

# Enhance indigenous agricultural systems to reduce migration

Changes in social and environmental conditions in the Western Highlands of Guatemala undermine food security and job opportunities. We describe how targeted assistance can build upon traditional agricultural systems to increase adaptive capacity, improve nutrition, provide jobs and thereby reduce pressures to migrate.

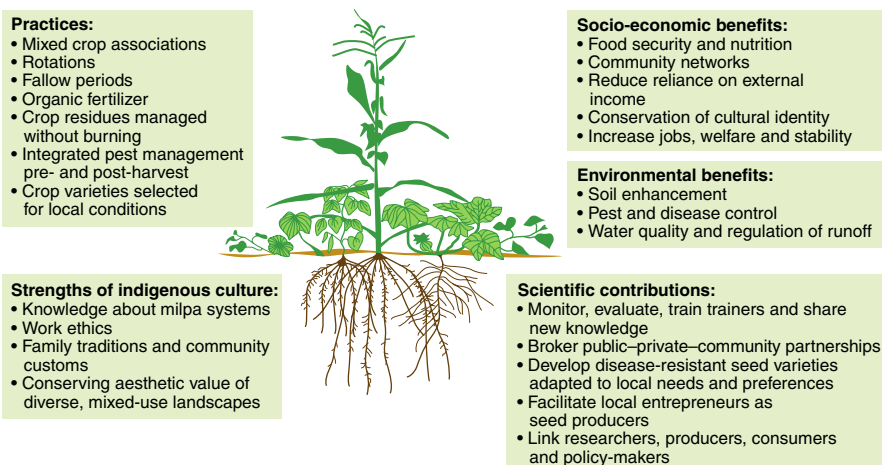
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Guatemala has one of the highest levels of child malnutrition and stunting in the world<sup>1</sup>, with 59% of the population living in poverty<sup>2</sup>. Approximately 70% of the impoverished population is in rural areas, with the highest prevalence occurring amongst indigenous Mayan communities in Guatemala's Western Highlands, where many villages lack adequate infrastructure (roads, water and sewage) and services for education and health<sup>3</sup>. Nearly half of the people in the Highlands live in extreme poverty, and 77% of children under the age of five show signs of moderate to severe stunting<sup>1</sup>.

The prevalence of poor health, poverty, low level of nutrition and few job opportunities is a legacy of historical policies, discrimination and evolving agricultural economies and practices in the Highlands<sup>1,4</sup>. Three-quarters of Highland farm households self-identify as indigenous, and agricultural production is insufficient to meet basic food needs in over half of all farm households<sup>5</sup>. Without the resources required to produce or buy enough food, family members seek sources of income elsewhere, as is common for many regions where small holders confront population growth, hunger and land pressures<sup>6,7</sup>.

In early 2019, over 90% of recent migrants to the southern border of the United States were from Guatemala, with the majority coming from impoverished regions such as the Highlands<sup>8</sup>. Several factors, including crop failures and lack of employment opportunities, can instigate migration<sup>9</sup>. In prior decades, men from the Highlands sought seasonal work in major cities or on coffee (*Coffea arabica* L.) and sugar (*Saccharum* spp.) plantations in other regions of Guatemala. With both coffee and sugar commodity prices falling<sup>10</sup>, fewer options exist within Guatemala<sup>8</sup>.

As men seek work in the United States and elsewhere, women remain in Highland villages to care for both children and small,



**Fig. 1 | Benefits of milpa systems in the Guatemalan Highlands.** Milpa systems support a diversity of benefits and products that can be raised on small plots including maize, beans, squash, vegetables, salad greens, herbs and chickens.

family farm plots. While 25% of rural households are reportedly led by single women<sup>2</sup>, in practice, an even larger share of small farm plots is managed by women. Thus, women increasingly make decisions about what to plant as well as what to feed their families<sup>11</sup>.

