Approaches and Benefits of NUS Value Chain Development under the NATURE+ Initiative: An Overview

CGIAR INITIATIVE ON Nature-Positive Solutions

CGIAR's Nature-Positive Solutions Initiative (NATURE+) conducts research to develop agricultural value chains in Burkina Faso, Kenya, India, Vietnam, and Colombia. The work focuses on the untapped potential of neglected and underutilized species (NUS) and unique landraces of major crops to promote agrobiodiversity, food security, and climate resilience. NUS contribute to economic empowerment, especially for women, who retain ancestral knowledge for NUS production, processing and meal preparation. NATURE+ employs community-based approaches involving smallholder farmers and micro-enterprises. It promotes agroecology, capacity building, and engagement with local authorities to influence policy. In the CGIAR Research Portfolio 2025-2030, researchers will use these insights further to integrate environmental, economic, and cultural sustainability to strengthen local food systems.

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Development of value chains for neglected and underutilized species in the NATURE+ Initiative

1. Introduction

In this document we provide a thorough overview of the approaches utilized by the CGIAR Nature-Positive Solutions Initiative (NATURE+) to develop agricultural value chains in Burkina Faso, Kenya, India, Vietnam, and Colombia. This document results from a collective effort to develop value chains for neglected and underutilized species (NUS) coordinated by the **group on value chain development** at the Alliance of Bioversity International and CIAT (HYPERLINK "https://alliancebioversityciat.org/who-we-are/andrea-ghione"Andrea Ghione, HYPERLINK "https://alliancebioversityciat.org/who-we-are/francesca-grazioli"Francesca Grazioli, and HYPERLINK "https://alliancebioversityciat.org/who-we-are/eleonora-de-falcis"Eleonora De Falcis) under NATURE+. This report includes contributions from Alliance researchers involved in NUS activities (Marleni Ramirez, Ronnie Vernooy, Gloria Otieno, Deborah Nabuuma, Evert Thomas, Teresa Borelli, Manoj Kaushal, and Yosef Gebrehawaryat).

This report's purposes are to capitalize and circulate information about promising approaches; and inform the activities and objectives of the programs that the Alliance of Bioversity International and CIAT will carry on from 2025 onward, building on the results of the NATURE+ initiative.

One strategic element of NATURE+ is its focus NUS. In this category, NATURE+ includes local landraces of commodity crops because their unique adaptations contribute to local agrobiodiversity, food and nutrition security, and resilience to climate change. Working with NUS through conservation, sustainable use, and value addition enables the economic empowerment of local communities. In addition, NUS are culturally relevant in traditional food and health-related practices. Women play key roles in NUS management within the communities, because they often retain ancestral knowledge for the production, processing, and preparation of meals and medicine derived from NUS. Women are also eager to explore NUS market opportunities.

In this document, NUS are defined as agricultural products which have been relatively neglected by mainstream research and development and whose potential is not fully exploited. This definition allows the inclusion of Indigenous and non-Indigenous products, such as those obtained from the cacay tree in Colombia, moringa tree in Burkina Faso or from landraces varieties of crops otherwise considered as main or even commodity crops such as maize, potato, sweet potato, mango and rice.

NUS and NATURE+: a holistic, community-focused approach

Several approaches are used by NATURE+ to foster the development of NUS value chains. All approaches are community-based, involve smallholder farmers and small enterprises, promote increased use of agrobiodiversity and agroecological practices, integrate the environmental, economic and cultural dimensions of sustainable development, focus on capacity building of local actors at both institutional and technical levels, and involve local authorities in dynamics meant to spur policy change.

The main approaches utilized are:

- The development of NUS value chains **by creating institutional capital at the community level** (e.g., **community seed banks and clonal gardens**, **cooperatives for marketing**) and the **development of linkages with local markets**. This strategy is pursued in all NATUE+ target countries with significant results in Burkina Faso, Colombia, India, Kenya, and Vietnam.

- The establishment of **aggregated farms** that follow permaculture principles and enable several smallholder farmers to collaboratively test agroecological and scalable business solutions. The farms use several nature-positive practices to restore key ecosystem services. This work is ongoing in Western Kenya's Kisumu County.

- The promotion of **agro-ecotourism** to empower local communities and valorize their culture, foster demand for local and native food and agricultural products, increase and diversify income at the local level, and enable communities to negotiate with local authorities for a more sustainable development path. This approach characterizes our work in the Colombian Andean municipality of Cumbal and the conditions for its pursuit have been set up in India and Vietnam.

- Fostering linkages between **farmers' cooperatives and associations** and **schools**, which are looking for local, nutritious, and safe food for their students. This strategy has been pursued with interesting results in Burkina Faso and is incipient or to be started in Vietnam, Colombia and Kenya.

The following sections provide a deep dive into NATURE+'s different NUS approaches.

2. Creating institutional capital and fostering market linkages for effective NUS value chains

The development of NUS value chains in NATURE+ target countries is characterized by the creation of sufficient institutional capital in communities, mainly through the establishment and strengthening of community seed banks (CSBs), which are key to the conservation and supply of agrobiodiversity. NUS work by the Initiative includes collaboration with local organizations such as women's associations and farming cooperatives.

Community seed banks are grassroots institutions that conserve and distribute locally adapted seeds, and enhance agrobiodiversity, food security and resilience in farming systems. They serve

as repositories for diverse seed varieties and provide farmers with access to planting materials that are often better suited to local conditions than commercial seeds. CSBs are also platforms for collective action and foster community collaboration, knowledge exchange and equitable access to resources.

By reducing dependency on external seed markets, they empower smallholder farmers to manage agricultural practices more sustainably. Following the experience Kenya, where CGIAR established a network of CSBs around the communities of Kisumu and Vihiga, new CSBs are being established in Burkina Faso, Colombia, and Vietnam (see below).

Institutional **support of grassroots institutions (farmers associations and cooperatives)** to operate as business entities, capable of planning and marketing, is a key component of NATURE+ action in all 5 countries.

In Kenya, two local associations located near Kisumu (the communities of Agoro East and Jimo East) are supported to obtain recognition as cooperatives that will manage aggregated farms composed of small parcels owned by members. These cooperatives are NATURE+'s main partners for the design and management of permaculture interventions, and they lead land management decision-making. They also decide on priority farm investments and which products to market. These cooperatives coordinate their activities with the CSBs, which provide their members with the necessary seeds.

In Vietnam, activities center on 7 Diet Health Clubs (139 farmers) and 2 vegetable farmers' groups (43 farmers) for the development of sustainable and agrobiodiverse farming systems. Work included end-to-end capacity building (seed procurement and conservation, production and post-harvest handling). The activities emphasize nature-positive practices and agrobiodiversity utilization, practical demonstrations to enable farmers to adapt practices to their contexts, and extension of practices learned for vegetables to other crops. The Initiative also worked to strengthen vegetable value chains through the improvement of produce and income with 2 vegetable farmer groups. Capacity building focused on improving the capacity and productivity of the farmer groups in the informal seed and vegetable value chains, and increasing the groups' crop portfolio to different vegetables, sweet corn, beans, strawberries, and other produce. Some groups are now linked to markets, others to schools (see below), while others are planning to set up CSBs.

In Colombia, NATURE+ progressed from capacity building and the co-design of activities (e.g., learning tour, dairy farm improved design) to implementation, with the application of learnings to business plans and marketing. The Association of Indigenous Women Entrepreneurs of La Boyera, Cumbal, the Initiative's key partner in agro-ecotourism in Cumbal, consists of indigenous women who engage in agro-ecological farming and provide restoration and hospitality services. They emphasize promoting local foods, agriculture, and cultural traditions.

The key role of farmers' organizations in Burkina and India are described below.

2.1 The experience in Burkina Faso

Context

The Sahel region faces an intricate web of challenges, including climate change, food insecurity, and socio-economic instability, that collectively threaten the livelihoods of its predominantly agrarian population. Prolonged droughts, erratic rainfall patterns, and land degradation have significantly reduced agricultural productivity, exacerbating vulnerabilities in rural communities. The region's dependence on staple crops like millet, sorghum, and maize – combined with limited diversification – further heightens food insecurity and economic fragility. Moreover, weak infrastructure, limited access to markets, and insufficient value addition have constrained the ability of smallholder farmers to thrive within local and regional economies.

In this context, developing local value chains for NUS offers a transformative solution to address these challenges. NUS, including crops like Bambara groundnut, amaranth, and sweet potato, are inherently resilient to the harsh climatic conditions of the Sahel and possess significant nutritional and economic potential. By fostering robust value chains around these crops, communities can unlock multiple benefits: improved livelihoods through diversified income streams, enhanced food security by promoting dietary diversity, and climate resilience through the cultivation of drought-tolerant species.

Strengthening local value chains involves creating opportunities at every stage – from production and processing to marketing and consumption. This requires building capacity among farmers – particularly women, who often play central roles in agriculture – to ensure equitable access to resources and to connect producers to markets through infrastructure development and policy support. By leveraging the untapped potential of NUS, local value chains can become engines of sustainable development, fostering not only economic growth but also social cohesion and environmental sustainability in the Sahel.

