The IFAD-EU NUS Project in Guatemala

Promoting drought-hardy tepary bean (*Phaseolus acutifolius*) and Mayan spinach (*Cnidoscolus aconitifolius*) in the dry corridor of Guatemala for better climate resilience and nutrition

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Introduction

The Project 'Linking agrobiodiversity value chains, climate adaptation and nutrition: Empowering the poor to manage risk' will be implemented in Guatemala by the Universidad Del Valle de Guatemala (UVG). The Biology Department at UVG is one of the key institutes, working on the conservation and use of agricultural biodiversity in Guatemala. They have an explicit focus on plant genetic resources in their academic programme. They have contributed to the Second State of the World's Plant Genetic Resources (FAO 2010) and to the State of the World's Forest Genetic Resources (FAO 2014) on behalf of Guatemala.

UVG, in collaboration with Fundación Manos de Amor, with technical support from FAO, and funding support from the Benefit Sharing Fund of the International Treaty for Plant Genetic Resources for Food and Agriculture, implemented a project to establish a network of communal seed banks and custodian farmers. Five seed banks were established in communities of four Departments of Guatemala: Alta Verapaz, Chiquimula, Zacapa and Solola. The seed banks together with capacity building activities related to good farming practices, seed bank management, and agricultural biodiversity conservation, benefited 1,340 families. Through the project, UVG documented local maize and bean diversity, characterized the morphological diversity of ears of the communities primary maize landraces, and the eco-geographic distribution of this agricultural biodiversity. UVG has also carried out research on morphological and molecular characterization of maize land races. The IFAD-EU NUS Project will build and expand on this work, promoting use and cultivation of underutilized crops with high potential to strengthen food and nutrition security and livelihood resilience of rural communities facing climate change.

Context

Guatemala is a rugged Mesoamerican country rich in cultural and biological diversity. The majority of the population is indigenous or of mixed indigenous and European ancestry (Minority Rights Group International 2015). Most are of Mayan descent, including K'iche 9.1%, Kaqchikel 8.4%, Mam 7.9%, Q'eqchi 6.3%, and other Mayan groups 8.6% (2001 census; Minority Rights Group International 2015). A total of 21 indigenous languages are spoken in Guatemala, while the official language is Spanish. This cultural diversity exists among rich biological diversity in this highly forested (37%) country characterized by high rates of species endemism (13%) (CBD, 2015).

Guatemala faces a serious situation of extreme poverty and hunger according to the Global Index for Hunger 2015 (IFPRI 2015). Around half of children under five are affected by chronic malnutrition (49.8%), while 1.4% are affected by acute malnutrition (ENSMI-2008/09). Some regions are more affected by these burdens. In particular, more than 20% of the population suffers extreme poverty in the departments of Alta Verapaz, Zacapa, Totonicapan, Izabel, Suchitepequez, Sololà, Baja Verapaz, and Chiquimula (INE 2011). Chronic malnutrition is higher in rural areas than urban areas and is high to very high (60-83%) in the departments of Totonicapan, Solola, Quiche, Hehuetenango and Chiquimula (ENSMI-2008/09). The prevalence of chronic malnutrition in children under five years of age is higher among subsistence farmers, indigenous children and children of mothers without access to education (ENSMI-2008/09, UNICEF, ICEFI & SUECIA

2013). Seasonal famine influences the livelihoods of many people in Guatemala, especially in the dry corridor, including areas of Quiche, Baja Verapaz, Chiquimula, Zacapa, El Progreso, Jutiapa and Jalapa departments. Malnutrition cases among children less than 5 years of age occur in conjunction with exhausted cereal reserves during the period from April to August, the end of the temporary work periods for the harvest of coffee, sugar and cardamom (November to March), and the rainy season, which is associated with issues with safe drinking water and infectious diseases (May to September).

In addition to issues of stability in food availability and access, there are also cases of deficiency in micronutrients and vitamins in Guatemala. 34.9% of children under 5 years of age have a deficiency in zinc, 12.9% in vitamin B12 and 26.3% in iron (ENMICRON 2009/10). Micronutrient deficiency is also seen in women of reproductive age, among whom 18.9% have a deficiency in vitamin B12, 18.4% in iron and 7% in erythrocyte folate (ENMICRON 2009/10). One of the consequences of these deficiencies is anaemia, which affects 48% of children under five, 29% of pregnant women and 21% of non-pregnant women (Encuesta Nacional de Salud Materno Infantil 2002, ENSMI-2008/09). At the same time, there are also cases of overweight, which affects 5.6% of children under five years of age (Encuesta Nacional de Salud Materno Infantil 2002) and is especially important in the capital city (Encuesto de Salud Escolar 2009).

