

CREATING ALLIANCES AND FOSTERING INNOVATIONS TO REDUCE POST-HARVEST LOSS OF NUTRITIOUS FOOD

EXPERIENCES FROM THE POSTHARVEST LOSS ALLIANCE FOR NUTRITION (PLAN)



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SUMMARY

Many of the most nutritious foods are perishable and at risk of being lost or wasted along the supply chain, which can reduce consumers' access to nutritious foods or increase prices. Such losses can be considerable, and most occur during postharvest processes such as handling, storage, and transportation. In 2015, GAIN, with the support of USAID, created the Postharvest Loss Alliance for Nutrition (PLAN) to bring together public- and private-sector stakeholders to collectively reduce loss and wasting of nutritious foods. Based on an external assessment, this working paper summarises PLAN's work in Nigeria (N-PLAN) and Indonesia (I-PLAN), impacts to date, and key learnings. Each PLAN focuses on one nutritious food and on specific areas along its supply chains, aiming to bring the right stakeholders together to improve coordination, to build their capacity, to encourage the adoption of improved practices and technologies, and to foster the development of new technologies.

The assessment indicated that PLAN has helped create influential networks, allowing diverse stakeholders to work together to address common issues related to post-harvest loss. The assessment also found that PLAN fostered inter-ministerial collaboration, that PLAN training and financing were well received and likely led to loss reduction, and that the programme surfaced new innovations. N-PLAN helped lead to the adoption of a government budget line for PHL, and members formed a new organisation to continue PLAN's objectives long after the project's end. However, PLAN also faced challenges related to catalysing financing, ensuring local relevance, and (in Indonesia) fostering sustainability.

KEY FINDINGS

- PLAN's participatory design phase was key for designing activities that had local buy-in and ultimately contributed to the creation of sustainable platforms that will hopefully continue long after the project has ended.
- PLAN's focus on one commodity and specific supply chain areas yielded benefits in bringing the right stakeholders together to address common challenges.
- The independent evaluations found that one of the greatest contributions of the PLAN programme was creating both formal and informal connections between supply chain actors through the alliances.
- PLAN members reported benefits from their engagement with PLAN, including new business deals. Some members reported significant reductions in post-harvest loss.
- PLAN has fostered innovation: in Indonesia and Nigeria, businesses reported adopting cold chain technologies and using reusable plastic crates instead of baskets for tomato transport as a result of their membership. The Business Innovation Challenge in Indonesia resulted in the launch of at least one successful product.
- PLAN also faced challenges related to catalysing financing, ensuring local relevance, fostering sustainability, and measuring impact.
- Government buy-in and alignment of PLAN objectives to existing government nutrition-related priorities were key to PLAN's success in both countries.

BACKGROUND AND OBJECTIVE

Today, one in nine people globally is hungry or undernourished, and one in three is overweight or obese (1). Malnutrition has important implications for health and wellbeing: poor diet is a leading underlying cause of death and a contributor to the non-communicable disease burden worldwide (2). In 2017, diet-related risk factors were responsible for about 11 million deaths - 22% of all adult deaths (3). Diets low in fruits, nuts and seeds, or vegetables are among the main dietary risks that contribute to the global burden of disease (3). Estimates suggest that improving dietary quality could prevent more than 11 million premature deaths, about 24% of total deaths in 2017 (4).

Ensuring healthy food is produced in a sustainable way and is accessible for all is key to tackling these challenges (1). At present, vegetable intake is below recommended levels in 88% of countries, and national vegetable production is insufficient to meet demand in 61% of countries (5). Sub-Saharan Africa, for example, has about half the per capita vegetable availability of North America, and this level has barely grown in the past 50 years (6).

These already low levels of production are exacerbated by the fact that, at present, up to 50% of fresh fruits and vegetables produced in sub-Saharan Africa are lost or wasted (7).¹ Post-harvest loss (PHL) represents about half of this amount (7), and happens when food is lost along the value chain before reaching the consumer (10), for example during storage, processing and transport. In addition to quantity losses, food can also undergo quality losses—for example, by undergoing visual damage or becoming spoiled. Postharvest losses are likely widespread (11): estimated food losses in 2017 were enough to feed about 940 million adults (12).

PHL lowers the market availability of foods compared to what was originally produced. Though the effects of loss on food security and nutrition are complex (13), this could mean that consumers have less access to nutritious foods or that those foods are more expensive than they would have been if the supply was greater. Estimates suggest that reducing food loss and waste in low- and middle-income countries (LMICs) by 10% could reduce fruit and vegetable prices by 14% (14). Damaged food may also be less appealing or pose food safety risks to consumers.

Reducing PHL thus presents a major opportunity for nutrition, with the potential to reduce the share of the population at risk of hunger by 11% and child undernutrition by 4% by 2050 (12). Reducing PHL would also make an important contribution to improving the environmental sustainability of the food system (15) and to a number of Sustainable Development Goals (SDGs)—such as SDG 12, which includes a specific target on PHL, as well as SDG 2, on reducing hunger, and SDG 1, on reducing poverty (15).

