distinct vantages from which to examine the implications of and determine recommendations for applying MSD and resilience approaches in fragile contexts.

Introduction

To improve food security at the household level in Timor-Leste, Mercy Corps' USAID/OFDA-funded, Effective Seed Storage (ESS) program aimed to mitigate seed and post-harvest storage losses—a frequent result of shocks and stresses ranging from pests and food shortages to drought—while maintaining access to better seed quality. Recognizing the pitfalls of previous programs that directly delivered products to farmers but struggled with low technology uptake and long-term sustainability, Mercy Corps used a market systems development

1 Mercy Corps' More Than Markets paper explores the limitations of a pure MSD approach in Northern Uganda, ultimately making a case for the critical role of resilience in achieving the full benefits of market systems work.

(MSD) approach to improve seed storage access and use, and thus contribute to food security.[2] ESS successfully introduced a new silo technology—a metal-based, customizable seed storage system—through the local market system. Since the program's inception, ESS has reached roughly 49% of rural households across Timor-Leste, 71,613 in total.

Methodology

While ESS did not explicitly set out to build resilience in its market program design, it targeted a market sector with the intention of reducing farmers' production risks as a means to increasing food security. Following a secondary data review focused on ESS evaluations, annual reports and other program documents, the assessment team conducted a resilience orientation and program mapping exercise with the ESS team to build common understanding around Mercy Corps' resilience approach. The mapping exercise also helped the team clarify key shocks and stresses—their drivers in the program context, the connections between them, and how they affected program stakeholders. The exercise also helped the team further brainstorm where their program was helping reduce risk. This work, along with a literature review, framed the field questionnaires and identified appropriate market actors for key informant interviews (KIIs) and focus group discussions (FGDs). Field interviews helped explore: 1) which elements of the MSD approach build resilience, 2) the effectiveness and tradeoffs of applying a resilience lens to MSD programs in fragile contexts, and 3) the ways in which MSD principles can strengthen resilience.

Understanding Risk and Fragility

Using systems mapping, interviews, focus groups and secondary research, the assessment team collaborated with program staff to identify the following as key drivers of fragility and risk.

Systemic Constraints

- Limited extension services
- Limited access to improved inputs and markets
- Limited access to financial services
- Gender norms/roles: Unequal decision-making or financial control between men and women

Shocks and Stresses

- Land degradation
- Climate disasters
- Rainfall variability
- Agricultural pests and disease
- Cultural expenditure

Program Context: Understanding Fragility in Timor-Leste

Systemic Constraints

With 66.9% of employed persons living on less than $2/day, Timor-Leste ranks 133rd on the Human Development Index.[3] Most farmers rely on small-scale agriculture for their livelihoods, which is plagued by a number of systemic constraints (i.e., persistent, historical challenges and barriers in the development context that affect farmers' ability to get ahead). A weak input supply network contributes to high costs and limits smallholder farmers' access to essential production technology. Heavy subsidies from government and non-governmental organizations contribute to the problem as they crowd out traders and retailers, resulting in limited examples of services for which farmers are willing to pay. These factors have led to weak private sector investment in agricultural supply chains. Underinvestment in staff, funding shortfalls, and poor, overly-centralized government management have stifled government extension services, both in reach and technical capacity. Farmers also have limited access to affordable financial services,

2 These programs found silos were not used for their intended purpose because of mismatch between consumer demand and design, the group-sharing model for seed storage failed because of lack of ownership, farmers lacked cash and access to credit to purchase these relatively expensive storage products, and subsidizing and directly delivering storage systems was not sustainable.

3 United Nations Development Programme. (2016). *Human development for everyone: Briefing note for countries on the 2016 human development report: Timor-Leste*. Retrieved from http://hdr.undp.org/sites/all/themes/hdr_theme/country-notes/es/TLS.pdf

often prohibiting them from making investments that could increase their incomes and ability to manage risks inherent in the agricultural system.

The gender-based division of labor in agricultural production and financial management in a typical Timorese household also constrains agricultural production. Men are primarily responsible for land preparation—tending to fields, harvesting and the sale of cash crops and cattle—while women are responsible for seed handling, storage and sowing, and share responsibilities in weeding and tending to fields between planting and harvesting. Despite women's critical role in agricultural production, gender norms hold that men interface with external market actors and government extension agents, retain financial decision-making power, and determine when to purchase larger household assets. These factors limit women's ability to acquire agricultural knowledge and assets linked to their roles and responsibilities, ultimately negatively affecting food production for the household, and increasing associated food production risks.