The major staple crops in Guatemala are maize and beans, while other widespread cultivations are cassava, sweet potato, squash, amaranth, pepper, papaya and avocado. Major export crops are coffee, banana, and sugar cane. Nearly half of farmers in Guatemala are subsistence producers (46.8%) and a similar amount are infra-subsistence producers (45.2%) (MAGA 1998). These farmers, while representing a majority of the population, cultivate only around one-fifth of the land (18.7% and 3.2%, respectively) (MAGA 1998). Most of the agricultural land in Guatemala is held by very few commercial and extensive farmers, who respectively cultivate 65.5% and 12.7% of arable land area (MAGA 1998).

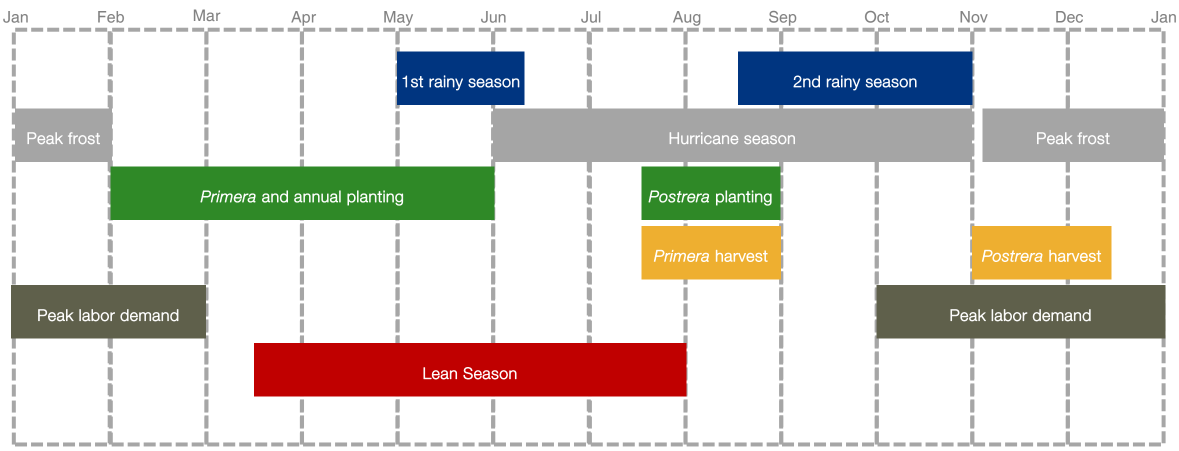

Figure 1: Agricultural calendar of a typical year in the Guatemalan highlands. Modified from: Famine Early Warning Systems Network (FEWS NET 2013).

The agricultural calendar in Guatemala is marked by seasonal weather events. The first rainy season from May to June precedes a heat wave and drought period referred to as the '*canicula*', which is followed by a second rainy period from September to October (FEWS NET 2013). Hurricanes can hit from August to December, while there is high frost risk from January to April (Figure 1). Changes have been occurring in this calendar in recent years. In particular, the beginning and the end of the rainy seasons have been shifting, making it difficult to predict when rain will come. In 2012, a two-month delay of the second rainy season resulted in famine (SESAN et al. 2013). In general the total annual rainfall has been the same, but the intensity and timing of the events has changed. Natural climate variability derived from phenomena such as El Niño and La Niña, are being amplified by climate change, bringing more severe droughts. In the past decade extreme events have been increasing in Latin America and the Caribbean, including extreme temperatures, wildfires, drought, storms and floods (ECLAC 2010). Guatemala is one of the ten countries most affected by extreme weather events in the last twenty years at the global level and in 2010 the country was ranked second in the Global Climate Risk Index. The expected future scenario (by 2100), will involve an increase of temperature from 2-6 °C and a decrease in rainfall between 10-20% (IPCC 2014).

Drought and climate variability, including extreme events like hurricanes, severely affect agricultural production in Guatemala. In 2014, due to prolonged drought between July and August, 80% of corn and 63% of the bean crop were lost affecting 266,000 families across the country, especially in the eastern region (SESAN 2014). Climate variability has caused damage to the agricultural sector in the range of 40-70%, affecting infrastructure and productivity of strategic crops. Yield declines, harvest losses, a higher incidence of pests and diseases and erosion of soil in intense rainfall events are part of these losses, with the most affected cultivations being corn, beans, coffee and certain vegetables.

