USAID
FROM THE AMERICAN PEOPLE

ADVANCING HORTICULTURE

ASSESSMENT OF CONSTRAINTS TO HORTICULTURAL SECTOR GROWTH IN CENTRAL AMERICA

DECEMBER 20, 2013
This publication was produced for review by the United States Agency for International Development. It was prepared by the Feed the Future Innovation Lab for Collaborative Research on Horticulture at the University of California, Davis.

Authors: Alonso González M., Tito Livio Zúniga, L. George Wilson
Editors: Elizabeth Mitcham, Amanda Crump, Michael Reid, Britta Hansen, Brenda Dawson, Kelsey Barale

ADVANCING HORTICULTURE:

ASSESSMENT OF CONSTRAINTS TO HORTICULTURAL SECTOR GROWTH IN CENTRAL AMERICA

December 2013
This publication was produced for review by the United States Agency for International Development.

It was prepared by
Alonso González M., Tito Livio Zúniga, and L. George Wilson
With additional editing by
Elizabeth Mitcham, Amanda Crump, Michael Reid, Britta Hansen, Brenda Dawson, and Kelsey Barale

Cover image: Farmers' fields in Almolonga, Guatemala. Photo credit: Kelsey Barale

Feed the Future Innovation Lab for Collaborative Research on Horticulture*
University of California, Davis

*also called the Horticulture
Collaborative Research Support Program

ACKNOWLEDGMENTS

The authors would like to express their sincere gratitude to USAID and USDA missions and staff who supported this study and provided valuable contacts and resources to conduct it, and to the Horticulture Innovation Lab support personnel at the University of California, Davis, for enabling us to concentrate on the assessment by taking care of the logistics for traveling within the visited countries, as well as preparing the workshops (consultation and dissemination). This study would not have been possible without the immense help of all people who shared their thoughts, documents and valuable time to respond to our queries, either through face to face interviews, participation in workshops and/or by responding to the online survey.

We hope that this document will provide useful guidance to the development of the horticulture sector in Central America. By doing so, it is hoped that this assessment and its recommendations will fulfill the expectations of the Feed the Future initiative—being instrumental in solving poverty, malnutrition and livelihood issues affecting the rural communities in the region.

TABLE OF CONTENTS

ACRONYMS

BID	Banco Interamericano de Desarrollo
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza
CGIAR	Consultative Group on International Agricultural Research
CRSP	a Collaborative Research Support Program (also known as a Feed the Future Innovation Lab for Collaborative Research)
CURLA	Centro Universitario Regional del Litoral Atlántico
DICTA	Dirección de Ciencia y Tecnología
FAUSAC	Facultad de Agricultura de la Universidad de San Carlos
FDA	U.S. Food and Drug Administration
FHIA	Fundación Hondureña de Investigación Agrícola
FHI 360	organization created in merger between Family Health International and Academy of Education Development
FSMA	Food Safety Modernization Act
GDP	gross domestic product
HLB	Huanglongbing
ICTA	Instituto de Ciencia y Tecnología Agrícola
IICA	Instituto Interamericano de Cooperación para la Agricultura
IPCC	Intergovernmental Panel on Climate Change
IPM	integrated pest management
LAC	Latin America and the Caribbean region
MRL	maximum reside limit
NARS	national agricultural research systems
NGO	non-governmental organization
OIRSA	Organismo Internacional Regional de Sanidad Agropecuaria
UC	University of California
UNA	Universidad Nacional de Agricultura
UNAH	National Autonomous University of Honduras
USAC	Universidad San de Carlos
USAID	U.S. Agency for International Development

UVG	Universidad del Valle de Guatemala
WEAI	Women's Empowerment in Agriculture Index

EXECUTIVE SUMMARY

ADVANCING HORTICULTURE

Horticultural crops, particularly vegetables and fruits, are key to increasing food security in the Feed the Future focus countries of the Central American region. Rural farm and business incomes can be increased by assisting small-scale producers to participate more fully in horticultural value chains, focusing on increased production, improved postharvest handling, value-addition through processing, and facilitated marketing. With funding provided by an associate award from the USAID Bureau for Latin America and the Caribbean, the Feed the Future Innovation Lab for Collaborative Research on Horticulture (also known as the Horticulture Innovation Lab or Horticulture CRSP) conducted an assessment of major constraints to continued growth and increased involvement of smallholder growers in the horticulture sector in Central America, based on looking at two of the region's countries (Honduras and Guatemala). This report identifies constraints to further sector growth in Honduras and Guatemala and recommends research, training, and policy initiatives to address those constraints that have potential relevance to other Central American countries' horticultural sector growth.