To date, many food loss-related interventions have focused on on-farm improvements, specifically on crop storage, and particularly on grains (10). However, in LMICs a considerable

¹ There is significant variation by crop and region, and no clear consensus on the magnitude of loss (8, 9).

amount of food loss is thought to occur after food leaves the farm, before it reaches the point of retail sale (13). In Sub-Saharan Africa, for example, perishable, nutritious foods like fresh produce, meat, dairy, and fish are most likely to be lost post-farmgate during the distribution, packaging, and processing stages (13). As such, there is a need for greater focus on loss reduction throughout the value chain. This includes working with small- and medium-sized enterprises (SMEs), which provide crucial warehousing, cold storage, logistical, wholesale, processing, and retail services and are central to the functioning of agricultural supply chains (16). Indeed, SMEs are estimated to handle, process or sell up to 70% of nutritious foods (17, 16). SMEs working between the farm gate and the market represent an important and underutilised pool of actors who could help reduce post-harvest food loss of nutritious foods.

To better tap the potential of supply chain SMEs to reduce postharvest loss, GAIN, with the support of the US Agency for International Development (USAID), created the Postharvest Loss Alliance for Nutrition (PLAN) in 2015. PLAN brings together different actors from across a given supply chain within a given setting to jointly identify the causes of PHL and work to address them, with a specific focus on the availability of highly nutritious foods. This working paper discusses the results of a recent external evaluation of PLAN, drawing lessons learned for future interventions to reduce PHL in LMICs through supply chain alliances. The first section summarises the PLAN approach and outlines the assessment methodology. The next sections detail the results from Nigeria and Indonesia, and the final sections discuss cross-cutting lessons learned from the programme.

GAIN'S POSTHARVEST LOSS ALLIANCE FOR NUTRITION (PLAN)

PLAN aims to bring together key stakeholders, particularly SMEs, within a given food supply chain to address the systemic barriers they face to reducing PHL, with a focus on a specific nutritious food. PLAN targets three main challenges: a lack of coordination among supply chain actors; a lack of access to the technical expertise needed to adopt improved technologies or support new innovations, particularly cold chain, crating, and processing; and insufficient access to the financial resources needed to adopt improved methods and technologies.

PLAN does this through three main interventions (Figure 1):

- i. Improving coordination among actors within a given food supply chain through the Alliance.
- ii. Building capacity, providing access to finance, and encouraging SMEs to adopt improved practices and technologies through business-to-business (B2B) mentorship.
- iii. Fostering new innovations in post-harvest loss technology through Innovation Challenges.

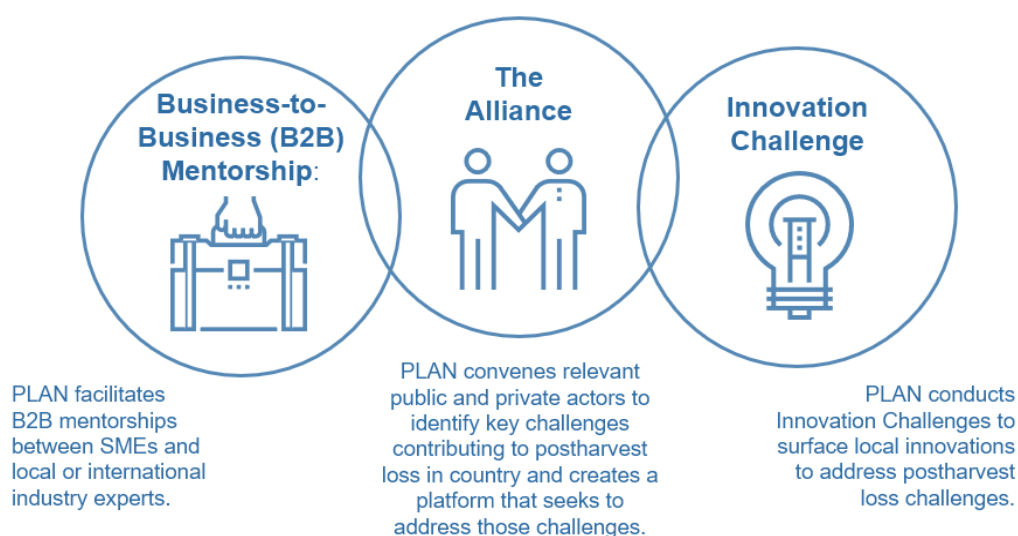


Figure 1: The three components of PLAN

PLAN provides the means for supply chain actors to meet likeminded business owners, share market information, and build social capital with other relevant actors. PLAN specifically focuses on three technical areas along supply chains for nutritious foods: packaging and crating; cold chain storage/logistics; and food processing (see Figure 2). To ensure that holistic, needed, and relevant support was provided to all elements of the food value chain, PLAN aimed to complement other existing PHL initiatives and collaborated with projects that worked directly with farmers.