Many factors contribute to the limitations and adaptation to the climate changes in Guatemala. Poverty greatly limits adaptation by preventing access to necessary resources. Vulnerable groups are affected by a low purchasing power. They often have poor land tenure rights and low access to basic services like health, water and infrastructure. Lack of education and knowledge on climate change adaptation also contribute to limited progress. The absence of climate change adaptation in government agendas, low prioritization for funding allocation, focus on short-term and medium-term planning, and corruption limit policy support.

The socio-cultural context is a decisive factor for climate adaptation and food insecurity as it affects eating habits and other behaviours. The socio-cultural context differs from community to community but studies have shown a lack of prioritization of the nutritional value of food against the economic and taste values. At the same time, there is often prioritization of other domestic activities and an influence by cultural beliefs and perceptions in their food habits. The social context of vulnerable groups is often characterized by a devaluation of women's role, where decision-making power is differentiated. Education on sexual and reproductive health is often deficient and there is low family planning. Violent episodes in the families are often reported, which can be linked to alcoholism, which is yet another important social issue. The perspectives and actions of community leaders, religious groups, community, and health providers have a notable influence on the socio-cultural context.

Target Crops

Guatemala is an important centre of origin and diversity for common bean (*Phaseolus vulgaris*) (Bittochia et al. 2011). This crop is a fundamental staple for the population, providing an important source of protein and carbohydrates that is complementarity to the nutrient profile of cereals and vegetables (Scheerens et al 1983). Common bean was domesticated in more humid regions of Central America, the Andes and the Amazon basin and heat and drought conditions cause major losses of this crop when they strike (Gaur et al. 2015, Blair et al. 2012). Such crop failures have devastating effects for the farming communities that depend on common bean for subsistence.

Tepary bean (*P. acutifolius*) is a relative of common bean in the same genus. Its precise centre of origin is not confirmed but it is thought to have been domesticated in dry regions of Central Mexico and the south western USA (Blair et al. 2012). The species is well-adapted to arid conditions, exhibiting a high level of drought, heat and cold tolerance, as well as early maturation (Blair et al. 2012, Beebe et al. 2013). Tepary bean is underutilized, grown at a limited scale in dry parts of Mesoamerica, but it shows potential to support climate change adaptation of farming systems in this region and other drought-prone areas through greater use and crossing with common bean (Blair et al. 2012, Gaur et al. 2015). Tepary bean is fairly high yielding and outperforms common bean in hot environments (Beebe et al 2013). The beans are comparable or superior in nutritional content compared to major pulses, with protein content between 17-32% (Nabhan & Felger 1978, Scheerens et al. 1983). Tepary beans were widely used by Sonoran peoples before the arrival of the Spanish but are now used on a much smaller scale (Scheerens et al. 1983). Two general types exist: white-seeded and brown-seed types, the latter characterized by a stronger and more distinctive flavour (Scheerens et al. 1983). The culinary properties of tepary bean are distinct from common bean (pintos) and Mexicans reportedly have used different recipes to prepare these pulses (Scheerens et al. 1983). Some people in the south western USA have been known to prefer teparies to common beans and use them as a prized soup ingredient (Scheerens et al. 1983). Evaluations of organoleptic quality by students in Saudi Arabia have also revealed them to be moderately to highly acceptable (Tinsley et al. 1985). Nevertheless, their "unfamiliar" taste was believed to have contributed to a failure of early commercialization attempts for tepary beans in USA, while others contend the failure of these attempts was due to poor timing of the interventions (Nabhan et a.l 1978, Scheerens et al. 1983).

Mayan spinach or chaya (*Cnidoscolus aconitifolius*) is a domesticated shrub that has been cultivated since pre-Hispanic times in the Mayan region (Ross-Ibarra & Molina-Cruz 2002). It was likely domesticated in the Yucatan but is used commonly throughout Mesoamerica, in Guatemala, Belize, southeast Mexico, and parts of Honduras (Ross-Ibarra 2003). There are four cultivated varieties, which are all grown in Guatemala (Ross-Ibarra & Molina-Cruz 2002). Chaya grows up to six meters tall and is used as a hedge and its leaves are consumed for food and medicine (Ross-Ibarra 2003). It is often planted in gardens, in cornfields or with other field crops (Ross-Ibarra 2003). The leaves are highly nutritious, containing significantly higher amounts of crude protein, fibre, calcium, potassium, iron, ascorbic acid and β-carotene than spinach (Kuti & Kuti 1999). Cooking slightly reduces the nutritional composition but is essential to inactivate toxic hydrocyanic glycosides (Kuti & Kuti 1999). Although the nutritive and agronomic potential of this shrub has been recognized for decades, and appreciation for its good taste, there has been little research and promotion of its use (Ross-Ibarra & Molina-Cruz 2002). The species has strong potential to enhance nutrition in communities in the dry corridor but also more widely in Guatemala and in distant markets. Promotion of chaya as a superfood could be an important income generation opportunity and its greater use can also valorise local culinary traditions in celebrating this food that was an important feature in the pre-Columbus diet.