The evaluation team was comprised of Dr. Alonso González M. of Colombia, Dr. Tito Livio Zúniga of Honduras, and Dr. L. George Wilson of North Carolina State University, who also served as liaison with the Horticulture Innovation Lab management team. Alonso González has more than 22 years of experience in horticultural research for development, as well as experience in assessments and value chain approaches, most recently with the International Center for Tropical Agriculture (CIAT). Tito Livio Zúniga holds a Ph.D. from Cornell University in Agriculture and Rural Development and has 13 years of experience in the field, most recently for the Honduras Ministry of Agriculture as national manager of the horticulture value chain. L. George Wilson has been a Professor of Horticulture at North Carolina State University since 1975. Prior to 1975, he worked as a researcher for Chiquita International in La Lima, Honduras.

Focused on Honduras and Guatemala, the evaluation included consultation workshops in Comayagua, Honduras and Antigua City, Guatemala, a series of in-person interviews with representatives from all sectors of the horticultural value chain (60 in Honduras and 73 in Guatemala), a web-based survey, and dissemination workshops at La Lima, Honduras and Antigua City, Guatemala. More than 190 people participated in person for interviews and workshops, including representatives of grower associations, trading organizations, financial institutions, input providers, universities, non-governmental organizations, and government. Constraints to the horticulture sector were discussed among the participants at each workshop and opinions were captured for this report. Our findings and recommendations were based on the totality of information collected from small group interviews, workshops, and survey respondents, representing broad coverage of the horticulture industry and associated sectors. Therefore, the prioritization of constraints and recommendations may require adjustment to account for specific local conditions within each country.

The evaluation was designed to serve as a springboard for new initiatives to address the constraints that limit the success of small-scale farmers in the horticultural industries in the Central American region. The workshops, interviews, and survey provided strong feedback on constraints to improving smallholder profitability in the horticulture value chains and on potential research, training, and policy initiatives to address those constraints.

CONSTRAINTS TO GROWTH OF THE HORTICULTURE SECTOR AND INCREASED PARTICIPATION OF SMALLHOLDER FARMERS:

LACK OF ACCESS TO ADEQUATE AND AFFORDABLE CREDIT AND CROP INSURANCE

Without access to credit, smallholder farmers—especially women and indigenous peoples—are limited in their ability to invest in inputs and infrastructure to enhance their crops. Needed inputs include quality seeds and plants, fertilizers, crop production and protection supplies, postharvest equipment and supplies, and infrastructure. Farmers do not invest in inputs for horticultural production due to insecure markets and a lack of funds to invest.

LACK OF AN ADEQUATE EXTENSION SYSTEM

There are few formal systems for communication of research needs and research findings between smallholder growers and horticultural researchers and research institutions. In fact, there is little transfer of well-established best practices to farmers.

POOR ACCESS TO HIGH-VALUE MARKETS

Most smallholder farmers, especially women and indigenous peoples, sell their produce through low-value venues, including direct sales in local markets or selling to intermediaries. Markets are difficult to reach due to distance and poor roads. Prices are volatile and smallholder farmers have little power in dealing with essential intermediaries.

WEATHER, CLIMATE VOLATILITY AND CLIMATE CHANGE

The Central American region is particularly vulnerable to weather-related events (drought, flooding, freezing, strong winds), which impact horticultural production, alter flowering/fruiting cycles and planting dates, increase vulnerability to pests and diseases and often result in severe economic losses. Temperatures in the region are expected to increase. Soil water holding capacity and fertility are reduced with poor soil conditions, and thus crop yield potential under climate change conditions. Irrigation, water harvesting and water storage strategies will become even more important.