Shocks and Stresses

A web of interconnected economic, ecological and social shocks and stresses exacerbate these systemic constraints, impacting farmers' agricultural productivity and food security, as well as their long-term economic growth potential and social well-being. In Timor-Leste, deforestation, shifting cultivation, open grazing practices and human-caused wildfires are rapidly degrading productive land. Seasonal monsoon rains and strong winds or cyclones regularly damage crops and houses. The local topography and climate increase vulnerability to stresses such as soil erosion, deforestation and declining soil fertility. Climate change further increases the variability and intensity of extreme rainfall and droughts, amplifying the impacts of land degradation and extending incidences of pests and diseases, causing devastating post-harvest crop losses.[4] El Niño, which elongates droughts, and La Niña, which results in significant monsoonal storms, are especially damaging to this island nation.[5]

Other shocks such as the death of a family member can also significantly limit a household's ability to build capital and savings, increasing vulnerability and decreasing their capacity to cope with ecological challenges. For example, cultural ceremonies can cost a Timorese household $1,000-$5,000 per year, where average rural annual income runs just below $3,600, often resulting in significant debt loads. While households save and prepare for these expenditures throughout the year, the sudden death of an immediate member can deplete savings and assets for years, affecting households' ability to meet basic needs and increasing their vulnerability to other shocks and stresses. Appendix B includes a more complete list of systemic constraints, and shocks and stresses identified during the assessment.

Program Background

ESS took a market systems approach to manufacturing, distributing and building farmers' capacity to use an improved seed storage technology that addressed their agricultural production risks and supported food security. ESS designed the silo to help farmers mitigate the threats of pests and disease and reduce overall seed losses,

4 The World Bank. (2009). *Reducing the risk of disasters and climate variability in the Pacific Islands: Timor-Leste country assessment.* Retrieved from http://siteresources.worldbank.org/INTPACIFICISLANDS/Resources/TIMOR_LESTE_ASSESSMENT.pdf

5 In 2008, La Niña storms produced localized wind, flood and landslides, impacting agriculture, roads, bridges and private homes in all 13 districts of Timor-Leste. The 2015/2016 El Niño elongated drought impacted 78% of Timorese households causing food shortages through low production and crop failure as well as sickness and death among livestock.

ultimately helping households better manage the threat of food shortages during and after a production shock, such as a drought. Beginning in 2013, and with two additional extension phases over 5 years, the program expanded from 2 districts to 11 districts, adapting its approach throughout to address other emerging constraints to household food security. Over the course of the intervention, the market price for silo technology dropped from $40 to $15, with 50% of the price of initial purchases subsidized by vouchers. Of the 71,613 households who purchased the silo, only 11,200 received vouchers, while the remaining 60,000+ purchased the silo independently after observing the benefits. To achieve these results, ESS introduced the following interventions.

The Market Intervention: An Improved Seed Storage System

Building the market for an improved seed storage system involved an assessment of client needs and demand, identifying and building partnerships for manufacturing and developing distribution channels for the technology, and ensuring that farmers could not only afford to purchase the product, but were equipped to use it appropriately. Specifically, the program trained local blacksmiths to produce and sell the silo and offered a voucher to incentivize initial purchase of the technology among the most vulnerable communities. The program also systematically worked to support blacksmiths in connecting with and exploiting local retail distribution channels to ensure the silo could reach even the most remote households in rural areas.

Photo Credit: Timor-Leste/Bruce Elliott-Litchfield

THE SILO

In partnership with researchers, blacksmiths and target communities, ESS used a design-thinking process to develop a seed storage system that met the needs of farmers: metal silos with a capacity of 35 kg, costing $23, and 75 kg, costing $26. Overall, target communities preferred these silos because they could be hermetically sealed—to control for insects without the need for pesticides—and protect seeds against rodents. The larger silo was also made available with a big open lid to allow the use of GrainPro Bags or plastic bottles to jointly store different kinds of seeds or food grains within one storage unit.