This is why, NATURE+ and the parallel EU-funded SUSTLIVES project emphasize promoting NUS by supporting community-driven solutions to seed management and value chain development. This approach places farmers at the center, acknowledging their pivotal role in local agriculture and food systems. Activities span from capacity building for women's groups to the integration of NUS into local economies through culinary promotion, market engagement and educational programs in schools from different economic backgrounds.

Activities, Outputs and Outcomes

Community Seed Bank Development

Seed systems are the backbone of agricultural resilience, particularly in regions like the Sahel, where climate change and socio-economic pressures threaten food security. Community Seed Banks (CSBs) serve as vital institutions to safeguard locally adapted seed varieties, enhance agrobiodiversity, and ensure farmer access to high-quality planting materials. By conserving and distributing seeds suited to local conditions, CSBs help smallholders to withstand climatic shocks and reduce their reliance on expensive, often less suitable, commercial seeds. Moreover, these banks act as hubs for knowledge exchange, where farmers can learn best practices in seed management, storage, and crop selection. Strengthening seed systems through CSBs not only empowers farming communities to achieve self-reliance but also promotes the preservation of traditional crops, including NUS, which are crucial for climate resilience and dietary diversity.

The establishment and expansion of CSBs require targeted investments in infrastructure, training, and capacity-building. They also demand collaboration with institutions like universities, NGOs, and local governments to ensure long-term sustainability. By fostering these partnerships, CSBs can become integral components of community-based agricultural development, enabling farmers to access the resources needed to adapt to changing environmental and market conditions.

As part of a NATURE+ collaboration with Slow Food Burkina Faso, eight community seed banks were established at in strategic locations across the country including Yako, Ouahigouya, Korsimoro, Koubri, Legmoin, Kongoussi, Saaba, and Ouagadougou to the preservation and accessibility of local seed varieties. These CSBs focus on promoting the conservation and use of NUS, such as Bambara groundnut, Fabirama (*Solenostemon rotundifolius*), and moringa (a tree species), which are vital for enhancing food and nutrition security, and resilience in local farming systems (see this link for the NUS Selection process and technical information for each of them).

Seed bank establishment involves working closely with communities to ensure the sustainability of these seed banks by training local management committees on governance, seed selection, and storage practices. NATURE+ and partners trained 19 members of the CSB management committees to strengthen their capacities in seed collection, conservation, and distribution. The activity also involved the participation of 12 local women chefs about the importance and utilization of NUS in their cuisine, strengthening the market link between producers and the food sector. By 2024, more than 96 different species and 40 varieties are conserved in the new CSBs.

Additionally, the CSBs in Burkina Faso collaborate with local and national stakeholders, such as plant breeders and policymakers, in alignment with wider agricultural strategies. This approach, which connects seed conservation to local markets and community involvement, enhances livelihoods and agrobiodiversity and serves as a model for other regions.

Promotion of NUS through Women-led Initiatives

Sustainable use of neglected and underutilized species represents a transformative opportunity to address food security and income inequality, particularly when championed through women-led initiatives. Women in many agricultural communities are custodians of traditional knowledge about NUS cultivation, processing, and utilization. Leveraging their expertise to promote these crops can enhance their economic empowerment and simultaneously improve community nutrition and climate resilience. Women-led initiatives can focus on activities such as seed production, processing, and value addition for NUS-based products like flours, oils, and snacks, which have growing demand in both local and regional markets.

To maximize the impact of these initiatives, it is crucial to provide women with access to credit, training, and markets. Establishing women-led cooperatives and networks can foster collaboration, ensure equitable profit-sharing, and amplify their voices in decision-making processes. Additionally, integrating NUS promotion into school programs and community outreach activities can create intergenerational knowledge transfer and broader awareness of the nutritional and economic benefits of these crops. By placing women at the forefront of NUS value chain development, we can address systemic gender disparities while driving sustainable agricultural innovation and community resilience.

Women-led groups in Burkina Faso were trained in processing and promoting NUS including amaranth, moringa, and sweet potato through a partnership with the Italian NGO Mani Tese. This collaboration focuses on enhancing skills in small-scale food processing and adherence to HACCP standards, empowering women to transform local crops into high-quality, marketable products. Additionally, the initiative supported these groups in developing attractive branding for NUS-based products.

By employing training cascades and participatory methods, the program has built local expertise, fostering the sustainability and resilience of agroecological systems in the region. This activity was carried out as part of NATURE+, furthering its mission to strengthen community-driven solutions for sustainable development.

Market Engagement and Culinary Innovations

One key NATURE+ activity aimed at strengthening NUS value chains is an ongoing process of mapping and analysis of local markets, which focuses on producers, processors and final consumers. This includes a systematic investigation about hotels, restaurants and points of sale in order to identify existing demand and potential integration of NUS into their product ranges. Another essential point is training aimed at strengthening the skills of women engaged in food processing as described in the above section. A survey to investigate the restaurants' interest in including NUS ingredients, client preferences and ways of preparation was developed and data are being collected. Furthermore, through a collaboration with Afrique Verte Burkina, the Alliance is leading the collection of NUS market prices to include them in an already existing Price Platform (Simagri) to address one of the strongest barriers to value chain development, which is asymmetry of information between producers, the retailers and consumers.

Next Steps

Building on the progress achieved so far, the Initiative's next steps in Burkina Faso (under the CGIAR Research Portfolio 2025-2030) will focus on reinforcing the resilience and sustainability of farming communities through targeted interventions that address seed systems, agroecological practices, women's empowerment, and market development. These efforts aim to create a holistic and integrated approach to food security, nutrition, and economic development.

Strengthening Farmers Through Seed Banks and Agroecological Technologies

Initiative scientists plan to expand and improve the Community Seed Banks (CSBs) network to ensure better access to high-quality seeds that are adapted to local conditions and resilient to climate challenges. This involves **training local communities** to manage and govern seed banks effectively, with an emphasis on equitable participation and benefit-sharing. In addition, the activities in Burkina Faso will aim at **integrating agroecological technologies**, such as participatory variety selection and improved seed storage techniques to enhance crop productivity and climate resilience. A key point will be **connecting CSBs with research institutions and plant breeders**, creating a feedback loop to ensure continued improvement of NUS varieties tailored to local conditions.

Empowering Women Through Agro-Processing and Leadership

Recognizing the pivotal role of women in the agricultural landscape, Alliance scientists will continue strengthening women-led groups with advanced training in food processing and

compliance with food safety standards, enabling them to produce high-quality, market-ready products from NUS.

Developing Markets and Enhancing Value Chains

To ensure that the benefits of NUS reach broader markets, the Alliance aims at keeping working with farmers, cooperatives, and women-led groups to **develop attractive branding and marketing strategies** for NUS-based products, increasing their appeal to consumers. To create a steady demand for NUS, ongoing work will facilitate linkages between producers and buyers, including local restaurants, schools, and urban markets. To ensure efficient distribution, fair pricing and consistent supply, support will be provided to establish local cooperatives to aggregate, process, and distribute NUS products.

Building Demand Through Education and Community Engagement

In Burkina Faso, NATURE+ scientists are complementing supply-side efforts by actively working to stimulate demand for NUS. A significant focus is on schools, where the Initiative and partners integrate NUS into nutrition education programs, school meal initiatives, and community outreach activities, as described in the next pages. These efforts aim to raise awareness about the nutritional and environmental benefits of NUS among young generations and their families, fostering a culture of appreciation and demand for these crops. By collaborating with local organizations and educational institutions, NATURE+ is creating a strong foundation for sustainable consumption patterns and market development for NUS.

2.2 The experience in India

Context

In India, NATURE+ focuses on enhancing livelihoods and conserving biodiversity by developing value chains for local, neglected and underutilized species (NUS), particularly traditional crops. By working with farming communities, the Initiative identifies and promotes sustainable cultivation and commercialization of unique, high-value crops integral to traditional production systems. NATURE+ operates in two districts, Akole[1] and Nandurbar[2], where it initiated value chain development for local varieties of rice and mango, respectively. The efforts offer economic opportunities and preserve intra-specific biodiversity and traditional food systems.

In Akole, community seed banks established by the Initiative's main implementing partner in India, BAIF Development Research Foundation, play a crucial role in conserving local varieties of staple crops such as millets, rice, and sorghum. Among these, the scented rice variety "Khalbhat," recognized for its quality and demand, is prioritized by farmers for market development. Its market potential is linked to local ecotourism, offering an opportunity to highlight its uniqueness and attract premium pricing. By connecting these varieties to niche markets, restaurants, and urban centers, including consumers in Pune, Mumbai or Nashik, and strengthening coordination along the value chain, the Initiative supports local communities in expanding market opportunities while preserving additional rice ecotypes which would establish a new market positioning and open opportunities for other traditional crops.

Women in Shahada peeling deshi (local) mango for drying. June 2024. Credit: Eleonora De Falcis

In Nandurbar, the Initiative supports value addition for indigenous mango varieties through the production of amchur, a dried mango powder widely used in Indian cuisine. Rich in vitamins A and C, iron, and antioxidants, amchur conserves mangoes for year-round availability without need of cold storage or specific treatment. Amchur is prioritized for its economic potential and cultural significance. The product not only traditionally serves as a key income source during the lean season for tribal communities. Amchur from Nandurbar holds Geographical Indication (GI) status, stemming from its uniqueness and typicality, and is an important leverage point for premium pricing in niche markets, providing substantial benefits to the producing communities.