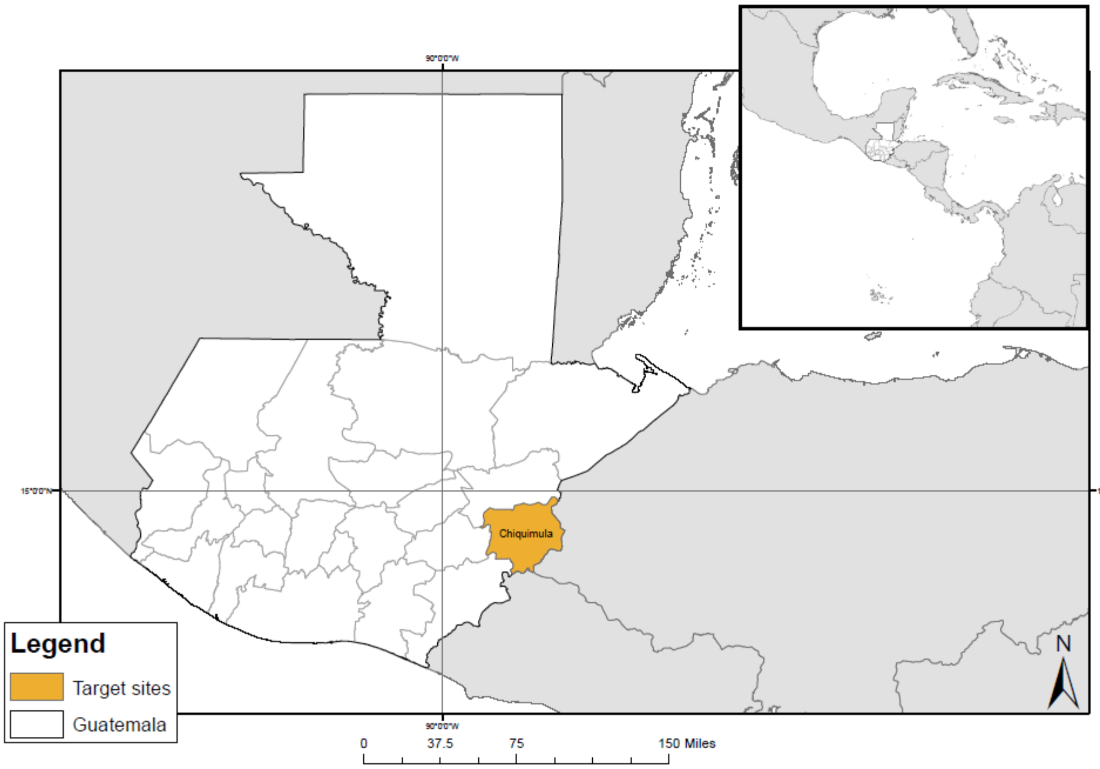

Figure 5. Target sites of the IFAD-EU NUS Project in Guatemala.

Target Sites

The IFAD-EU NUS Project is targeting communities in Chiquimula, which is part of the dry corridor of Guatemala and faces a high burden of malnutrition, poverty and climate risk (Figure 2). Baseline surveys will be carried out in the communities of Tesoro Abajo, Jocotán (Caserío) Petentá (Camotán) and Caserío La Brea (Camotán). The Project will work with communities involved in

FAO's 'Mesoamérica sin Hambre' Project that works through the Mancomunidades (associations of various municipalities). Opportunities to involve their communities that have been part of the Mesoamerican Agroenvironmental Program (MAP) with the Centro Agronomico Tropical de Investigacion y Ensenanza (CATIE) will also be explored to collaborate and build on their existing efforts applying a holistic approach for climate change adaptation, involving promotion of home gardens, exchange of local and scientific knowledge in farmer field fora, training on poultry production, household finance and establishment of seed banks (see abstract on page 14).