Finally, ESS also trained farmers to adapt their seed management practices to better manage risks and increase productivity. Key components of this approach included:

- Supporting local blacksmiths with business training and connecting them to the supply channels necessary to source materials for, construct and build a farmer-preferred seed storage model called the silo.
- Building a local supply chain for the silo by connecting blacksmiths with village retailers and facilitating linkages to distribution channels.
- Partnering with Ministry of Agriculture and Fisheries (MAF) extension workers, to provide extension services and improve farmers' technical capacity, including proper seed selection, drying and storage mechanisms. Extension services later provided climate information via SMS to farmers affected by the 2015 El Niño.
- Distributing smart subsidies, in the form of vouchers, partially covering the cost of silos to increase demand and ensure the most vulnerable farmers could afford the technology.

Supporting Interventions

The team implemented ESS using an adaptive management approach, which enabled them to learn, test and evaluate additional interventions critical to increasing food security in Timor-Leste. These included:

❯ Advancing Gender Inclusion

Photo Credit: Timor-Leste/Bruce Elliott-Litchfield

While the initial program recipients of the seed handling storage and capacity building interventions were mostly men, the program quickly pivoted its approach after learning the central role women play in seed harvesting, storage and handling in Timor-Leste. In addition to increasing women's inclusion in seed storage and handling trainings and better targeting them for voucher distribution, the program added interventions helping women to capitalize on their existing role of managing *osan ki'ik,* or small money, at the household level. Specifically, ESS supported a subset of women to better earn and manage small money through lean seasons and in response to and prevention of food insecurity. These interventions included:

- **Establishing or Strengthening Savings and Internal Lending Communities (SILC):** Based on a traditional group-based informal finance model, SILCs improved the financial capacity of farmers, particularly women, in better managing their income around lean seasons and food production risks. To help the households get through difficult periods, SILCs encouraged women to save earnings from traditionally women-led productive activities (e.g., selling eggs or vegetables) in increments. Referred to as the social fund, SILCs served as a type of local social safety net members could access when faced with household-level shocks and stresses.

- **Encouraging Uptake of Keyhole Gardens:** A traditional food security intervention, keyhole gardens are a water-efficient home gardening system that allow farmers to grow vegetables throughout the year, primarily for home consumption, improving their food and often their income security. Under ESS, women were targeted with capacity-building interventions on kitchen garden start-up and management. They were also encouraged to sell excess product on the market and contribute to their SILC savings.

❯ Facilitating Agricultural Extension for Drought Management

In response to the Rapid Drought Impact Assessment of El Niño 2015/2016, ESS introduced two critical complementary interventions to increase farmers' knowledge around and capacity to manage drought. The program partnered with MAF to restore soil fertility through conservation agriculture, and facilitated access to weather and climate information in the form of SMS-based seasonal planting forecasts. In increasing seed productivity, these interventions directly complemented the seed silo technology.

Key Findings

Understanding the Synergies Between Market Systems Development and Resilience

The evaluation of ESS yielded insights into synergies—where the MSD model benefited both market and resilience outcomes—and challenges, strategies and processes that resulted in unanticipated consequences for resilience. These lessons explore both the substance of these approaches—what the team focused on—and how they were implemented. Overall, these findings underline the potential of MSD to build resilience, especially where it widely expands market access for risk-reducing technology. The analysis also suggests that MSD approaches must consider household-and community-level social norms, particularly those related to gender, to enhance the performance of market systems in meeting resilience outcomes.

This section provides a case narrative organized by major finding, each of which explores these synergies, challenges and tradeoffs in making market systems development work for resilience.

Silo Success Stories

Celina Rita Maria is one the farmers in Ahic Village, Sub-District Lacluta, District Viqueque. She is 52 years old and is the head of her four-family-member household. She remarked, "A couple of year ago, I was using the traditional system for storing seed, such as hanging on the fireplace or on the trees or in the sacks. After I attended the training and using a silo, I am practicing what I have heard in the training. I am very content with the silo because it can protect my seeds from the rat and weevil that usually destroy many of my seeds and now I will not have to purchase seeds in the market when planting time comes. With the silo, I feel that I can guarantee that my seeds will be safe for the next planting time."

Eliza Pereira of Manatuto bought her first silo using a voucher. After witnessing the benefits of silo firsthand, she has bought 5 more using her savings. She uses 2 small and 4 big silos for seeds, maize grain, peanuts, and soy and local beans.

Assessing local preferences and risks can improve market intervention design for resilience

To address food self-sufficiency constraints and avoid the often unsustainable practice of distributing new technology without a longer-term supply network, the ESS team conducted market assessments and a community engagement process aimed at developing a more robust, customer-driven seed storage product. During this year-long process, ESS first commissioned a study to assess existing storage techniques, preferences and willingness to pay for new storage as the foundation for recommending potential storage types. Importantly, as part of this process, the program sourced vulnerable farmers' perceptions and experience with risk to help strengthen the silo design and increase its uptake. This included identifying types of pests and disease, length of prolonged storage periods during drought, and how much capital farmers could reasonably risk for purchase.