PESTS, DISEASES, AND WEEDS

Horticultural crops in the Central American region are subject to attack by an array of pests and diseases, frequently resulting in major losses or intensive use of pesticides. Implementation of the Food Safety Modernization Act in the U.S. may push some smallholder farmers out of the export market due to its strict requirements.

LACK OF RESEARCH ADDRESSING REGIONAL, NATIONAL, AND LOCAL ISSUES OF THE HORTICULTURE SECTOR

Although a number of quality institutions conduct research and teaching on agricultural production and pest management for the region, targeted research on horticultural crops is limited by lack of financial and human resources. Capacity for research on postharvest and marketing issues is especially low. There is a lack of training at the Master's and Ph.D. levels.

POSTHARVEST LOSSES AND FOOD SAFETY

More than 30 percent of the yield of many horticultural crops is lost after harvest as the result of mishandling or the lack of adequate postharvest infrastructure. Moreover, access to international markets requires rigorous attention to food safety, during production and postharvest, particularly under the new U.S. Food Safety Modernization Act.

KEY RECOMMENDATIONS FOR RESEARCH, TRAINING, AND POLICY INITIATIVES:

REGIONAL APPROACHES

1. Promote initiatives to **adapt horticulture to climate volatility** through better adapted varieties, protected culture, increased access to irrigation systems, and better weather forecasting.
2. Establish **regional research programs to address cross-cutting constraints** affecting the region, particularly new pests and diseases and sustainable production systems.
3. Promote regional and national **training and education programs on appropriate technologies to reduce postharvest losses** and comply with the Food Safety Modernization Act (FSMA).
4. Promote regional initiatives to conserve, characterize, and facilitate access to diverse and **improved germplasm of horticultural species**.

NATIONAL APPROACHES

1. Reduce the economic risks to horticulture farmers through availability of **effective crop insurance** programs.
2. Design and test an **interlinked microcredit-index insurance** product.
3. **Improve national extension systems** to ensure research information, best practices, knowledge and technologies are delivered to smallholder farmers.
4. Develop trusts or other microfinance means for **financing smallholder farmers**, particularly women.
5. Develop national policies to support **well-funded, long-term national agricultural research systems** (NARS), including training of graduate students.
6. Develop mechanisms to **coordinate and enhance the marketing of horticultural products** from smallholder growers.
7. Create incentives and an enabling environment to **develop horticulture-oriented business services**.
8. Develop policies to **facilitate the participation of indigenous peoples, smallholders and women in value chains**.

1. INTRODUCTION

Since the mid-1980s, USAID has made significant investments in Latin America and the Caribbean to develop the export of horticultural crops, including investments in production, pest management, postharvest handling, processing, marketing, and value-added product development. As a result of these investments, the export of high-value crops and value-added products has generated a greater volume of international trade and contributed to a growing percentage of GDP. This has resulted in greater opportunities for producers and other agricultural enterprises to generate jobs.

With the adoption of free trade agreements between countries in the Central American region and the United States, there is an urgent need to improve the competitiveness of smallholder farmers. Access to finance, suitable land, markets and market information, technical assistance, input providers, research services, production technologies and sustainable cropping systems (including best strategies for pest management) are required to operate effectively and contribute to competitiveness of smallholders. In addition to increasing the opportunities for smallholder farmers to export horticultural crops, improving horticulture along the value chain can benefit domestic markets. Because horticultural crops are nutritious and a critical part of a balanced diet, increased production and consumption of these crops also benefits Central American consumers.

Horticulture is the science, technology, and business involved in intensive cultivation of plants for human use, including fruits, vegetables and ornamental plants. Horticultural value chains are complex, regardless of which country or specific product is considered. The different links in the horticultural value chain, and the impacts of different actors (producers, service providers, input suppliers, researchers and extensionists, buyers, consumers, and regulators) on the production and flow of horticultural crops to diverse markets (informal, intermediary, formal markets, and processing) influence benefits and benefit sharing among stakeholders. Different markets require different levels of sophistication in presentation and quality of the product, with informal markets being most tolerant in terms of product quality and presentation. The effectiveness and efficiency of the value chain to benefit different links of the chain, requires a degree of coordination, transparency, flexibility, and shared goals. It is clear that if one or more links are either inoperative or absent, the chain will not function effectively.