The Buena Milpa project, a partnership between Guatemala's Agricultural Science and Technology Institute (ICTA) and the International Maize and Wheat Improvement Center (CIMMYT), aims to implement a sustainable intensification strategy while reducing poverty, malnutrition and environmental damage in the Highlands<sup>12</sup>. Acknowledging the importance of conserving and recuperating indigenous knowledge<sup>13</sup>, the project fosters engagement of historically marginalized ethnic Mayan farmers in diversification, biodiversity conservation, participative plant breeding and soil conservation in mixed maize (*Zea mays* subsp. *mays*) production systems.

## Degradation of the milpa system

Highland maize production is based on the milpa system in which small agricultural plots of maize together with climbing beans (*Phaseolus* spp.) are mixed with a variety of squash (*Cucurbita pepo*) and other crops (see Fig. 1). Maize plants provide the structural support for the climbing beans; while beans enrich soils via symbiotic association with nitrogen-fixing bacteria and provide essential dietary protein that complements maize. Squash and other crops protect the soil surface from erosion, decrease water losses through evaporation and limit weed pressure. Traditional milpa practices do not include the use of chemicals. Milpa farmers, particularly women, most of whom speak Mayan dialects, often lack access to technical services and inputs.

Over time, average farm size in Guatemala has declined and self-sufficiency in maize production has plummeted, due to many factors including sectoral

restructuring that shifted resources from milpa systems to non-traditional exports<sup>4</sup>. Nationally, half of all farms are smaller than one hectare<sup>5</sup> and one recent survey found that farms in the Highlands averaged just 0.4 ha<sup>11</sup>. Land cleared for crops has spread up mountainsides onto steeper slopes and marginal land<sup>1</sup>, where erosion is problematic, yields are low, and degradation of soil, water and biodiversity is inevitable. As inherited land is divided among children into smaller parcels, the declining farm size leads to reduced household production<sup>1</sup>. To meet basic needs, more than half of farm households in the Highlands must rely on other sources of food, off-farm income, or remittances from family members working in the United States<sup>5</sup>.

In recent decades, traditional milpa diversity in the Highlands has declined, exacerbating malnutrition and environmental sustainability of production practices. A survey of 4,790 farm households in the Western Highlands found 32% were characterized by very small plots (median total arable land size of 0.2 ha per household), mainly devoted to the production of maize rather than traditional milpa<sup>5</sup>. The survey found that maize was also predominant for another 29% of households characterized by somewhat larger farms (median size of 0.7 ha with 58% of the area, on average, in maize), although this group also raised coffee, beans and other crops. The share of maize consumed increases as household income declines, and over-reliance on maize, an incomplete source of protein and nutrients, contributes to low dietary diversity resulting in high rates of infant mortality, poor nutrition and stunting<sup>1</sup>.

Recent crop failures associated with drought, pests, flood, hail and other atypical weather events have exacerbated food shortages for Highland farm communities. Prolonged mid-season droughts in 2014 and 2015 resulted in food insecurity for 44% and 55%, respectively, of the population<sup>14</sup>. Mid-season droughts can be especially damaging to climbing beans, which milpa farmers usually plant after maize is established. Continuation of unpredictable weather may further undermine crop yields, food supplies and nutrition.

### Opportunities and challenges

Notwithstanding many difficulties, the Highland region offers opportunities because of the people's strong work ethics and ancestral traditions, complemented by a climate suitable for a range of crops. The productive volcanic soils are deep and have a sandy loam texture<sup>15</sup>. The temperate climate supports diverse vegetables, but the rainy

season is becoming more erratic due to late onset of the rainy season and longer and more severe dry spells.

International assistance for agriculture in Guatemala has mostly targeted industries that promote non-traditional exports<sup>4</sup>. Assistance for commercial growers and specialty, mono-culture crops, overlooks the needs of Highland milpa farmers. Few programs consider the importance of cultural practices of indigenous people<sup>13</sup> and issues pertinent to landscape sustainability, such as how agricultural practices relate to environmental, social and economic conditions of the collection of farms and communities in the region<sup>16</sup>. Among the few initiatives targeting indigenous farming systems on which the poorest families rely are the Buena Milpa project<sup>12</sup> and the Program for Family Agriculture<sup>3</sup>, which, with limited public funds, is developing infrastructure and hiring extension agents.