In collaboration with local blacksmiths, the program then developed prototypes for trial and feedback within target communities. The resulting design was a best fit for the preferences and needs of farmers: metal silos with a capacity of 35 kg, costing $23 (unsubsidized), and 75 kg, costing $36 (unsubsidized).[6] Overall, target communities preferred these silos because they could be hermetically sealed to protect seeds against insects and rodents without the need for pesticides.

6 At the time of writing, prices for these original silo designs were reduced to $17-$20 for the 35kg silo and $26-$30 for the 75kg size.

Carefully crafted subsidies can foster long-term market access for resilience-building technologies

ESS promoted early adoption of silos among poor, vulnerable farmers through a voucher-based subsidy, which brought down their retail cost. Because farmers could afford the initial investment without risking too much capital, they were much more likely to purchase and test the product. After initial testing and sales, the program linked new blacksmiths with the original manufacturers to build their capacity and increase production, expanding the network of silo manufacturers and suppliers from 2 to 17 over the course of the program. In total, ESS distributed 27,055 vouchers through local NGO partners and in close coordination with the Ministry of Agriculture and Fisheries extension officers to the most vulnerable households in the least developed villages.[7] When farmers quickly understood the silo's value after the first purchase—encouraging others to adopt the technology and increasing the overall willingness to pay—the program increased its focus on marketing and demonstrating the savings effect of silo adoption. In fact, ESS successfully encouraged farmers to purchase additional silos using their savings, to which the first purchase contributed. In ESS's first pilot site, Klakuk, where relatively wealthier farmers have larger land holdings of at least 2 hectares per household, 90% of farmers purchased one silo through a voucher subsidy, and most a second at full price. Ultimately, these smart subsidies created a larger longer-term, self-sustaining silo market for the farmers, blacksmiths and their distribution networks. The seed silo now has a penetration of 49% rural penetration rate, with 71,613 households having purchased the product.

ESS's success in using smart subsidies to build a market for the silo storage system underscores MSD's ability to stimulate demand for and scale new resilience-building technologies in the context of weak markets. Subsidies were necessary in this context, but were crafted carefully to plan for and ensure a transition to a self-sustaining market that met farmer demand and willingness to pay. For example, the scale of voucher distribution and the corresponding manufacturing requirements stimulated increased imports of the core metal material that went into silo production. This increased demand drove additional metal importers to crowd the market: the number of sheet metal importers in Dili grew from 1 to 20 wholesalers over the life of the program, reducing production costs. The combination of increased sheet metal supply and improved efficiencies in transportation networks decreased silo prices by 40%, while allowing blacksmiths to increase their profit by $5-7 per unit.[8] Most recently, blacksmiths have begun offering alternative payment methods, such as installment plans and barter systems, based on their understanding of customer need. In addition, the silo market system has played a strong role in transforming norms for seed handling and storage practice in nearly half of Timor-Leste households—far beyond the reaches of a typical direct delivery model.[9] At the beginning of the program, 83% of households relied on ineffective traditional techniques—from storing seeds in sacks to smoking them over the fire and hanging them on trees. Beyond effective storage, farmers are now separating seeds by type and using improved seed varieties. Ultimately, seed storage losses to pests and diseases have decreased 87.7% for maize, 80.3% for rice and 73.7% for beans.

Cultivating social capital and networks across farmers and market actors stimulates local markets that support resilience

Tradeoffs exist when selecting market actors as partners, as well-established, larger businesses are often favored to help MSD programs gain traction and market penetration. This analysis found that smaller but well-connected market actors may be better trusted by local farmers, allowing them deeper access within rural communities

7 Asian Development Bank. (2013). Least developed sucos: Timor-Leste. Retrieved from, https://www.adb.org/sites/default/files/publication/30343/least-developed-sucos-timor-leste.pdf
8 Mercy Corps. (2016). Phase 2 final evaluation.
9 Mercy Corps. (2016). Phase 2 final evaluation.

and ultimately strengthening rural markets' ability to build resilience. ESS's decision to engage local blacksmiths for sourcing, constructing and selling the silos—instead of a larger high-skilled business—helped build strong relationships throughout the market, from input suppliers and transporters to farmers.