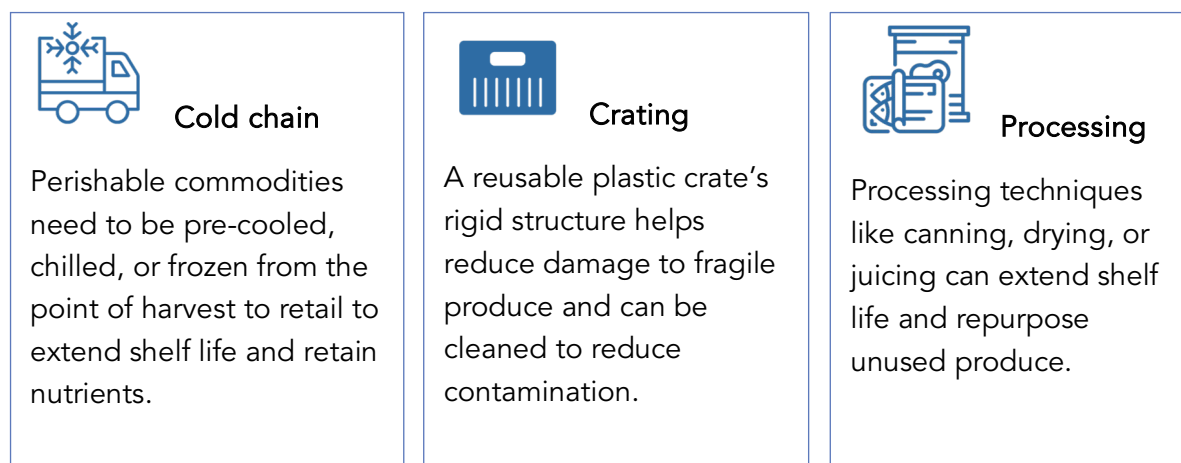


Figure 2: PLAN focus areas

PLAN is currently being implemented in Ethiopia in the early stages of implementation (with a focus on tomatoes) and in Indonesia (with a focus on fish). PLAN closed project-based operations in Nigeria in December 2019 after four years of supporting loss reduction in the tomato value chain (See Figure 3).

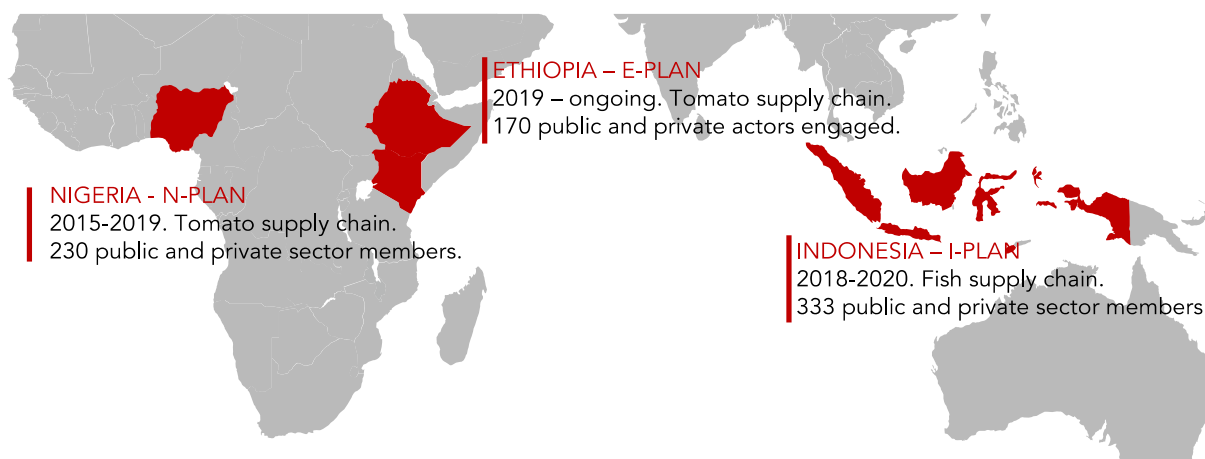


Figure 3: Locations of PLAN projects

In order to contextualise the programme to local settings, PLAN undertook a six- to eight-month design phase involving local stakeholders in each location. As a result, PLAN Nigeria implemented a Business-to-Business Engine to fill capacity gaps in cold chain logistics, PLAN Indonesia launched an Innovation Challenge to support the government’s interest in surfacing local innovations, and PLAN Ethiopia focused on an innovation—reusable plastic crates—to address transportation and packaging challenges.

This paper focuses on results and learnings from Nigeria and Indonesia. The methods used for the programme assessment are described in the next section.

ASSESSMENT METHODOLOGY

In 2019, GAIN commissioned an external consultant (Dalberg) to assess the programme’s performance in Nigeria and Indonesia.² The study aimed to assess the relevance of the programme’s design to the country context, the quality of its implementation, and its impact mapped against its theory of change. The assessment also drew out lessons for other GAIN supply chain programmes more broadly. Dalberg took a mixed methods approach involving desk research, semi-structured stakeholder interviews, and data analysis. A detailed analysis of quantitative information sourced during the desk review included progress against programme indicators, annual budgets categorised by activity, participant type, and training topics. This information was used to strengthen or refute findings from the wider desk review and stakeholder interviews. The research also synthesised qualitative information from 76 in-depth interviews with participants and stakeholders from across I-PLAN and N-PLAN, drawing out themes and common opinions to feed into the assessment. Quantitative and qualitative data was analysed and interpreted independently by Dalberg, without involvement from GAIN.