Activities, Outputs and Outcomes

In Nandurbar, amchur production involves over 2,000 families in 120 villages. Women are the driving force behind the process, contributing expertise and labor to peeling, slicing, and drying mangoes, all of which are influence product quality. Traditional production methods pose challenges, including the use of iron knives and sickles, which increases the risk of injuries and oxidation, and open-air sun drying, which can lead to contamination and inconsistent quality. The traditional process will be enhanced by improving safety standards, which results in a higher-quality product that can fetch better market prices and open new markets. A recently established farmers producer organization provides a common platform for aggregating sliced, dried mango, offering bulk storage and managing consistent pricing to support income stability for the farmers. Currently, no facilities are available and developed for farmers and local vendors in Nandurbar to convert Amchur into powder form also because no market exists for powder form of Amchur, this further step along the value chain could be explored and evaluated during the next stages. Importantly, the collective approach in processing and selling will help reduce the financial vulnerability of small-scale producers. They will be able to avoid distress sales that

farmers normally experience when they bring the product to the market, which are caused by having no storage to preserve the product and limited bargaining power.

Dozens of rice and sorghum varieties conserved by the community seed bank in the Akole cluster. June 2024. Credit: Eleonora De Falcis

In Akole, local rice varieties were identified for their premium market value, with "Khalbhat" the main variety farmers considered to have the highest potential. NATURE+ researchers will study its nutritional properties, cultivation performance, and commercial viability. To support this, a Farmer Producer Organization (FPO) was established to handle milling, processing and, in the future, branding. The FPO operates a solar-powered pilot milling machine, which enables sustainable processing. This unit is directly linked to the Community Seed Bank (CSB), which conducts participatory variety selection and manages seed sales, creating a circular model where seed production, processing, and marketing reinforce one another. The FPO processing unit could be also complemented with collective packaging and branding to ensure farmers can supply a uniquely branded product directly to tourists and local consumers, capturing more value from their rice production. By connecting these unique varieties to the ecotourism market and restaurants in the urban centers and increasing coordination along the value chain, the Initiative is supporting local communities to increase market opportunities and restore cultivation

of local varieties, which can potentially involve more rice ecotypes and other crops in the local production system.

Khalbat Rice conserved in the ICAR-NIASM facilities in Pune (Maharashtra). The brand "The Farming Monk" was developed by BAIF for marketing purposes. Credit: Andrea Ghione.

Impact

Efforts to develop these value chains demonstrate significant contributions to conservation and resilience in the communities involved. The rice FPO, for instance, can engage over 500 farmers and has potential to expand further, supporting a sustainable model that improves farmer incomes and conserves agrobiodiversity. Products like Khalbhat rice and amchur have high market values due to their unique qualities and traditional significance. For example, Khalbhat rice sold in shops can sell for 100-150 Indian rupees per kilogram compared to 70 rupees for more commercial varieties. This premium incentivizes farmers to continue cultivating this indigenous variety. Similarly, amchur benefits from its GI status, which offers it market protection and helps to differentiate it as a product unique to Nandurbar, maintaining its value and appeal to niche consumers.

In addition to economic benefits, these efforts also align with environmental sustainability goals. Solar-powered milling for rice processing and the reliance on organic, rain-fed cultivation methods for mangoes to minimize environmental impact and support low-carbon, circular

economy principles. By reducing dependency on high-input farming and focusing on rain-fed and solar-powered systems, the Initiative promotes rural ecological stability and sustainability.

Next Steps

To further strengthen these value chains, the Initiative plans to scale up the FPO's capacity to engage additional farmers, thereby expanding the economic reach and increasing rural incomes. There are also plans to develop stronger linkages with regional and international markets, including partnerships with restaurants and retailers in Pune and other cities and potential branding and packaging of collective products. By connecting these traditional crops to larger markets, the Initiative can help these products gain recognition beyond local markets. For Amchur in particular, leveraging its GI status and promoting it as a unique regional product will attract higher demand, improve market recognition, and open opportunities for premium pricing. Through these next steps, NATURE+ aims to establish a replicable model for supporting traditional crop-based value chains, enhancing rural livelihoods, and simultaneously ensuring that agrobiodiversity and cultural heritage are preserved for future generations.

2.3 The experience in Vietnam

Context

Agriculture in Northern Vietnam is characterized by a rich diversity of crops and farming practices, supported by a unique agrobiodiversity that sustains local communities and ecosystems. The ethnic minority groups in this region produce a large diversity of crops, which are used for home consumption and sale, contributing to nutrition security and income generation. However, much of this diversity is produced and maintained by only a few farmers. This was noted in previous studies on vegetable diversity and seed systems, where vegetable production was found to be limited by inadequate availability and poor quality of vegetable seeds. This is accelerated by the harsh local climatic conditions such as frost, high and fluctuated air humidity, and prolonged rains. Reports indicate that the number of vegetables grown varies by ethnic group and vegetable category. Factors that influence the numbers and types of vegetable diversity are, foremost, land availability, followed by agroecological conditions, culture, relative importance of vegetables versus other crops, availability of labor, production experience, seed access, and diverse seed sources.

Overall, there is considerable intra-specific diversity of pumpkin among the ethnic groups largely made up of farmer-managed, open-pollinated, varieties. However, farmers have reported declines in production of local and Indigenous pumpkin varieties in some villages, poor productivity of preferred varieties, degeneration of local seed, loss of local cultivars, and poor access to high-quality seed.

Activities, Outputs and Outcomes

NATURE+ collaborated with two ethnic minority groups in Northern Vietnam to select, cultivate and learn more about six local and 2 hybrid pumpkin varieties. (The Thai ethnic group in Co Noi commune, Mai Son district, Son La province; and the Dao ethnic group in Ngu Chi Son commune in Sa Pa district, Lao Cai province. These northern regions have different varieties and contrasting eco-agrological systems.) Farmers and researchers jointly implemented experimental monitoring and evaluation at mid-season and end of season. This was followed with farmer discussions to reflect on the process, lessons and opportunities.

The pumpkin production decision making process is far from simple, as farmers consider the different sale and home uses, land availability and labor requirements, and agroecological and weather conditions. The 60 women involved the work reported learning many new things about pumpkins, including crop management techniques, the importance of maintaining varietal diversity and the need to conserve adequate quantities of good quality seed. They also express interest in exploring opportunities to market the best-performing local varieties.

Farmers observations and evaluations showed that sowing seeds in trays and transplanting seedlings made it easier for caring practices after sowing. It was notably more convenient to water seeds in trays than watering seeded plots and the process was more effective compared to direct seeding in traditional practices in terms of accelerated germination, seedling emergence, and increased emergence rate. Growing pumpkins in pure stands (i.e., not intercropped or mixed with other crops like maize) increased fruit yield. However, land available for pure stands of pumpkins was limited for some farmers.

Local varieties appeared to better tolerate pests and diseases (especially fungal pathogens). New (improved) varieties were sensitive to diseases such as leaf yellowing and leaf scabs due to fungal infection. However, even when infected by diseases, improved varieties still had high number of fruits but grew poorer, and the farmers only sprayed where plants were infected (not spraying all the plants).

Overall, farmers were proactive, interested in the research, and eager to maintain diversity of pumpkin varieties. Through the NATURE+ intervention, they gained a more comprehensive awareness of the key phases of variety evaluation throughout the crop cycle and built their capacity to choose varieties that best fitted their objectives in pumpkin production. The farmers acknowledged that the production decision making process is far from simple, as farmers have to consider producing for sale or home uses, land availability, labor requirements, and agroecological and weather conditions. Farmers in both sites remarked that seed saving has become more challenging given the dwindling number of varieties and reduced production area of local varieties, which are leading to a loss of interest and capacities to maintain seeds on farms.

Farmers expressed interest in forming a farmer group for maintaining diversity of different pumpkin varieties by assigning specific varieties to some farmers to maintain on-farm, seed-sharing and knowledge exchange. How to maintain such a group was seen as a challenge, for which external support would be needed. As such, the importance of improving access to different varieties through mechanisms such as the community seed bank was evident in both sites. Furthermore, the value of assessing different varieties was appreciated with farmers sharing interest in applying the same methodology to other crops, which have a rich local varietal diversity, including H'mong cucumber, H'mong mustard, beans and local rice. Because seeds of these local varieties were not readily available in the seed markets, either saving seeds or building social networks between NUS growers are crucial to access local varieties.
The two farmers groups involved in the participatory variety selection are part of the 7 Diet Health Clubs that received practical capacity building for sustainable farming, diversification of seeds, production, post-harvest handling, and nutrition. In addition, connections to cooperatives and schools are being explored and supported.