Research plots show how increasing crop diversity, improved varieties, technical guidance and other advancements in mixed cropping can build on traditional practices to improve milpa systems, nutrition and employment options<sup>11,12</sup>. Whereas common climbing beans are susceptible to many diseases and pests, new disease-resistant varieties were recently developed that are suitable for small plots and cultural tastes in the Highlands (see Fig. 2). Insect pests, such as the bean pod weevil (*Apion godmani*), can be effectively managed with timely implementation of control measures.

Guatemala committed to the United Nations' Sustainable Development Goals (SDGs), including targets to eradicate poverty and hunger by 2030; yet little progress has been made<sup>17</sup>. The situation is most bleak in rural, indigenous communities, where women increasingly find it impossible to adequately feed their children. Guatemala's commitment to the SDGs is laudable and initiatives that address the needs of marginalized groups are encouraging. For example, Guatemala's recent strategy to improve rural food security highlights diversification of milpa systems<sup>3</sup> but means to implement this approach are limited.

### Recommendations

Reducing poverty and hunger requires the engagement of stakeholders, including indigenous women, to facilitate adoption of improved crop varieties and milpa management practices that lead toward more sustainable agricultural landscapes<sup>18</sup>. In the Highlands, components for improving milpa systems include support for extensive production and dissemination of improved seeds, and integration of training and



**Fig. 2 | Beans growing in a milpa system in the Highlands of Guatemala.** Preferred bean varieties in the Highlands reflect trade-offs among yield, aggressiveness, culinary preferences and longevity of food availability based on input from farmers and consumers. Social acceptance is key to enabling widespread adoption, which creates demand and leads to local opportunities for jobs in seed production and distribution, extension, and pest control.

technical assistance to recuperate and enhance local traditions. Agricultural extension programs, cooperatives and community-based entrepreneurs are needed to provide the required services. Dissemination of locally adapted seeds and training should take advantage of existing social networks that sustain milpa systems whereby families cooperate with neighbours in planting and harvesting. In some ways, improving milpa is going 'back to the future', but technical assistance must be targeted to include youth and women, and production systems must be resilient to changing pests, diseases and weather patterns.

We recommend investments that recognize and advance ancestral knowledge by engaging with milpa farmers to validate and implement improvements that are best suited to their situation. We encourage building capacities for adaptive management so that small producers are empowered to identify appropriate responses to new circumstances and information. Agronomists, ecologists, sociologists and economists must collaborate with local institutions, farmers and community organizations to determine, test and deploy innovations. Rather than cutting aid,

investments should increase and target milpa farmers as a strategic intervention to reduce migration from the region. With access to improved seed, technical assistance, market intelligence, weather warning systems and basic infrastructure, traditional agricultural landscapes can be better managed for multiple benefits. However, the challenges of poverty and migration cannot be addressed by improving milpa alone.

Supporting more sustainable agricultural landscapes in the Highlands is just one part of a bigger picture for achieving SDGs and reducing migration from the region. Similar to other poverty reduction strategies, policies that only target efficiency or commercial production are unlikely to meet the needs of indigenous, smallholder farmers<sup>4,6,7</sup>. Additional needs include institutional strengthening to provide health, education, security, democratic representation, communications and other services; creation of non-agricultural jobs; and basic infrastructure including that required to access markets. However, development and adoption of more sustainable milpa systems offer a foundation for healthier households and stability that underlie many of these other needs. If the people in the Highlands have reliable options to feed their families at home, most would prefer to stay in Guatemala.

### Data availability

Additional field reports on bean varieties and trials are available in Spanish from ICTA ([www.icta.gob.gt](http://www.icta.gob.gt)) and the Buena Milpa project ([www.cimmyt.org/projects/buena-milpa/](http://www.cimmyt.org/projects/buena-milpa/)). □

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### Author contributions

K.L.K. and V.H.D. contributed equally to conceptualization, preparation of the original draft and revisions; L.F.R., C.S., and S.L.-R. contributed to investigation, project administration, reviews and editing; all authors contributed to funding acquisition.

### Competing interests

L.F.R. and C.S. serve as Project Coordinator and Training Coordinator, respectively, for the Buena Milpa Project. The other authors declare no competing interests.