Choosing fledgling and smaller-scale service providers in a weak market context meant the program had to invest substantially in business development training and entrepreneurship skill development, while supporting market linkages with input suppliers, transporters and retailers. Once the blacksmiths became comfortable with the product and sales model, the program helped them leverage and grow their networks of importers, transporters and retailers. They also capitalized on their relationships with vehicle renters and bus service providers to create a more efficient distribution chain, and some blacksmiths earned enough income to invest in their own trucks.

This analysis found that increased capacity and connections among blacksmiths and other market actors ultimately allowed them to adapt and respond to market needs, expanding their business models in unanticipated ways that contributed not only to farmers' market opportunities, but also to resilience. In Faulata, Ainaro, one blacksmith capitalized on his newfound knowledge on how to prototype products by developing a local cooling technology for fish farmers. Another blacksmith in a nearby community designed and sold improved water harvesting and storage systems. To increase accessibility, blacksmiths offered these products (and their transport to customers) in barter for livestock and crops.

Another critical example of market expansion and social capital contributing to resilience is the role of blacksmiths in creating livestock off-take channels during the onset of the 2015-16 El Niño-affected drought. For rural households in Timor-Leste, livestock are a traditional safety net. During the drought, livestock health deteriorated in two districts and farmers sought outlets for selling ailing animals (known as destocking) to prevent losing this stored capital. Transportation and business connections built through ESS allowed three blacksmiths interviewed in the El Niño affected area to buy livestock locally and resell them in Dili or a district market. Because blacksmiths also had access to a greater amount of financial resources, they were able to pay farmers in cash at the time of sale, rather than paying them only upon delivery to end markets. This destocking reduced farmers' risk of investment loses, while providing them the cash critical to maintaining food security during a shock or stress. This unanticipated ripple effect from the program showed how building local market linkages, and the capacity of trusted local actors, can create both economic and resilience benefits in unexpected areas, enabling market actors to pivot in the face of shocks and stresses to meet local needs. Other blacksmiths in comparable situations are increasingly leveraging their transportation networks to engage in livestock brokering, an activity with a high potential for building household resilience.

Finally, blacksmiths and agri-input suppliers in Dili formed an association with the intention of influencing policies (e.g., efforts to prohibit flooding the market with handouts prior to elections, advocating for freer market) at the national level. These behaviors helped strengthen market actors' ability to withstand and avoid the effects of shocks and stresses, with potential positive effects on the resilience of the households they serve. Importantly, with a product lifecycle of over 10 years, the market for silos cannot grow indefinitely, but the seed silo's market expansion catalyzed growth in other products and sectors that have had important contributions to protecting farmers against risk.

Failure to target gender-based norms and vulnerabilities in markets programs can undermine resilience

One critical area where ESS had limited success is in transforming gender norms and increasing women's participation in the market and productive activities. During its start-up phase, the program worked through

Photo Credit: Timor-Leste/Miguel Samper

traditional government-led channels to identify vulnerable beneficiaries for the intervention. As a result, only men were initially selected to represent their households in seed storage and handling trainings, as well as receive the voucher. Targeting male beneficiaries enabled swift decision-making around paying the $15-20 cost share for the silo, while helping to stimulate the market. However, because women in Timor-Leste are primarily responsible for seed storage and handling and did not have access to this new knowledge, the program missed critical opportunities to benefit household resilience.

In its second year, the program began to address this gap by targeting women for trainings and voucher distribution, increasing the initially minimal percentage of female recipients of voucher subsidies to 43% by the fifth year. The program also developed activities designed to empower women and help households manage lean seasons and challenging points in food production cycles. ESS promoted keyhole gardening to help stabilize household food production and allow women to earn income selling excess yield, and SILCs to help them accumulate small money useful for a variety of purposes, including absorbing or adapting to shocks and/or stresses. While somewhat successful, these initiatives reinforced women's role in managing only small money, while increasing the expectation that more of their limited household budget be allocated to risk management. Without promoting joint decision-making and shared responsibility for risk management, the program not only lost opportunities to transform gender norms, it decreased households' ability to invest in long-term risk reduction, often limiting the interventions' resilience benefits.