Na Hun pumpkin experimental group, Mai Son district, Son La province, Vietnam. Credit: Deborah Nabuuma/Alliance

Pumpkin diversity Pho Hin village, Sa Pa, Lao Cai province, Vietnam. Credit: Ronnie Vernooy, Alliance

Mid-term evaluation of pumpkin experiment. Credit: Bioversity International/Nguyen Thi Phuong

Next Steps

In addition to challenges already noted, farmers also mentioned that seeds from vendors are often not reliable, and they would rather have alternative seed sources. To resolve the situation, they proposed establishing a community seed bank, expressing keen interest to learn more about what is required to establish and manage a community seed bank. Based on the results of the pumpkin experiment, the research partners – Vietnam's Plant Resources Centre, the Fruit and Vegetable Research Institute (FAVRI), and the Alliance – agreed to develop a proposal for two pilot community seed banks – one at each site – in each site in 2025.

The new CSBs will be managed by two Dietary Health Clubs led by women farmers who share knowledge and exchange skills related to producing and consuming a diversity of vegetables for health and nutritional security. Their inclusive model addresses gender disparities and fosters collective resilience, ensuring that all community members benefit from improved access to seeds, economic opportunities, and contribute to increased availability of diverse and nutritious food.

Additionally, there is a need for further research and experimental trials and capacity development to improve seed production, diversity conservation and utilization, and exploring potential market opportunities for local and Indigenous NUS varieties.

2.4 The experience in Colombia

Context

The Putumayo Department in the Colombian Amazon is a biodiversity hotspot but has been heavily impacted by deforestation and armed conflict. Post-conflict areas like Putumayo offer potential for productive land restoration and sustainable rural development through sustainable utilisation and valorisation of natural resources including biodiversity.

Small-scale farmers frequently maintain sections of forests on their lands but are often drawn to illegal agricultural activities that promise higher income opportunities, or to deforestation-causing cropping and cattle ranching systems. NATURE+ therefore aims to scale profitable, equitable, environmentally friendly agroforestry-based land uses that enhance carbon sequestration through an online decision-support tool for cacao agroforestry design (www.cacaodiversity.org).

The principal assumption NATURE+ work in Putumayo was that if farmers have access to reliable information and technical support to develop productive activities on already deforested land that are as profitable than current illegal or unsustainable agricultural activities, they are more likely to adopt legal land uses with low to net-negative carbon emissions, while retaining or increasing income.

Multiple timber and non-timber products have increasingly high value in the target region, and for many of these, current supply is a fraction of demand for produces such as asaí (*Euterpe* spp.) berries or cacay (*Caryodendron orinocense*) seed oil. Through combinations of such species with different harvest cycles, blended with revenue from carbon and biodiversity creditsm, and supplementary activities such as honey or vanilla production, it is possible to attain comparable or higher yearly incomes than illegal crop cultivation.

However, multiple barriers currently limit wide-scale adoption of such land uses, such as lack of investment capital and incentive mechanisms; adverse rules, regulations and bureaucracy; absence of reliable cost-benefit data for different land use options; limited access to quality planting material; limited knowledge on crop and tree management, harvest and post-harvest management; and constrained access to profitable markets and related knowledge to capitalize on transitioning to nature-positive production. Moreover, access to such information, resources, and markets is inequitably distributed within the target communities, thereby excluding women and marginalized groups from potentially profitable livelihood opportunities.

Activities, Outputs and Outcomes

NATURE+ carried out an extensive market study to understand the demand for and current trading volumes of timber and non-timber products that can be grown in agroforestry systems. The work identified 22 species that produce fruits, nuts or seeds with commercial value and 78 local buyers of these products. It also identified 33 commercial timber species and 133 local businesses that buy and process timber. These species are prioritized for planting in agroforestry systems depending on the current supply-demand balance. Good quality planting material of these species is guaranteed through (i) the identification of 1,200 tree species in the forest and on farms from which seeds can be harvested, in collaboration with Corpoamazonia, a government environment-management organization, and (ii) the set-up of clonal gardens and seed orchards for the most commercially important species (five species thus far), in collaboration with NATURE+ partner Forestpa SAS, and NGO. The clonal gardens and orchards

are established on land provided by Corpoamazonia, which will guarantee accessibility to the material for all farmers interested. The key species established in clonal gardens is cacay (*caryodendron orinocense*), an edible nut also used for extraction of a high-value cosmetic oil that is currently harvested mainly from natural trees and has a rapidly growing market with multiple investors establishing large plantations. The clonal garden will permit smallholders to access quality propagation material and hence connect to this value chain in full expansion.

Next Steps

NATURE+ closely collaborates with Conservation International (CI) on the development of demonstrative agroforestry plots through the co-design process implemented in our decision-support tool cacaodiversity.org with ten beneficiary families of the CI agroforestry projects. The co-design process includes species with local commercial value to develop cost-benefit projections and supports farmers' access to quality planting materials from identified seed trees and clonal gardens.

3. The Aggregated Farm Model in Kenya

Context

The aggregated farm model developed by NATURE+ in collaboration with communities in Western Kenya is a holistic, scalable approach to enhancing agricultural productivity and sustainability on degraded, fragmented landscapes.

The NATURE+ aggregated farm Kisumu is rooted in the principles of permaculture, a regenerative agricultural approach designed to work in sync with natural ecosystems. The approach emphasizes sustainable land use, integrating crops, livestock, and agroforestry to create self-sustaining systems that reduce external inputs and environmental impacts. Through soil regeneration, water conservation, and biodiversity enhancement, the permaculture framework supports the development of climate-resilient, nature-positive farming tailored to local contexts.

Key interventions include **soil health restoration** using organic matter (including crop residue and food waste), crop rotations, **water harvesting systems** to ensure consistent irrigation during dry periods, and the **integration of tree crops** and native plants for enhanced agrobiodiversity and ecological balance. The aggregated farms also employ circular bio-economic activity so that all waste produced on the farms is recycled and re-used within the farms.

The aggregated farms operate on a shared land management model, where cooperatives of farmers collaboratively govern the land and resources. Farmers in the cooperative retain ownership of their plots but agree to relinquish possession and to manage the aggregated land according to a broader rationale. Collective management ensures that benefits are distributed equitably among members, fostering social cohesion and shared responsibility.

The model includes **joint design and planning of investments and activities in the aggregated farm**, setting of **ground rules for land use and governance**, including the election of cooperative boards and the equitable distribution of responsibilities and profits, **joint investment in shared infrastructure** such as irrigation systems, processing units, and storage facilities, and **collective risk management**, which enables smallholder farmers to pool resources and mitigate individual vulnerabilities.

Central to the aggregated farm model is the **development of value chains** that connect producers to markets in a sustainable and profitable manner. NATURE+ focuses on diverse products, including cereals, beans, leafy vegetables, fish, poultry, and livestock. Special attention is given to value addition of produce, processing and branding to maximize market value.

Current efforts include **post-harvest processing and value addition**, such as solar drying leafy vegetables or producing high-quality fish fillets. The farmers are also currently producing and branding composite flour made from finger millet sorghum, cassava sweet potatoes and amaranth. **Local market linkages** connect farmers with schools, restaurants, and community markets. The Initiative and local partners **support women entrepreneurs**, enabling them to lead value chain activities and benefit from income diversification.

Aggregated farming is synergistically linked with Community Seed Banks (CSBs) in Kisumu (membership in CSBs and the cooperatives managing the aggregated farms also overlap), ensuring access to high-quality seeds that are locally adapted and resilient. These seed banks play a crucial role in:

- **Maintaining biodiversity** with a focus on indigenous crops that are well-suited to local conditions. Crops include sorghum, finger millet, cow peas, pigeon peas, traditional leafy vegetables, cassava, sweet potatoes, yams, pumpkins, arrow root, common bean, local maize varieties, banana and fruit trees (mango, oranges, guava, papaya and passion fruits).
- **Providing seed security** by increasing the diversity of crops available to farmers through availability of quality seed and improving accessibility of seed to farmers.
- **Empowering women** as key custodians and managers of the community seed banks, making collective decisions about the conservation, sustainable management, and value addition activities related to seeds and produce.

Through this integrated approach, the aggregated farm mode enhances agricultural productivity, strengthens community resilience and promotes sustainable development. By combining permaculture principles, collective governance, value chain development, and synergies with CSBs, the model creates a robust framework for addressing food security, economic empowerment, and environmental challenges in Kenya. For more details, please see this comprehensive description of all activities planned: https://www.cgiar.org/news-events/news/initiatives-first-nature-positive-farms-are-a-community-effort-in-kenya/

Farmers in Kisumu led the planning phase of an aggregated farm.

Activities, Outputs and Outcomes

Farm aggregation integrates diverse value chains and fosters collective action among farmers to address systemic challenges in modern agriculture. The production of African Leafy Vegetables (ALVs) holds significant potential for growth due to their relatively straightforward cultivation requirements. Many farmers are already successfully increasing their production, albeit on a garden-sized scale. Part of the community farm initiative involves providing training to farmers on how to scale up their plot-level production to meet market demands. However, some challenges persist.