² The full assessment reports are available upon request to the authors.

NIGERIA: N-PLAN

N-PLAN CONTEXT AND GOALS

N-PLAN was implemented from 2015 to 2019 with the goal of reducing PHL in Nigeria's domestic tomato value chain. This was meant to help address limited micronutrient content in the average Nigerian diet, which is a key driver of malnutrition: only 21% of Nigerian children aged 6-24 months and 55% of Nigerian women ages 15-49 eat a diet that meets the threshold for minimum diversity of food groups (a proxy for micronutrient adequacy) (18). Increasing local tomato consumption could help increase consumption of micronutrients, such as vitamins A and C, as well as antioxidants. As of 2015, tomato loss was estimated at around 40-50%, mostly during crating and transport (19), as illustrated in Figure 4. For both nutritional and economic reasons, promoting tomatoes is a priority for the Nigerian government. N-PLAN anticipated that reducing PHL in the tomato value chain would increase tomato supply and potentially reduce prices, which would foster increased consumption.

N-PLAN focused on two main activity areas:

- **Alliance and platform building:** creating a multi-sectoral alliance across different actors involved in the tomato supply chain, with training, capacity building, facilitation of access to finance, and government engagement.
- **A Business-to-Business Engine:** diagnosing challenges facing businesses, determining their technical and financial needs, and matching them with global experts to provide specialised, in-person training and mentorship.

N-PLAN reached 354 businesses (including traders, growers, aggregators, distributors, government representatives, banks, and local universities), including 230 alliance members as well as other non-member firms that attended trainings. The Business-to-Business Engine matched 15 Nigerian businesses with international and national industry experts that provided one-on-one technical assistance.

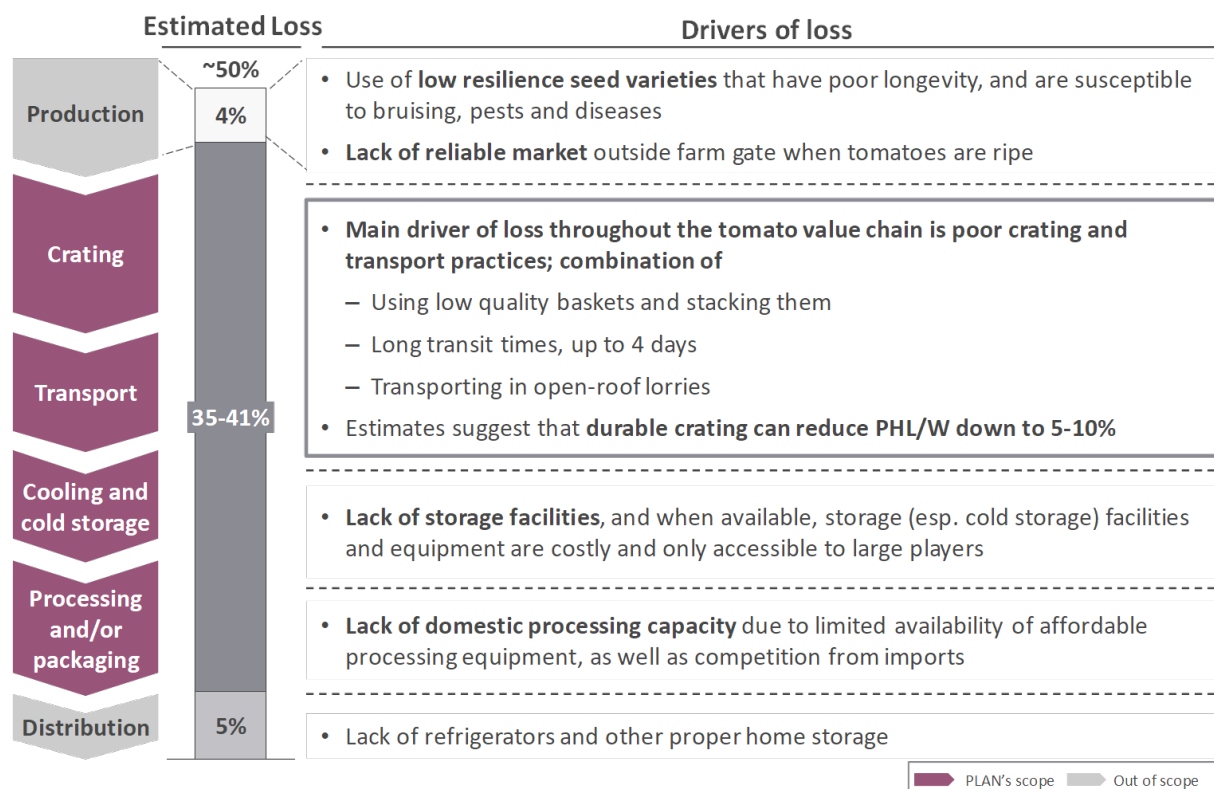


Figure 4 - Drivers of loss in the tomato value chain (19) (20)