Major Activities

The IFAD-EU NUS Project in Guatemala will promote the cultivation, consumption and conservation of tepary bean and Mayan spinach to strengthen food and nutrition security and livelihood resilience of target communities in the face of climate change. Investigations will also be made, starting with baseline household surveys and focus group discussions in the first year, to understand the current use of local agricultural biodiversity in target communities and identify species that could be promoted to address critical nutrition gaps, enhance resilience of cropping and livelihood systems and generate income for target communities.

The Project will involve students from Valle de Guatemala University in carrying out many of the activities which is seen as a strong opportunity to raise capacity in Guatemala for the holistic, integrated approach to agricultural development promoted in the Project. The plans for the Project activities in the first year are detailed below. These activities will be continued and expanded in subsequent years based on findings emerging from the surveys and interactions with the communities.

Surveys and assessments

In the first year of the Project, surveys will identify and document the local food plants in the communities participating in the Project and their tolerance to abiotic factors and nutritional value. These initial investigations will document the state of *in situ* conservation and the use of local crops and other food plants. Work will be done to identify and document degree of threat and genetic erosion they face.

Consultation for value chain enhancement of target crops

Consultation and capacity building workshops with local stakeholders (including the National agriculture research system) will be held to analyse the value chains of target species and determine a strategy and mechanisms for their development in Guatemala using a holistic value chain approach. Systems to make market information available to the farmer communities will be investigated.

Production of high quality Chaya

Researchers at the Universidad Del Valle de Guatemala have been working on chaya since 1992 investigating its nutritional, chemical, molecular, botanical and agronomic aspects. The Project will leverage these efforts and move forward with value chain interventions to raise demand among consumers. In the first year, work will be done to multiply chaya in the communities participating in the Project. A manual will also be elaborated and shared with the farmers with best practices for managing the crop on farm.

Crowd-sourcing evaluation of tepary bean

For the close relationship with common bean, hardy tepary bean could easily fit within the established diets and farming practices in Guatemala. The Project will introduce tepary bean through trials to evaluate the performance and taste compared to a diversity of common bean varieties. These trials will use a 'crowd-sourcing' approach developed by Bioversity International that engages a large number of farmers to grow and evaluate just a few varieties each, ultimately resulting in a big dataset that can be used to identify varieties suited for different microclimates and preferences.

Strengthening networks of conservation farmers and communal seed banks

Guatemala is an important centre of origin and diversity for common bean and a major concern is that introduction of new varieties or promotion of just a few varieties could threaten the persistence of the native diversity. With this risk in mind, various actions will be taken through the Project to support conservation and promote greater use of native bean diversity. The crowd-sourcing trials will in fact disseminate many native common bean varieties to farmers as well as tepary bean, and these varieties may be taken up by farmers who appreciate their qualities. Strengthening seed exchange networks and community seed banks are other actions that will be taken to support conservation, which will build on recent efforts by FAO, the International Treaty for Plant Genetic Resources for Food and Agriculture and UVG.

In the first year, meetings and capacity building workshops will be organized with farmer groups, and national institutions to strengthen existing networks and establish new mechanisms to cooperate and exchange best practices and seeds to strengthen conservation of plant genetic resources. Linkage between in situ and ex situ efforts will be promoted through at least one visit of farmer network representatives to the national gene bank.

Feasibility study for rewards/compensation for agricultural biodiversity conservation services (PACS)

To further contribute to conservation of vulnerable crop genetic diversity and mitigate risk of losing valuable bean genetic diversity with value chain development, an assessment of Guatemala's bean genetic diversity will be carried out based on genebank records to identify distinct varieties that should be prioritized for conservation through a rewards/compensation for agricultural biodiversity conservation services (PACS) scheme. This work will involve a Weitzman analysis and several stakeholder meetings to prioritize material for conservation and assess the feasibility of supporting this work at a national level.

Policy enhancement for the conservation, sustainable use and nutritional value of agricultural biodiversity

A review of existing policies relating to the conservation, sustainable use and nutritional value of agricultural biodiversity in Guatemala will be carried out. Discussion will be promoted through consultation workshops with key stakeholders on how to develop and leverage these policies to enhance the conservation, sustainable use and nutritional value of agricultural biodiversity in Guatemala. Among the policies that will be evaluated are the Politica National de Disarollo Rural Integral (PNDRI), Programa de Agricultura Familiar Para el Fortalecimiento de la Economia Campesina (PAFFEC), the Sistema National de Extension Rural (SNER) and the Plan de acción estratégico para la conservación y el uso de los recursos fitogenéticos Mesoamericanos para la adaptación de la agricultura al cambio climático (PAEM).

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