The project activities focus on millet, sorghum and local varieties of maize. Millet plays a crucial role in the food security and cultural practices of communities in Kisumu. As a drought-resistant crop, it is highly valued for its ability to thrive in semi-arid conditions, making it a reliable staple for many households. Economically, millet is often grown on a small scale by subsistence farmers, contributing to local food supplies and providing a source of income through local markets. Culturally, millet is deeply ingrained in traditional diets and is used in the preparation of various local dishes, including porridge and fermented beverages, which are integral to social and ceremonial occasions. Despite its importance, the production of millet faces challenges such as fluctuating market prices and limited access to improved farming techniques.

Sorghum is another vital crop in Kisumu because of its versatility and resilience to climate change. Economically, sorghum serves as a key cereal crop, providing food and fodder, and offers farmers a source of income through sales at local markets. Its ability to withstand dry conditions makes it a preferred choice among farmers in regions with unpredictable rainfall. Sorghum is also culturally significant as it is used in the preparation of traditional foods and beverages that

are central to the culinary heritage of the region (e.g., weddings). Additionally, sorghum used for brewing local beers contributes to its economic value. However, like millet, sorghum production is challenged by limited marketing opportunities and the need for better storage and processing facilities.

Maize is the most widely cultivated crop in Kisumu, serving as both a staple food and a major economic commodity. Farmers in the region focus strongly on cultivating local and traditional maize varieties, which are well-adapted to climate and soil conditions. The varieties are integral to the region's food security and contribute to preserving agricultural biodiversity. Economically, local maize varieties are a primary source of income for many farmers, who sell surplus produce in local and regional markets. Culturally, maize-based dishes such as ugali, made from these traditional varieties, are central to the daily diet. However, maize production in Kisumu, particularly traditional varieties, faces challenges, including vulnerability to pests and diseases, fluctuating input costs, and the impacts of climate change, which affect yields and livelihoods. To sustain the cultivation of these traditional varieties, it is essential to improve agricultural practices, enhance access to inputs, and strengthen market linkages, ensuring the continued profitability and cultural relevance of maize in the region.

Complimentary crops include cassava, a drought-tolerant crop that is available all year and provides calories during the off-season. Cassava is also used to blend with maize, sorghum and finger millet for composite flour used for various local traditional dishes. Traditional African leafy vegetables (ALVs) are integral to local crop production. A diversity of 17 genotypes of ALVs, grown mainly by women, provides a rich source of dietary diversity and nutrition. ALVs also provide income for women who sell surplus in the local market. Another major crop is the common bean, the most important source of protein in the community. The seedbanks conserve about 47 varieties of beans, which are locally adapted and drought tolerant. Beans are mainly grown during the short rainy season and are used for intercropping with maize and sorghum.

All the above-mentioned diversity is conserved in Community Seed Banks (CSBs). CSBs promote gender equity by creating opportunities for women in seed management, decision-making and governance. Women often lead efforts in seed selection and value addition, such as in Kenya, where the CSBs are processing grains into flour or drying vegetables for sale, which generates income and elevates their status in the community. Community seed banks also intentionally involve men to ensure their participation and support, preventing a sense of exclusion and fostering shared responsibility. By including women and men in training programs and decision-making processes, CSBs strengthen community-wide collaboration and create a more inclusive approach to sustainable agriculture.

The Kabudi-Agoro Women's seed bank was established by 27 women to help improve their seed security. There, they access seeds by borrowing and returning seeds instead of having to purchase them. This only improved seed security and enabled the women to engage in the production and aggregation of sorghum, finger millet, cassava and ALVs for sale at the local market or to private sector buyers. The women are also engaged in value addition through the production of composite flour consisting of different formulations with sorghum, finger millet, amaranth cassava, sweet potatoes and pumpkins.

Kabudi Women's community seedbank produces composite flours. Photo credit: Bioversity International/R. Vernooy

Another important aspect of this work involves the development of composite flour, an innovative product that blends locally grown crops like sorghum, finger millet, cassava, amaranth, sweet potatoes, and pumpkins. NATURE+-supported efforts are directed toward refining the composite flour recipe, focusing on nutritional analysis, taste, texture, and

adaptability for traditional and novel dishes. Collaborative trials are conducted with local partners, including restaurants like the Reeds Rivera Hotel and Dani Ahero in Agoro and Jimo. These partnerships allow chefs to test the flour in diverse culinary applications and provide critical feedback for product improvement.

Additionally, the project includes innovative circular bioeconomy approaches like black soldier fly (BSF) farming. The larvae produced are sold to local chicken farmers, as a protein-rich substitute for more costly feed, thereby enhancing poultry production systems. Plans are underway to integrate the larvae more broadly into poultry farming while expanding the scope to include future ventures in dairy farming and the development of organic fertilizers. This will further diversify income streams, enhance soil fertility and health, and increase productivity, decrease costs, and improve the socio-economic status of the communities.

By connecting these activities through CSBs, the project strengthens the community's ability to preserve agrobiodiversity, empower women through production and value addition, and foster inclusive decision-making processes. These efforts collectively create a resilient agricultural ecosystem that supports sustainable livelihoods, food security, and environmental health.

In addition, efforts to reinforce and study the traditional ALV value chain focus on understanding the intricate dynamics of their production, marketing and consumption. Initial studies mapped existing supply chains and identified key actors including women farmers who dominate production, local vendors, and small-scale processors. These assessments highlight the barriers to scaling up production, such as limited access to quality seeds, insufficient technical knowledge, and weak market linkages. Through participatory research, farmers provide critical insights about local challenges, ensuring interventions are locally tailored and impactful.

To enhance production, targeted training programs were recommended, focusing on sustainable farming practices such as integrated pest and disease management, soil and water management, intercropping and crop rotation techniques specifically suited to ALVs. Post-harvest losses have been a significant issue, and capacity-building workshops on handling, drying, and packaging TLVs have been suggested as well, to enable farmers to retain the nutritional value of the produce while extending its shelf life. These measures not only will support the livelihoods of the producers but also contribute to the broader goals of food security and biodiversity conservation.

On the marketing side, informal surveys with local restaurants and market outlets were done to increase demand for ALVs, emphasizing their nutritional and culinary value. Branding and promotional activities are in the pipeline to position ALVs as premium products that are attractive to urban consumers seeking healthy and locally sourced foods. Such initiatives will bolster the visibility and economic viability of ALVs, turning them into profitable ventures for farmers while preserving their cultural significance and nutritional importance.

Next steps

The Aggregated farms in Kisumu faces several challenges that underscore the complexities of implementing sustainable agricultural practices in a dynamic socio-economic and environmental context. One of the primary hurdles is the need for continuous capacity building among farmers, many of whom are transitioning from traditional practices to more integrated, resource-intensive approaches. Ensuring consistent knowledge transfer, particularly regarding permaculture techniques and cooperative governance, is critical to maintaining momentum and achieving

long-term sustainability. Soil is also a concern; one challenge will be restoring long-degraded soil to sustain future agriculturally diverse cultivations.

Another significant challenge concerns developing market linkages and value chains. While the model emphasizes local production and processing, the infrastructure for storage, transportation, and access to high-value markets remains underdeveloped, often limiting farmers' ability to maximize profits. Additionally, the equitable distribution of benefits within the cooperative framework can sometimes lead to tensions, requiring robust conflict resolution mechanisms and transparent decision-making processes.

Looking ahead to continued work under the CGIAR Research Portfolio 2025-2030, the focus will be on reinforcing farmer capacity through targeted training programs that address knowledge gaps in permaculture, agroecological practices, and value chain management. Investments in infrastructure, including storage facilities and processing units, will be prioritized to enhance market readiness and reduce post-harvest losses. To strengthen governance, the cooperative boards will be equipped with tools for effective decision-making and conflict resolution, ensuring inclusivity and accountability.

Building synergies between the aggregated farm model and CSBs remain a strategic priority. Expanding the role of seed banks in providing resilient, locally adapted seeds can further support the farm's efforts to enhance agrobiodiversity and climate resilience. Women, as central actors in seed management and value addition, will be empowered through tailored programs that amplify their leadership and entrepreneurial roles.

Ultimately, the next steps will involve fostering partnerships with policymakers, market actors, and research institutions to create an enabling environment for the aggregated farms. These collaborations will be vital in scaling the initiative, addressing systemic challenges, and ensuring that the model delivers on its promise of sustainable and inclusive agricultural development in Kisumu.

4. Creating a supportive environment for agro-ecotourism development

4.1 The experience in Colombia

Context

Resguardo Cumbal, Nariño, boasts a beautiful landscape of rolling hills and dairy and farm plots separated with live fences and the Paramo vegetation from the Tropical Andes, commanded by the Cumbal Volcano (in picture spewing fumes). The Pasto ethnic group makes up over 90% of the community's population of 43,000. The Association of Indigenous Women Entrepreneurs (AIWE) of the Boyera Sector (42 members, 40 women, 2 men) are direct NATURE+ participants in agro-ecotourism. AIWE membership includes owners of agroecological farms, production of bioinputs for self-consumption by several farmers and spaces partially conditioned to receive visitors. All farmers keep dairy cows.

The active Cumbal Volcano, Colombia. Photo: Bioversity International/R.Vernooy

Cumba'ls lake, Laguna de la Bolsa, near the Cumbal Volcano. Photo by Andrea Ghione.