RESULTS OF THE N-PLAN ASSESSMENT: SUCCESSES

The results of the external assessment indicate that N-PLAN was well received by stakeholders. The majority of participants found the information disseminated through N-PLAN's Alliance meetings and training sessions relevant, well-presented, and implementable. This positive feedback extended to government officials at the national and state levels, who spoke highly of N-PLAN's cooperation, success, and transparency. Stakeholders recognised that N-PLAN was different to other similar donor-funded programmes in terms of having a high-touch model with on-the-ground staff, branding, direct engagement with value chain actors (for example in local markets), and in engaging with the government early to identify challenges and co-create the project.

The external assessment also found that N-PLAN created positive outcomes across various dimensions of PHL in Nigeria. The N-PLAN platform, training and capacity building, and direct funding support were found to be the project's strongest activities.

N-PLAN platform: The N-PLAN platform provided a space for SMEs and other actors to come together to discuss common challenges and potential solutions that they might not have been able to address on their own. The

"They [N-PLAN] are doing an excellent job – they showed me how to preserve perishable produce by drying it, which was very impactful on my business."

- A tomato processor

platform also created a discussion space for actors from different sectors who would otherwise not be connected, and several stakeholders struck new business deals as a result of relationships developed through these interactions. For example, Cold Care, a cold storage manufacturing firm, began leasing cold room space to Fruits and Veggies Global, a fresh fruit and vegetable processing firm, in a transaction worth USD 12,000 per year to improve food safety and reduce PHL (20).

Training: N-PLAN trained over 1,500 participants through 17 workshops, summits, and seminars held in seven cities and over 30 capacity-building opportunities. Training primarily aimed to increase the demand for PHL technologies, such as cold storage units and RPCs. It also improved handling practices by demonstrating their importance to value chain actors, both in terms of business value and nutrition value. N-PLAN delivered five types of training: crating; market sensitisation; cold chains; processing; and writing business proposals. Of these, all but the training on writing business proposals were well received by participants. Participants reported that the training had delivered new, business-relevant, and actionable information, and many participants had already implemented the technologies and practices discussed. Trainees also recognised that the continuity of communication after training was highly valuable – for example, the trainers were available for follow-up questions on WhatsApp groups or in-person. Moreover, attendees reported that the networks they formed were as useful as the training itself.

Funding support: N-PLAN's grant funding of approximately USD 200,000, with co-investment from companies, helped contribute to increasing SMEs' cold storage capacity, including 46 MT of solar-powered cold rooms, 60 MT of diesel-powered cold rooms, and 45 MT of cold truck capacity. N-PLAN also provided subsidies for RPCs and seed capital for innovators to build new technology prototypes. Project stakeholders found this support highly impactful, given the constraints in the broader financing environment for local agribusinesses and entrepreneurs. For example, N-PLAN provided 50% match funding to

Some PLAN Nigeria members saw a reduction in post-harvest losses of tomatoes from 35-40% to below 10% after adopting RPCs.

incentivise the adoption of 17,000 RPCs. This investment influenced the purchase of over 120,000 RPCs by public and private stakeholders. Stakeholders who had adopted the technologies and practices disseminated through N-PLAN training reported a significant reduction in PHL – from 35-40% to under 10% (20). One unintended positive benefit of N-PLAN was value chain actors' use of PHL reduction technologies for fresh fruits and vegetables other than tomatoes –

this will directly contribute to improving other fruit and vegetable value chains in the country.

Technical advice and sustainability. In addition to the above outcomes, N-PLAN served as a technical expert for the government, providing input into proposed legislation to mandate the use of RPCs in Lagos' Mile 12 Market. N-PLAN members formed a new organisation to continue PLAN's objectives long after the project's end. The Organisation for Technology Advancement of Cold Chain in West Africa (OTACCWA) has over 80 paying members and

continues to advance N-PLAN's cold chain development objectives for food-loss reduction in Nigeria. OTACCWA and N-PLAN also successfully advocated for—and provided technical support to enable—a dedicated line item for PHL reduction in the Ministry of Agriculture and Rural Development annual budget (20). This helps lay a foundation for continued high-level attention to and support for PHL reduction.

RESULTS OF THE N-PLAN ASSESSMENT: CHALLENGES

N-PLAN faced a number of challenges in achieving its objectives. Firstly, N-PLAN's efforts to catalyse formal financing for agribusinesses looking to reduce PHL were not successful. Commercial banks continue to perceive this sector as high risk and typically insist on 100% collateral and high-interest rates (25-30%)—conditions that most agribusinesses cannot meet. Secondly, while N-PLAN processing training courses were among the most well-received, there has been little increase in local processing businesses as a result. This is largely due to broader ecosystem challenges, such as a lack of formal financing, high land costs, unreliable electricity, and import duties on machinery. Both these issues and the financing constraint are linked to broader systemic challenges for agribusinesses in Nigeria. While N-PLAN, given its scale and duration, was not positioned to address these issues, they will need to be addressed in the future in order to enable larger, sustained levels of PHL reduction.