Conclusion and Recommendations

ESS took a market systems approach to manufacturing and distributing the silo, as well as to building farmers' capacity to use an improved seed storage technology. A risk assessment at the program outset informed the design of the silo to help farmers mitigate the threats of pests and disease and reduce overall seed losses, ultimately helping households better manage the threat of food shortages during and after a production shock, such as a drought. In addition, this analysis found that the program's selection of partnerships and market expansion approach created unintended but positive market effects that directly supported farmers' resilience. Our analysis also revealed where the program fell short in building household resilience holistically, by failing to more adequately address the gender barriers that prevented women from making improved resilience investments given their agricultural roles.

The following recommendations synthesize the key findings, providing a set of considerations for ensuring program design and implementation maximize both resilience and economic outcomes.

Assess stakeholder risks and needs holistically to inform MSD intervention design and partner selection

Because ESS was originally designed as a seed storage improvement program, it inherently focused on a sector that helped farmers address a key threat to food security, specifically seed and post-harvest losses. In

addition, at the outset of the program, the ESS team conducted a more in-depth, participatory assessment of farmers' experiences and tolerance of risk, as well as their seed storage preferences, which helped inform program decisions around product design, private sector partner selection and market penetration approach. The current study found that contextualizing interventions based on a localized understanding of farmers' risk at the outset of implementation helped ESS contribute to resilience (see below). Specifically, ESS partnered with local blacksmiths for manufacturing a farmer-preferred silo to maximize local market outreach and penetration, and designed an appropriately scaled transitional subsidy model that increased farmers' willingness to pay and ultimately led 49% of rural households in Timor-Leste to purchase and adopt the technology. The team's subsequent awareness and understanding of emerging risks allowed them to pivot during the 2015/2016 El Niño-induced drought to target farmers with additional resilience capacities—such as access to climate information—further highlighting how a holistic risk analysis can help inform supplementary interventions that strengthen farmers' resilience.

Harness market systems change to catalyze risk reduction and build resilience at scale

Mercy Corps' analysis found that MSD's central focus on catalyzing market systems change to bring benefits to the poor can foster relationships, ingenuity and open up unintended, but favorable, market opportunities that enable vulnerable households to better manage shocks and stresses in complex risk environments. The new connections between blacksmith manufacturers, transporters, retailers and farmers, which ESS facilitated to further a market for the silo technology, spurred new market innovations that contributed to resilience. These included a network for purchasing and selling-off of distressed livestock during the El Niño drought—reducing farmers' potential loses and providing them the cash critical to maintain food security—as well as the independent prototyping and sale of a new, local cooling system for fish, which helped households preserve food and increase incomes throughout lean seasons. Ultimately, by investing in the right sectors, actors and partnerships can enhance the performance of the market as a whole, catalyzing the provision of other resilience-building products and services and enhancing sustainability.

Build and leverage social networks to enhance markets' risk-reducing potential

Mercy Corps' analysis of ESS revealed that some contexts call for working with partners who possess or can generate high social capital with vulnerable target beneficiary groups even if they have lower capacity. The ESS team's decision to support and train blacksmiths as producers and central distributors of the silo leveraged existing relationships with farmers and market actors up the supply chain. These partnerships not only fostered the adoption of the risk-reducing technology by 71,613 households, they also catalyzed new product offerings for farmers to help them better manage shocks and stresses, as described above. Existing networks and social capital were integral to ensuring even the most vulnerable farmers could access and take advantage of these new markets. Mapping social networks, understanding how they support vulnerable households in the face of risk, and supporting the best positioned social networks and actors, can help market-focused programs ensure target beneficiary groups are equipped to better manage their risk environment.

Design smart subsidies to target immediate risks while building long-term resilience through market system change

MSD programs have long used smart subsidies to reduce investment risk. ESS's carefully crafted, short-term silo subsidies constituted a facilitation tactic that addressed farmers' immediate financial and ecological risks, and ultimately provided the necessary stimulus and capital to spark a vibrant and sustainable market for the risk-reducing silo technology. The improved market efficiency spurred by amount and scale of the subsidy ultimately decreased silo prices by 40%, while increasing a manufacturers' profit. This transition—from managing short-term risks through subsidies to addressing long-term ones through sustained market access to risk-reducing

technology—can be particularly challenging, but is even more essential, in environments where government and other development actors directly provide products they perceive farmers need but can never afford. ESS shared many of these challenges, and the subsidy design was a critical tool for ensuring the program could meet farmer demand and willingness to pay in the short term while building a self-sustaining market that supported resilience in the long-term.