When NATURE+ visited sites in Colombia looking for locations to develop nature-positive activities, researchers found that the Cabildo of Resguardo Cumbal, the community's Indigenous authority, had several concerns with the area's existing development path. Of particular concern is their reliance on milk production from cows and the consequent reduction of farming areas dedicated to crops; and loss of traditional crops, culinary traditions and cultural heritage, particularly among younger generations. They are also very conscious of the negative effects of dairy farming on the survival of the paramo landscapes, which are key for water conservation but are being lost and contaminated by farming.

Indigenous leadership advised the Initiative to work directly through community associations, given their support for nature-positive activity.

Selection of strategy (why agro-ecotourism)

Given the population's interest in utilizing local crops for development, NATURE+ examined four value chains to determine their potential for improvements, or development, consistent with nature-positive principles. Researchers considered Chaucha native potatoes, dairy milk value chains, bioinputs, and agroe-cotourism. The lattermostresulted in the most promising for NATURE+ support. There is already an influx of tourists (mostly national) that come to the area attracted by Cumbal's volcanic lake and to climb the volcano. There is strong potential to develop sustainable tourism that focused on rural and agricultural experiences that support the cultural and ecological conditions needed for quality of life in Cumbal.

Tourists seeking a unique and enriching experience that contributes to the conservation of the natural and cultural heritage would find a quality offer in Cumbal. Such tourism would respond to a strategy of income diversification that most if not all families practice already, but feel that they need new options given the fluctuations of the prices of milk (which remains the main source of income) and their interest in transitioning towards nature-friendlier economic activities that could potentially attract more youth interest in agricultural and related activities.

Details of the strategy – what elements are included

- An assessment of the human capital and budding interest in the Resguardo Cumbal was done through a workshop that identified potential participants.
- A follow-up gathering about food and lore was convened to determine the use and knowledge about local foods, food traditions (recipes) and participants' motivations.
- Market assessment through a value chain study confirmed the gap this initiative could fill, including exploring perceived opportunities with tourism authorities in the Department of Nariño.
- The initial focus was on capacity-building activities of the Women's Association (AIWE) with a view to offering a high-quality agro-ecotourism experiences.
- Close alignment with other NATURE+ activities supporting the increased conservation and use of agrobiodiversity, such as (i) the establishment of a new CSB in the region, (ii) the identification of chefs of restaurants interested in buying native products from Cumbal, (ii) and the transition of livestock raising for dairy-milk towards nature-friendlier practices via the cultivation of native forages, activities which are fully complementary and synergistic with agro-ecotourism in the locality.

  The CSB is hosted by the Indigenous Technical Agricultural Education Institution of Cumbe. It is expected that the agro-ecotourism ventures and the Indigenous school

will collaborate to include the CSB in visitor tours. The CSB and its co-management by the community and Student's Assembly will be part of the attractions for locals and visitors.

Photo: The new CSB in Cumbal, Colombia, named Yel Pue or our seed house. Photo: Bioversity International/R.Vernooy

Activities

The main actions taken are:

1. Experiential training programs on agrotourism and Novo Nariñense cooking were designed after we undertook the first stakeholder and food traditions assessments, and in consultation with would-be trainees.
    - Learning tour on agro-ecotourism. A group of 6 women entrepreneurs with membership in two associations traveled to Northern Ecuador to learn firsthand from two successful experiences in agro-ecotourism of two indigenous Quichua communities, Santa Barbara and San Clemente (Tours de aprendizajes - Nature-Positive Solutions). They stayed at community lodgings, experienced the services provided and had exchange sessions with their hosts to learn about their stories and challenges over their 20 years of development. The learning tour was a resounding success at many levels (Informe Tours de aprendizaje.docx). Afterward, both groups of trainees (including the gastronomic internships below) shared and demonstrated their learnings to about 60 people from the Associations and other interested parties in Cumbal. These learnings were immediately put into practice by AIWE and have spurred Association meetings – beyond the trainees – to experiment and adapt the learnings to Cumbal's context.

- Training, gastronomic deep dive. Two young people (one man, one woman) from Cumbal had a one-week internship in a famous restaurant of Novo-Nariñense food in the capital city of Nariño, Pasto.

2. Development of branding for the agro-ecotourism and fresh produce offerings, through participatory exercises. Consulted with knowledgeable partners from the Indigenous School to recover naming options in the extinct Pasto language. The brand name is YARPURAM (House of Life), below with the logo (stylized hand, sun and seed).

3. Creation of the Yel-Pue Community Seed Bank at the Cumbe Indigenous Education Institution. The CSB will focus initial efforts on collecting and maintaining NUS seeds to distribute for wider use within the Resguardo and elsewhere (see 5 above for relevance **https://alliancebioversityciat.org/stories/new-indigenous-community-seedbank-everyone-cumbal-colombia).**

The main outputs are:

• Business plans. Each of the women who went on the learning tour to Ecuador developed a business plan, which included a detailed listing of the needs to complete the furnishings for lodgings, naming of lodgings, signaling, and gardening. Costs and timetables are included. Many also listed the need for further training in customer service, learning about and communicating their local history, origin and characteristics of foods and lore.

• Partnerships with chefs from several large cities (Pasto, Medellin, Bogota and Cali) are being nurtured. All chefs indicated genuine interest in obtaining products from known Cumbal farmers. A catalog showcasing the most important products produced by the women entrepreneurs and other farmers from Cumbal is under development. The YARPURAM brand will be used and orders channeled through AIWE.

• Rapprochement with the departmental tourism office in the regional capital, Pasto. This office welcomed the agro-ecotourism initiative and offered its support in publicizing the lodgings through their webpage and visitor displays in the Pasto airport. Additionally, tourism officials could provide direct support through a local tourism office which the municipal government of Cumbal has indicated interest in opening, after attending a NATURE+ event where the women entrepreneurs reported on the learning tours in Ecuador and shared their plans with the larger Cumbal community. Meanwhile, two applications are being prepared for two women to attend Colombia's Annual Tourism Fair in early in 2015. A video was prepared for their application.

• New partnership with the NGO Impulso Verde (IV), a French- and Colombian-registered NGO focused on restoration with native plants is very interested in collaborating with the implementation of restoration activities in Cumbal. It is expected that IV will soon distribute NUS in their collaborations with farmers, based on NATURE+ research on documenting the presence and loss of NUS from the Nariño highlands in our ongoing work. The exploration of value-added products derived from recovered and re-introduced NUS is expected soon and will most likely find resonance in the work of IV.

• A Native Forage Management Manual for the Highlands as an additional element to facilitate the adoption of native biodiversity and develop value chains that follow agroecological principles. This is part of a multi-year plan to transition dairy farming to nature-positive practices and add value to dairy products.

• Recognition and promotion of local agricultural practices. A new space within the Cabildo building has been designated as a museum that contains some volcanic stone artifacts and farming tools. The NATURE+ pictures taken by Lexicon in Colombia and exhibited the Alliance campus during the Convention on Biological Diversity, or COP16, will likely be shown displayed at a community center in Cumbal. The exhibit, which includes artworks about NATURE+ activities in India and Kenya, is planned for exhibits in more cities in Colombia to promote awareness about the Initiative and its work.

Outcomes

The main achievements and behavioral changes are:

- After returning from the learning tours to Ecuador and Pasto, participants worked on developing business plans, beautifying their front yards, and meeting with the director of the Indigenous school to select a name for each lodging in the extinct Pasto language. Their sense of purpose appears in evidence in the plans being made to finance the acquisition of remaining furnishings, the painting of spaces, improving the entrances to lodgings, laying stone paths, re-planting decorative plants, thinking about diversifying their backyards (shagras), organizing meetings to cook while learning and

practicing the techniques and practices to serve food to visitors (**see picture of desserts**). Women trainees also reflected on what they want to offer their future guests as inspired by their visit to Ecuador. It is evident that they are interested in offering quality service. An inauguration is planned with local authorities invited for the ribbon-cutting ceremony in early 2025.

- At the community sharing event, food was served that demonstrated the application and adaptation of decorating tips acquired during the trainings and visits.
- Most women make crafts and learned a couple of new techniques during the Ecuador visit. For example, they have started to make felt out of sheep wool.
- It is notable how quickly the women trainees are implementing their learnings.

Next Steps

If in the short to medium term we **continue building the skills to undertake enterprises that value, the maintenance and use of native food and biodiversity in sustainable ways**. While decreasing pressure on paramo ecosystems, agro-ecotourism, crafts people, local restaurants, and virtuous dairy transition all have a good chance of long-term success in Cumbal and perhaps in similar locations. Furthermore, there is **great potential to benefit youth and other farmers who can produce other biodiversity-based products** to offer locals and visitors, inspired by the landscape, the biodiversity, and living culture of Cumbal. The Yal-Pue Cumbe will become one of the stops on the tourist routes, together with the existing agroecological farms and bio-inputs facilities. The **transition work with the dairy farms and circular economy activities planned for 2025** fit very well with the overall aspiration of transforming this landscape from destructive practices, which are damaging to the Paramo and disregard the wellbeing of future generations. Replacing status-quo extractive pracitcies with harmonious nature-positive activities respects the environment and honors the beliefs and local traditions without spurning the benefits of modernity.