On the programmatic side, the assessment found that PLAN could have done more to ensure that local businesses received support suited to the local context. For example, businesses participating in the Business-to-Business Engine found the guidance from some of the international experts to be mismatched to the local context and, therefore, less valuable than the training provided. The timing and scale of funding also limited N-PLAN's ability to plan longer-term activities: N-PLAN was funded for short periods of time (one year or less) by a variety of different donors. This meant that the project could only plan for activities in the short term—for example, the funding structure was a key reason for limited investment in monitoring and evaluation systems, which would have required more advance knowledge of the funding available over the full duration of the project.

INDONESIA: I-PLAN

I-PLAN CONTEXT AND GOALS

I-PLAN is being implemented from 2018-2020 to reduce PHL in the domestic fish value chain. Fish is an excellent source of protein, healthy fats, and essential nutrients such as omega-3 fatty acids, iodine, vitamin D, and calcium (21). Omega-3 fatty acids are essential for growth and development, so fish consumption is particularly beneficial for pregnant women and young children (21). Increasing the local supply of fish could help lead to greater consumption, which can help address current inadequacies in many Indonesian diets: only about half of Indonesian children aged 6-23 months eat a minimally diverse diet (12). This could help reduce stunting, a key presidential priority in Indonesia, where 31% of children under the age of five are stunted (22).

I-PLAN has two main components:

- **Alliance and platform building:** creating a multi-sectoral alliance from across the fish supply chain. The focus is on training, capacity building, facilitating access to finance, and engaging government.
- **A Business Innovation Challenge (BIC)** to promote local innovations to reduce food loss and waste throughout the fish supply chain. The BIC used a competitive public call for innovative new technologies to respond to an important social need. Winners received a cash prize, mentorship, and follow-up support. The first BIC solicited ideas on cold chain technologies with the potential to reduce loss, thereby saving fish supply chain actors money while helping improve fish safety and freshness. The second focused on novel fish-based food products. Box 1 showcases some of the winners of the two contests.

I-PLAN worked in collaboration with Indonesia's Ministry of Maritime Affairs (MMAF) District Fisheries Offices, which has close relationships with fishers, fish traders, and fish distributors in each district. As of June 2020, I-PLAN had reached 305 business members and 28 non-business members and received over 250 innovative applicants for each of the two BICs.

RESULTS OF THE I-PLAN ASSESSMENT: SUCCESSES

By June 2020, I-PLAN had set up a national-level Alliance, steadily grown its membership, held two rounds of the BIC, and supported various training and dissemination events in the cities of Surabaya and Probolinggo and in Probolinggo district. The Alliance has also been active at the local level, co-investing with the three District Fisheries Offices in a PHL assessment of the fish supply chain, organising training, and convening stakeholders at sub-national levels. It also held two regional focus group discussions to generate awareness and understanding of the project and associated issues at the local level.

The external assessment of I-PLAN was undertaken midway through the project. Even at the halfway point, stakeholder feedback was positive. Alliance members expressed enthusiasm for the project and willingness to take ownership of it. In Jakarta, where the national-level Alliance is based, members demonstrated a willingness to take time out of their regular jobs to take on more formal positions within the Alliance. In Surabaya and Probolinggo, government officials were found to be eager to take on more formal leadership positions in the local chapter.

The assessment also found that I-PLAN has achieved a number of positive results.

Business Innovation Challenge. The BIC succeeded in surfacing four local innovations for PHL reduction in the informal and small-scale parts of the fish supply chain (See Box 1). This was a key priority for the government. To do this, I-PLAN engaged with non-traditional entrepreneurs (for example academics, value chain actors, and government employees), thereby tapping into a generally under-explored pool of innovators in the country. Three of the four BIC winners were not traditional entrepreneurs. The BIC winners were satisfied with the project and praised I-PLAN for providing a first-of-its-kind

“There are other innovation challenges, but this one has helped to scale up, which makes it attractive”

- Business Innovation Challenge participant

platform to bring their technologies forward, in some cases motivating them to develop their prototypes faster, and providing them with technical, financial, and business support to further refine their ideas. Fish sellers using technologies identified through the BIC (for example Maslaha, CoFresh) report reducing their spending on ice and improved fish quality leading to shorter sales times and happier customers. They are also able to sell more fish without having to lower their prices towards the end of the day (or the next day).

Training. Participants found I-PLAN training useful in exposing them to new technologies and innovations. The training sessions aimed to improve fish value chain actors' approaches to fish handling and food safety and to introduce them to new technologies. Organising training next to local wet markets enabled participants to access and participate without disrupting their normal routines or incurring additional expenses.