Understand and address gender-based vulnerabilities to build individual and household resilience more effectively

Aside from efforts through the SILCs and keyhole gardens to increase women's capacity to earn "small money," ESS's failure to address several gender norms during markets intervention design may have limited long-term resilience impacts. While well intentioned, complementary silo interventions, which helped women gain and manage small income streams during lean seasons through SILCs and keyhole gardens, only reinforced household decision-making norms favoring men's control over large assets and expenditures. Though women eventually comprised 43% of silo voucher recipients, continued norms around household financial decision-making and the expectation that men typically interact with market actors limited women's ability to make future investments in agricultural input technology or to fully leverage the new market opportunities that the silo intervention supported. Given women's traditional role in seed storage, handling and sowing, failure to address these norms may have undermined resilience. Better understanding gender roles, rules and vulnerabilities should inform market systems development strategies to maximize resilience outcomes.

These findings underscore the potential of an MSD approach to yield significant resilience benefits, particularly where it builds wide-reaching market access for risk-reducing technologies. Investing in the right sectors, actors and partnerships can enhance the resilience of the market as a whole, catalyzing the provision of other resilience-building products and services and improving the long-term sustainability of interventions. At the same time, this analysis highlights the importance of focusing on household-and community-level social norms, particularly related to gender, within MSD programs to enhance the performance of market systems in meeting resilience outcomes.

Appendix A: Glossary

- **Crowding-in:** Similar or competing market players copy and diversify pro-poor changes supported by an intervention.
- **Demonstration effect:** Independent replication of a particular behavior, or uptake of a technology or practice, as a result of observing the benefits of someone else exhibiting these same behaviors or practices.
- **Embedded credit:** Lending arrangements between market actors engaged in business (e.g. arranging delayed payment for goods such as inputs or pre-financing business activities such as agricultural production).
- **Facilitation or a facilitative approach:** Refers to temporary interventions to stimulate and strengthen (rather than displace) market functions and players in ways that create system-wide benefits for the poor.
- **Farm gate prices:** The net value of the product when it leaves the farm, after marketing costs have been subtracted.
- **Market systems development:** Market systems development works by identifying actors that can serve as leverage points for generating widespread, sustainable change in market systems.
- **Market systems change:** A change in the way supporting functions and rules perform that ultimately improves the poor's participation in a market system.
- **Resilience:** Mercy Corps defines resilience as the capacity of communities in complex socio-ecological systems to learn, cope, adapt and transform in the face of shocks and stresses.
- **Resilience Capacities:** The ability to deal with shocks and stresses. The means by which households, communities, and groups of communities cope, adapt and transform in the face of shocks and stresses. Target beneficiaries would need to overcome these threats.
- **Shocks:** Sudden onset, unexpected, high-impact events. These are dangerous natural phenomena, human activities, or conditions that may cause loss of life, injury, or other health impacts; property damage; loss of livelihoods and services; social and economic disruption; or environmental damage.
- **Social capital:** The quality and quantity of relationships and networks that people have.
  - **Bonding social capital:** How people connect within a group, based on shared characteristics. This could include gender, caste, or being part of the same neighborhood.
  - **Bridging social capital:** Connections across groups and communities to create horizontal networks.
  - **Linking social capital:** How people connect with district, regional or national institutions and those in power.
- **Stresses:** Ongoing pressures or seasonal factors—such as land degradation, unemployment, ongoing conflict, price instability, or climate variability—that undermine resilience capacities.
- **Systemic constraints:** Broad and generalized conditions endemic to a development context such as poor mobility, weak governance, or social inequality.
- **Systems-based approach:** A development program approach that recognizes the complexity, interdependence, and dynamism of social, political, economic, and ecological conditions in a particular context, and seeks to leverage or transform these conditions to achieve lasting development outcomes for poor and vulnerable populations.