In the actors' survey (Analisis Mapeo de actores 1.docx) NATURE+ documented many short-term interventions, the majority of which were not based on demand. As a result, there is a scattering of experiences throughout the different sectors of the Resguardo, but not even the Governor, or members of the Cabildo, or community members know much about them, nor does the Municipality. **Initiative scientists and collaborators expect to develop the Plan of Action for a Nature-Positive Cumbal in 2025**, where different stakeholders will be convened to work on an integrated Plan of Action that builds on what has already been initiated. The NATURE+ team is experienced in the development of such plans at national and sectoral level. Given the Initiative's integrated engagement in Cumbal Initative scientists and collaborators foresee good chances of implementing such a Plan once it is developed.

If NATURE+ and collaborators are successful at establishing stable commercial links with chefs and other potential buyers of Cumbal NUS products, it will be necessary to **collect, multiply and preserve NUS vegetables for the Cumbe CSB**. These crops are notably absent from most shagras. These include Caigua (*Cyclantera pedate*)*;* exploding cucumber (*C. Brachystachya*), chayote (*Sechium edule*) among others, but also promote products derived from milk. This should diversify the offer for marketing to chefs and others under the collective brand.

The number of women entrepreneurs and youth receiving training on income generation from biodiversity and adding value to milk production will likely expand. This will include **training by NATURE+ and Colombia's extended learning agency, SENA, through a joint workplan for**

2025, which needs developing and is based on exchange and utilization of the organizations' comparative strengths.

Digital marketing involving the indigenous youth will be key in communicating offerings from Cumbal throughout the year to customers in restaurants and niche markets. This **needs to be developed and tested** in alongside capacity development and market-related activities.

A **school module on seeds linked to the CSB** was discussed for inclusion in the curriculum of the Cumbe Indigenous School starting in 2025.

Community Seed Bank basic infrastructure and equipment for the satellite banks located in the smaller schools that will be **linked to the Yal-Pue Cumbe banks**. These satellite banks will be established in one-room schools, initially on a display case, in different ecologies, which are appropriate for the multiplication of crops with different requirements.

Write a **manual or guidelines on agro-ecotourism development.** NATURE+'s agro-ecotourism concept – as practiced by indigenous women – proved to be an attractive entry point and piqued the interest of restauranteurs and chefs of upscale restaurants from large cities.

NATURE+ scientists plan to formally engage the NGO Impulso Verde in silvopastoral work in the Páramo of Nariño and to influence their inclusion of native NUS in their work. The Initiative also hopes to continue more focused engagement with the International Union for Conservation of Nature in Latin America and the Caribbean.

Open invitation to share experiences of learning tour to Ecuador.

Cumbal residents prepare samples of local products for test shipment to Bogota restaurant.

4.2 Incipient processes in Vietnam

Following a field mission in April 2024, two studies were launched on the **Agro-Eco-Cultural Tourism Potential for Harnessing Local Agrobiodiversity** and on the **Market Opportunities for Selected Indigenous Fruits and Vegetables** in the Provinces of Son La and Lao Cai in Northern Vietnam. The studies, respectively carried out by the Center for Agrarian Systems Research and Development (CASRAD) and FAVRI suggest substantial potential for the development of agro-ecological and cultural tourism, which could boost the production of local varieties of agricultural products and local dishes that are threatened with disappearance.

The production and market potential of the following Indigenous vegetables and fruits were explored: H'mong mustard, H'mong cucumber, thom squash, hoi mango and tron mango (in Mai Son); and pumpkin, H'mong mustard, H'mong cucumber and nep squash, Indigenous peach and plum (in Sa Pa). The existing and growing production and marketing of these crops were noted, with farmers selling the produce to collectors from within their communities, commune and district, to even other districts, buyers at the roadside and retailers in the markets, among others.

The actors who produce and trade local and Indigenous vegetables and fruits include producers, cooperatives, collectors, wholesalers, retailers, restaurants and homestay operators. There is promising market demand for these vegetables and fruits related to the unique characteristics of the produce, their quality, cultural significance, and location-specific origins.

Challenges identified are related to limited investment in production, with farmers relying mainly on experience with limited application of improved production practices, organic practices or the Vietnamese Good Agricultural Practices Standards (VietGAP). There are no collective production units, and limited opportunities to access technical and marketing support. Despite the range of actors identified in production and value chains, their linkages are limited due to small-scale production, and inconsistent availability and quality.

Different opportunities were identified including improving and promoting collective production. In particular, NATURE+ and partners identified opportunities including agro-ecological practices, linking farmers to agro-tourism actors promoting the potential and importance of the indigenous products, certification of products to reflect their value, safety and quality, and **development of territorial branding** for indigenous products in partnership with local authorities. This last activity could benefit from other ongoing activities by the French Agricultural Research Center for International Development (CIRAD), in partnership with CASRAD, FAVRI, the University of Firenze and others) in the in the northern provinces of Son La and Dien Bien).

Further analysis of the opportunities arising from NATURE+ research is ongoing. This will inform the participatory identification and development of indigenous vegetable and fruit production models associated with tourism and culture that the region is well known for and models that support unique ethnicities. This is particularly important given the boom of mainstream tourism especially in Sa Pa (from all over the world, including Vietnam and neighboring China), which often negatively impact the environment and local cultures. The most promising area for future interventions appear in the district of Sa Pa, commune of Ta Van, where around 60 families hailing from ethnic minorities (H'mong, Dao, Giay) have constituted a cooperative, which unites farmers, homestay managers, artisans, guides, and pursue a sustainable development path through the

tourism services, local dishes and the organic production of local products. In 2025, The Alliance, CASRAD and FAVRI will work with the local communities, organizations and authorities in the two provinces to draft **local plans for agro-eco tourism development** and begin implementing key activities.

Ta Van village. Photo by Andrea Ghione.

(L) Mui tomato, (R) H'mong cucumber

Homestay in Ta Van, photo by Andrea Ghione

Discussion with the president of the Ta Van cooperative, herself the owner of a homestay. On the table there are several local dishes. Photo by Thịnh Lê Như.

5. NUS and school feeding programs

In Burkina Faso, Vietnam, Kenya, and Colombia, NATURE+ and collaborators are developing programs to establish direct linkages between farmers' cooperatives and primary and secondary schools. These initiatives aim to enhance the school meal programs by introducing more nutritious and culturally appropriate food options. This approach addresses malnutrition and reinforces the importance of locally grown crops, contributing to the preservation of agricultural biodiversity and cultural heritage.

Home-grown school feeding (HGSF) programs, supported by direct procurement from local farmers, have demonstrated multiple benefits. Nutritionally, they ensure that children receive diverse and balanced meals, rich in vitamins and minerals, particularly through the inclusion of neglected and underutilized species (NUS). Economically, HGSFs provide a stable market for farmers, boosting rural incomes and fostering economic resilience.

Moreover, these programs promote cultural preservation by valuing traditional crops and recipes, which are often at risk of being overshadowed by imported, nutritionally deficient, or highly processed foods. By integrating NUS into school meals, children are exposed to local food traditions, fostering a sense of pride and connection to their heritage from a young age.

From a gender perspective, these initiatives also create unique opportunities for women. Women play a significant role in producing and marketing non-staple crops in many parts of the world. They are also more likely to handle routine management tasks like weeding, cleaning, and grading, which are especially common for vegetables (Singh et al. 2018). In Burkina Faso, for example, women lead in the production of Bambara groundnut, okra, hibiscus and moringa (Oumarou et al. 2024).

Women are empowered through increased demand for their crops and knowledge. By sourcing food from smallholder farmers, particularly women and women's cooperatives, these programs create economic opportunities and empower women who often have limited market access (FAO & WFP, 2018). The assured demand for their produce can contribute to increased income, financial independence and social standing within families and communities (FAO and WFP, 2018). The training of school cooks to prepare nutritious meals using NUS offers another interesting opportunity for women (Beltrame et al. 2021). However, such schemes should be accompanied by gender-sensitive strategies to ensure that traditional gender norms are not reinforced and that additional responsibilities are not placed on women (FAO & WFP, 2018).
By aligning nutritional, economic, cultural, and gender outcomes, these school programs represent a holistic strategy to promote the sustainable use of NUS, improve community well-being, and strengthen local food systems.

Beyond schools, linkages with smallholder farmers can extend to other public procurement spaces such as health clinics, prisons and private restaurants and hotels.

5.1 The experience in Burkina Faso

Activities, outputs and outcomes

Development of school modules focused on NUS
In Burkina Faso, as part of the NATURE+ initiative and the parallel EU-funded SUSTLIVES project, home-grown school feeding (HGSF) programs actively enhance child nutrition and access to education by serving diverse and nutritious meals and reducing hunger-related educational barriers.

A partnership with the local NGO Association Watinoma helped introduce new recipes featuring underutilized crops like hibiscus and moringa into school meals. It has also educated primary school students about the nutritional and cultural importance of indigenous crops via curricular work and other hands-on activities like establishing and maintaining a school garden, managed in collaboration with local women farmers.