Inter-ministerial collaboration. I-PLAN provided a platform for Indonesia's Ministry of Health (MoH) and the MMAF to collaborate more effectively on increasing the production and consumption of fish, setting a precedent for inter-ministerial collaboration in Indonesia (23). As a result of I-PLAN's coordination and advocacy, there has been increased government action to address PHL issues, including training delivered by District Fisheries Offices to fish supply-chain actors on post-harvest management and government procurement of PHL-reduction technologies (23). The MoH and MMAF signed an agreement to establish the I-PLAN Alliance, based on the alignment of I-PLAN's activities with those of MMAF, which was key to the issuance of a Decree that formalised I-PLAN in Indonesia. The MoH and MMAF have also recently signed an agreement—independent of GAIN and I-PLAN—to promote excellence in Indonesian human capital through increased fish consumption (23).

BOX 1: BUSINESS INNOVATION CHALLENGE

The first BIC identified innovative ways to prevent postharvest fish loss. Bringing together non-traditional entrepreneurs, it surfaced four winning ideas for cold chain technologies:

- **Maslaha:** A re-freezable plastic ice pack to replace ice for cooling, which sold more than 20,000 cold banks to 400 fishermen and other users (such as lactating mothers, street food vendors, and vaccine-carrying health workers) between June and December 2019.
- **CoFresh:** A fish storage and display unit for motorbikes of last-mile sellers, to replace existing Styrofoam storage boxes.
- **Prominator:** A cooling attachment towed by three-wheeled motorbikes to maintain the cold chain for fish deliverers.
- **Coolla:** A fibreglass storage box and cooling system, similar in function to a portable refrigerator.

The second BIC focused on innovative processed fish products that could reduce loss and provide a new, convenient, and nutritious fish-based food for consumers. It surfaced five winning ideas for ready-to-cook or ready-to-eat products:

- **I-Fit Serealikan,** a healthy nutritious drink made from pangasius fish, milk, and cereal; suitable for everyone, especially children and pregnant mothers.
- **Uni Urchin,** a jam made from sea urchin gonad, seaweed, and local herbs that are rich in vitamins and minerals.
- **Hokkytop,** a nutritious noodle made from milkfish fillet, egg, and high-protein wheat and tapioca flour.
- **Purulla,** a sprinkle made from seaweed, biopeptides from hydrolysate soy, and fortified with minerals and vitamins to increase iron intake.
- **Biskuit Ikan Gabus Kelor,** a nutritious biscuit for malnourished children, made from snakehead fish and moringa, which are widely available in the district.

Elevating the importance of PHL reduction. I-PLAN facilitated cross-sector dialogue by convening academics alongside private- and public-sector actors and catalysed the exchange of knowledge and information, which all stakeholders interviewed deeply appreciated. Faculty members from local universities reported that meeting new private-sector players through the Alliance had allowed them to adapt their coursework to reflect a more practical lens. Through member WhatsApp groups, fish sellers in one market were introduced to those in other markets, and these sellers frequently exchange information with each other—on PHL

reduction as well as other topics (for example, where they might purchase fish, given price and availability in different locations).

RESULTS OF THE I-PLAN ASSESSMENT: CHALLENGES

However, the assessment also found some challenges with I-PLAN implementation. Some BIC participants felt constrained by the short timelines of technical support. Other stakeholders highlighted the need for ongoing local expertise to support BIC winners, to ensure continuity of support and relevance to the local context. Stakeholders recommended adjustments to the eligibility criteria to include business models and marketing strategies, so that the road to commercialisation of future BIC innovations is clearer.



Photo: fish handler demonstrating Maslaha, a reusable ice pack for keeping fish cool supported by the BIC.

Some aspects relating to I-PLAN's long-term impact and legacy remain unclear. There are three main drivers of this. The first is scalability. While value chain actors are receptive to new ideas and technologies for PHL reduction, the actual adoption of these technologies will depend on their availability and affordability. Currently, the BIC winners (barring Maslaha; see Box 1 and picture to the left) are two to three years from being able to take their technologies to market and are in

the process of developing their manufacturing and marketing strategies. This poses a risk to I-PLAN's aim of supporting the adoption of PHL-reduction innovations at scale. Interviews with value chain actors indicated that they are likely to adopt a new technology only after having tried it themselves first, rather than by simply observing others using it. Secondly, the adoption of I-PLAN's model in Surabaya and Probolinggo remains heavily reliant on buy-in from the local government, given Indonesia's decentralised political system. However, it is unclear which local agency will anchor the project and secure buy-in from local governments beyond I-PLAN's duration. Thirdly, increased availability, accessibility, and affordability of fish will only translate to increased consumption if community members are eager to consume more fish. It remains unclear whether fish is a preferred animal-source protein for many Indonesians. If not, behaviour change interventions may be needed to increase fish consumption.

LESSONS LEARNED FROM PLAN NIGERIA AND INDONESIA

Design for local ownership. Both I-PLAN and N-PLAN implemented a six- to eight-month design phase with local public- and private-sector actors. The design phase focused on understanding the local context and challenges through participatory workshops. By engaging businesses and public stakeholders early on, PLAN was able to foster key

partnerships and contextualise the project to fit the needs of the stakeholders. Ultimately, the participants of the design workshops became the founding members and often the leaders of both countries' alliances. This phase was key for building the project and designing activities that had local buy-in and ultimately contributed to the creation of sustainable platforms that will hopefully continue on long after the PLAN project has ended.