Appendix B: Resilience Context

Systemic Constraint	Description
Limited Extension Services	The majority of farmers in Timor-Leste rely on subsistence agriculture for their livelihoods and are faced with considerable constraints including limited access to improved inputs and markets, and limited knowledge of seed storage and agricultural best practices—all of which erode farmers' ability to respond to land degradation, pest and disease infestations and recover production from disasters. Agri-input prices are high, inventory is unreliable, and access is difficult outside of Dili due to a poor transport and road network system.[10] Extension services from both the government and private sector are limited and have low technical capacity. A centralized government system focused in Dili and lack of effective reward/punishment system further limits the ability of extension workers to provide timely support. An environment where direct delivery of services is common and supports election cycles poses challenges to a gradually developing private sector for agri-inputs.
Financial Services	Access to affordable financial services is a barrier to farmers making investments in economic opportunities that can lower their vulnerability against shocks and stresses to subsistence agriculture. Given Timor-Leste's topography and developing economy, commercial banks do not reach beyond district capitals. In comparison, microfinance institutions have a better outreach but their high interest rates, weekly payment scheme and inflexible rules make it unfavorable for farmers practicing subsistence farming with slow returns.
Gender Roles in a Timorese Household	Mercy Corps' assessment in different program target areas found that there is usually a gender division of labor in agricultural production and financial management in a typical Timorese household. Men are primarily responsible for land preparation and harvesting while it is largely the responsibility of the women to handle drying and seed storage as well as managing stored grain for consumption during the year. Men earn and manage *osan bo'ot,* or big money, that is made from selling cash crops (coffee and maize) or cattle. *Osan bo'ot* is usually used for special expenditures like cultural events (parties, rituals, weddings, funerals, constructing sacral houses, etc.) and to build or repair houses. A small portion of *osan bo'ot* is transferred to women for daily household expenses who manage *osan ki'ik,* or small money. Women add to *osan ki'ik* by selling garden cash crops (e.g., vegetables, banana and betel nut) and small livestock. Pronounced gender norms constrain gender inclusive programs targeting women to make substantial resilience impacts at the household level when the decision leaving power and finance to respond to any major shock and stress only to men.

10 Food and Agriculture Organization of the United Nations. (2008). *Timor-Leste national action program to combat land degradation.* http://www.fao.org/fileadmin/templates/cplpuncd/Biblioteca/bib_TL_/Timor-Leste_NAP_Revised_Draft.pdf

Shocks and Stresses	Description
Land Degradation	A combination of deforestation, shifting cultivation, open grazing practices and human-caused wildfires has made land degradation a widespread challenge to farming communities in Timor-Leste. Timor-Leste's soil is derived from limestone and metamorphosed marine clay that is low in fertility and fragile.[11] Farmers practice shifting cultivation because of low productivity of land, a practice which lowers fertility of soil in the long run, perpetuating the cycle.
Climate Disasters	The mountainous ridge that runs through the center of the country forms conditions for localized microclimates with varying wet and dry seasons across the country. Seasonal monsoon rains and strong winds or cyclones in Timor-Leste regularly damage crops and houses. Local topography and climate also make it particularly susceptible to slow onset disasters related to soil erosion, deforestation and declining soil fertility. Climate change has further increased the variability and intensity of extreme rainfall and droughts posing a threat to food security of rural farmers, amplifying the impacts of degradation and extending incidences of pests and diseases.[12] The island nation is also greatly influenced by El Niño and La Niña climate events with the first elongating droughts—the latter inducing extreme monsoonal storms.
Agricultural Pests and Diseases	In Timor-Leste, insect and rodent infestations and bacterial plant diseases pose a consistent problem during crop production and post-harvest. Infestations are further exacerbated by the combination of degradation and catastrophic weather events.[13] In the seed storage context, post-harvest crop losses are mainly credited to rodents, mold, rotting seeds (due to high moisture content) and insect infestation (e.g., weevils that particularly target maize seeds).
Cultural Expenditures	For a Timorese household, the highest expenditure is often cultural ceremonies usually around the harvest season (September–November). Depending on the household's capacity to contribute, cultural expenses can reduce household by $1,000 - $5,000 per year. These expenses are perceived as normal and households save and prepare for them throughout the year. However, a death or a wedding of an immediate member can serve as a devastating shock to household income, plummeting savings and assets for years.

11 The World Bank. (2009). *Reducing the risk of disasters and climate variability in the Pacific Islands: Timor-Leste country assessment.* Retrieved from http://siteresources.worldbank.org/INTPACIFICISLANDS/Resources/TIMOR_LESTE_ASSESSMENT.pdf

12 During the 2007-08 El Niño drought, farmers experienced locust infestations which left their crops severely damaged. Cited in: Food and Agriculture Organization of the United Nations. (2008). *Timor-Leste national action programme to combat land degradation.* http://www.fao.org/fileadmin/templates/cplpunccd/Biblioteca/bib_TL_/Timor-Leste_NAP_Revised_Draft.pdf

13 United States Agency for International Development. (2013). *The fresh vegetable value chain in Timor-Leste.* Retrieved from http://pdf.usaid.gov/pdf_docs/PA00K167.pdf

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