As the consumers of tomorrow, young people can be agents of change in transforming agriculture and food systems. They can do so by learning and sharing knowledge about their unique food systems. Yet, the transition to modern schooling has led to traditional knowledge being overlooked or dismissed as outdated. As a result, younger generations may feel detached from their food heritage and abandon traditional practices, despite their cultural significance and the sustainability and nutritional advantages provided by traditional diets. Strengthening local research and innovation networks, especially by exchanging and promoting traditional, ecological, and community knowledge, is highly effective.

To bridge this gap, the Alliance and the Association Watinoma jointly developed a teacher's manual to bring primary school students closer to their food culture and to learn to appreciate the many benefits of local NUS. The integrated module, which targets primary school children aged 7 to 11, fosters intergenerational knowledge exchange, whereby children are encouraged to interview grandparents and elders within their communities to learn the lore and traditions associated with NUS. Quizzes and competitions make learning fun and lessons are

complemented with practical, firsthand training in which children are involved in establishing a school garden and learn to grow and care for NUS.

Focusing on the five NUS identified for the SUSTLIVES project – amaranth, Bambara groundnut, hibiscus, moringa, and sweet potato – and originally designed for use in Burkina Faso and Niger, the manual can be adapted for use in other regions. This educational resource is thought to be the first to establish a methodology for introducing NUS in schools and to build awareness of the importance of agrobiodiversity conservation and use.
In terms of impact, it is still too early to assess livelihood and production improvements or behavioral changes, although there is anecdotal evidence that children in one urban school in Ouagadougou, Burkina Faso, have requested for some of these largely forgotten crops to be included in school meals.

Next Steps
The approach was piloted in three schools in Burkina Faso, in both rural and urban settings, involving over 200 students. In 2025, the NUS modules will be tested in Niamey, Niger. **For more information**: Sowing the seeds of tomorrow, one school garden at a time
Download the fee manual at the following link.

5.2 Incipient processes in Vietnam, Colombia and Kenya

Similar to the experience in Burkina Faso, in northern Vietnam, in an area characterized by a high degree of ethnic heterogeneity, NATURE+ is working with local communities and schools to preserve knowledge of local recipes and spur their adoption in the school feeding programs.
Alongside the establishment of school diversity gardens in both implementation districts, awareness events were conducted to promote local agrobiodiversity, recipes, culture, and

nutrition. The events included garden visits, cooking demonstrations and contests with the participation of school staff, students, parents and local authorities.

The winner of a food competition at the Mương Hoa secondary school in Sa Pa. Photos by Andrea Ghione

In Kenya, efforts are underway to link the 3 cooperatives in Vihiga and Kisumu (Agoro East and Jimo East) with local schools to develop market channels for traditional African leafy vegetables. The schools' representatives have shown to appreciate the cultural and nutritional value of the produces, as well as the safety deriving from the organic method of production utilised by the smallholder farmers.

Finally, a newly established community seed bank in Cumbal, Colombia, hosted by the Indigenous Technical Agricultural Education Institution of Cumbe, integrates another function in its activities: the education of youth about the importance of the conservation of agrobiodiversity and hands-on training on how to manage a community seed bank.

6. Conclusion and Call to Action

Conclusion: from NUS to opportunity crops

In this document, we presented several innovative approaches in countries on three continents to make NUS more prominent in diverse contexts.

The focus on NUS is warranted by the value they have in terms of agrobiodiversity, resilience to climate change, nutrition, women empowerment, and expression of local culture.

In a world where globalization has been driven by short-term economic profit-making by way of standardization of agricultural products, production processes and consumer diets, focus on yield and scale, with disregard for the environmental, public health, social, and cultural consequences, is no surprise that local communities and their agriculture have been marginalized. Additionally, this contributed to the deterioration of the position of women in families and society, and even consumers have started to consider anything local and indigenous as backward. The term neglected and underutilized species (which are largely ignored by mainstream research, and underutilized by societies to the point of extinction) stems from this.

The rural communities NATURE+ works with are deeply aware of this state of affairs; they see how the development path imposed on them (by state policies and markets) is leading toward a dead end: yields are diminishing as soil becomes less and less fertile, commercial varieties suffer from climate change, local varieties and the knowledge that goes with their cultivation is lost, chemicals negatively impact farmer and consumer health, and young people leave the countryside for already overcrowded urban centers.

However, rural communities in all 5 NATURE+ countries are also showing resilience and creativity: in the Andean region of Colombia, women are determinedly looking for alternative paths that will give their children a reason to stay; in central Colombia, young graduates in environmental studies are coming back to their small towns with new methods and new business models. Since the 2008 food price spike (Piesse, J., Thirtle C., 2009), consumers in Ouagadougou, Burkina Faso, are looking for alternatives to imported rice and pasta, including the consumption of cassava in the form of acheke (brought by Burkinabé returning from Ivory Coast during the last civil war), which is increasing spectacularly; the iconic Maggi cube is being substituted by Gombo; soda is being substituted by bissap (hibiscus tea) and ginger juice as people grow more attentive to diabetes and other noncommunicable diseases. In Vietnam, both

government authorities and local communities are deeply aware of the environmental disaster produced by green-revolution agriculture. Among the strategies identified, branding of local and organically produced food and promotion of agro-tourism are prominent. In India, the government is taking concrete steps to promote millet and sorghum as staple crops and allow trade in landrace seed varieties at state levels. In Kenya, consumers, producers, schools' managers and local authorities are keen to recognize the benefits arising from agroecological methods of production and we are witnessing behavioral changes (e.g., schools interested in procuring from aggregated farms) and policy changes (e.g., new policies in favor of nature positive agriculture the Vihiga county).

Meanwhile, the world is changing. Globalization is in retreat, scholars and policymakers are no longer shy about the fact that industrial policies (such as intervention in favor of the environment, public health and nutrition, social cohesion, gender equality) have a broader role to play in the contemporary world (Aiginger and Rodrik, 2020) and that tariffs can and should be imposed when justified by national interests. Since 2008, dependence on food imports is widely recognized as a major liability for developing countries (Timmer, 2009; Adesina, 2017).

In addition to the widespread acknowledgment of climate change and loss of biodiversity, the change in incentives for government, producers and consumers is setting the stage for a new agenda where NUS are seen as opportunity crops, short value chains a smart idea, and valorization of local knowledge and culture as a source of empowerment and pride.

This new context and the new rules of the game that are slowly emerging (e.g., incentives for environmental services; public schemes that promote the consumption of local food in schools) call for new ideas and tools, and we have shown here a few (CSBs, community cooperatives, school feeding programs and agro-ecotourism) were born out of necessity to redress past mistakes and the desire to explore new, nature-positive and sustainable paths by the many communities with which NATURE+ had the privilege to engage.

The strategic partnerships and policy outcomes at local, national and regional levels of NATURE+ in Africa are among the most promising institutional changes.

At the local level in Kenya, cooperatives have created linkages with community seed banks and agricultural extension services for capacity building on various aspects including seed production and improved agricultural practices. The county government of Kisumu provided partnerships in policy development by integrating nature-positive principles in the Kisumu County Integrated Development Plan (CIDP). The Kenya Industrial Development and Research Institute (KIRDI) provided training on value addition and processing of composite flour. The aggregated farms have partnered with the Kenya Agricultural and Livestock Research Organization (KALRO) to provide clean planting material of bananas and help develop community-based seed value chains for the crop.

At the national level in Kenya, 73 CSBs formed a platform through which they share information and exchange genetic resources and related indigenous knowledge for value addition and product development. In Burkina Faso, stakeholders consisting of researchers, breeders, NGOs, private sector organizations, universities and farmer organizations formed a national stakeholder forum to enable stakeholders to share information and best practices on NUS research, breeding, value addition and nutrition and health, the forum also discusses key policy issues related to NUS food systems.

At the continental level, a series of policy and stakeholder meetings in Burkina Faso led to a proposal to create an African stakeholder platform. The meeting brought together researchers, farmers, market operators, policymakers and other stakeholders from 13 countries in Africa to drive inter-country collaboration around the conservation and use of NUS. The link to the meeting can be found on: https://alliancebioversityciat.org/stories/scaling-neglected-underutilized-crops-across-africa-multi-stakeholder-platform-collaboration .

The proposed multi-stakeholder platform (MSP) on Opportunity Crops is to be hosted by the African Union's Africa Seed and Biotechnology Platform (ASPB). The proposed MSP is to bring together stakeholders in the NUS food systems including conservation and gene banks, breeding and seed systems, value addition and product development, nutrition and public health and policy in a cluster within the ASBP to drive NUS food systems agenda within the continent.

In the Southern Andes of Colombia, the re-introduction and enhanced utilization of NUS crops, most of which are native, is part of an integrated effort to transition from an unsustainable development path to one where biodiversity is treated as a valuable and valued asset by its Indigenous population in its aspiration to reverse the business-as-usual course of action. The participatory actions taken so far have elements of collective learning and self-reflection that appear to respond to the stakeholders' vision of food security and improved livelihoods in harmony and respectful of their surroundings, where better opportunities for women, youth and future generations appear likely.

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