Networks are powerful. The independent assessments (20, 23) found that one of the greatest contributions of the PLAN programme was creating both formal and informal connections between supply chain actors through the alliances. In Nigeria and Indonesia, PLAN alliances provided an opportunity for private- and public-sector stakeholders to connect, to share knowledge, challenges and experiences, and to work together to address common issues related to PHL.

Institutional sustainability is key. In Nigeria, PLAN supported the formation of a nationally owned body that continues to function, even after the end of the project. In Indonesia, a locally owned body has not yet been constructed, so it is unclear whether I-PLAN will continue to exist beyond the current project's intervention.

Scalability of new technologies depends on their availability and affordability. Experience in Indonesia suggests that, while value chain actors remain receptive to new ideas and technologies for PHL reduction, it can take two years or more for most new technologies to be ready to take to market, and most users want to test technologies before adopting them. Supporting businesses to develop and test the technology with their target customer, as I-PLAN did, creates a valuable feedback loop critical to improving the product and ensuring it fits the needs of the market.

While the BIC surfaced new technologies for PHL reduction, the road to commercialisation of these innovations was less clear. Within a market environment, new technologies are only as good as their business model—i.e. the entrepreneurs' plans for making a profit and thereby staying in business so that the innovations can be adopted. Entrepreneurs need support to develop effective business models that ensure that innovations are well-tailored to user needs and that consider from the outset factors such as potential for mass production and transport.

Aligning with government priorities and engaging government stakeholders are important. I-PLAN and N-PLAN both chose to focus on commodities that were a priority for government: this made it easier to gain government actors' buy-in and support, fostering long-term, post-project sustainability of the results.

Catalysing financing for postharvest loss may require a different approach. The 'access to finance' pillar of the PLAN approach was perhaps the least successful aspect of the programme. Although N-PLAN trained businesses to write professional business plans and connected businesses and banks through its platform, banks' low appetite for risk and high collateral requirements make accessing

"I wish there were investors or banks that could see the bigger picture and help people like us, because the opportunities are there, but unfortunately the funding is not there"

– A farmer

financing a challenge for many businesses. In the future, approaches that work directly with local financial institutions to build their capacity in understanding PHL equipment or connecting SMEs with social impact investors that consider the environmental or nutritional contribution of a business might yield better results.

Local connections and knowledge are key. Local participants viewed matches with international businesses with scepticism, as they felt that visiting businesses did not have sufficient local contextual understanding to provide appropriate recommendations. For example, one Nigerian business owner mentioned that an expert from the US advised him to add GPS trackers to crates, which was not feasible for the business given current technologies and costs in Nigeria (20).

Measuring the full impact of the programme during its implementation period proved challenging. For example, N-PLAN was based on the assumption that reduction of PHL of tomatoes would lead to increased accessibility and availability for low-income communities. This assumption is likely to be true in the long-term: interviews with value chain actors suggest significant reductions in PHL (from around 40% to under 10%) and short payback periods for RPCs. Moreover, a separate financial modelling analysis of cold chain technologies in Nigeria (24) indicated that many of the promoted PHL-reduction technologies are viable investments for the businesses concerned. As technologies like RPCs are adopted more widely across the country, it is likely that PHL will reduce significantly, leading to increased availability and accessibility of tomatoes in the country. To measure this long-term impact, however, would require several more years of data collection, evaluation, and additional funding—as well as careful consideration of evaluation design for a non-standard intervention in complex settings. Future efforts at alliance-building and other approaches for PHL reduction to improve nutrition must invest in assessing an intervention's impact over the long term in order to be able to evaluate their effect on nutrition.

CONCLUSION

Food loss is a major global problem with negative implications for both environmental sustainability and human nutrition. The experiences of PLAN in Nigeria and Indonesia suggest that there is considerable potential for improving supply chain efficiency and reducing food loss through greater coordination and capacity-building across supply chains. It is also clear that working with SMEs and expanding the focus of PHL reduction efforts beyond the farm and into the broader supply chain can help reduce PHL, through catalysing innovation, forming strong alliances to influence government, and providing sound capacity building and technical support. Indeed, PLAN's greatest contribution to date has likely been the influential networks it has fostered, which allow public- and private-sector stakeholders to share knowledge, challenges, and experiences and to work together to address common issues related to PHL. By focusing explicitly on nutrient-rich foods, PLAN has helped to better link reduced PHL with improved nutrition in the minds of stakeholders and to influence policy through that dual-goal lens.

There remains much more work to be done to foster greater PHL reduction and to make that reduction impactful for nutrition. New endeavours working with SMEs across supply chains to reduce PHL could seek to overcome some of the barriers that PLAN encountered, such as access to finance for entrepreneurs, measurement of impact on nutrition outcomes, and ensuring that new technologies are scalable. Future interventions could also consider how to build coordination and social capital in other ways, such as the use of technology-based platforms to foster transparency. Drawing on the lessons and successes of PLAN, GAIN looks forward to working with the international development community to further contribute to reducing loss of nutritious foods.

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