Producers must respond to the demands from regulatory agencies, the pressures of service providers (i.e. selling chemical inputs), the volume and quality demands of end users (i.e. formal markets, domestic and export), and the perishability of their commodities. Under such pressures, small-scale farmers are particularly vulnerable because of low bargaining power, lack of technical knowledge, and difficulties accessing capital. Therefore, special attention is needed to support smallholder farmers and provide the tools and enabling environment necessary to facilitate access to the economic benefits of profitable horticulture.

The assessment conducted in Guatemala and Honduras focused on identifying the kinds of constraints (economic, physical, biological, policy, training and technical capability) that affect the horticultural value chain; recognizing their effects on productivity, product quality, and therefore profitability; and identifying what is required to achieve sustainable growth of the horticultural sector.

This report focuses on the opportunities and threats related to fruit and vegetable production and marketing in the region, and the capacity of local institutions to conduct appropriate horticultural research and training to address the challenges.

1.1 CONTEXT

Economic investment for agriculture declined significantly in the last 20 years (Cleaver 2012). Since the food price crisis in 2008, there has been a rebound in interest from both donors and developing country governments in agriculture as a vehicle to reduce poverty and increase food security.

High-value horticulture is consistently more profitable than alternatives. Basic grain production by small-scale growers is less profitable than cultivation and marketing of high-value crops. For example, fruit and vegetable producers in India generate five to eight times more in profits than cereal farmers (Subramanian et al. 2000). In Kenya, farmers producing fruit, vegetables or flowers for export can earn six to twenty times more than maize growers (Gabre-Mahdin and Hagglade 2003; Minot and Ngigi 2003). Horticulture creates more jobs and produces higher income, but at the same time is more demanding in technology, infrastructure, pre- and postharvest management, finance and knowledge.

High demands of food safety and quality (from both consumers and regulatory agencies) impose stringent standards for growers and other value-chain participants to deliver a competitive product. With the pending implementation of the Food Safety Modernization Act, those requirements will become more stringent.

Changing the agricultural focus of smallholders from basic commodity crops into horticultural crops or mixed cropping systems requires that proper technologies, research and extension support, finance mechanisms, and markets be developed and accessible. Whether the right technologies required along the value chain are available in any particular country depend on whether that country has a technology adaptation, generation, and transfer system that is focused on addressing the constraints that reduce the productivity and quality of horticultural crops (fresh or processed) in horticultural value chains. In turn, the ability of small-scale producers to adopt and successfully apply improved horticultural technologies will also depend on the overall enabling environment for innovation, investment in, production of, and trading of horticultural crops.

Globally, horticulture research has received very little attention. However, the emphasis of the Feed the Future initiative in Guatemala and Honduras is on diversification of smallholder cropping systems toward increased production, postharvest handling, value-added processing, and marketing of horticultural crops.

The weaknesses in agricultural research and technology transfer capacity within Central America are well recognized (Segura Consulting LLC 2011), as are constraints to conducting agribusiness in the region. The objectives of this assessment were to identify specific constraints and opportunities, to assess local capacity to carry out horticultural research within the region, and to prioritize research needs for the horticultural sector.

1.1.1 HISTORY, GEOGRAPHY, AND MARKETS

Military dictatorship ruled many countries in the Central American region during most of the 20th century. Civil wars within El Salvador, Guatemala, Honduras, Nicaragua, and Panama affected economic development and the business environment, leaving a legacy of poverty and migration. The wars ended in the 1990s, paving the way for economic recovery and development in the region. However, natural disasters like Hurricane Mitch in 1998 delayed progress of Honduras and Nicaragua. The region is regularly exposed to hurricanes, which affects infrastructure and hinders agricultural development in the region.

The Central American Common Market was established in the 1960s; however, economic cooperation among Central American countries lacked dynamism because of conflicts, violence, military uprisings, and human rights violations that prevailed until the 1990s. Since the conflicts in the region ended, the Central American Common Market is becoming an instrument of economic development for the region. However, despite the economic liberalization and evident recovery in many countries, poverty and malnutrition prevail.

According to the Economic Commission for Latin America and the Caribbean, by the end of the past decade country level poverty was 67.5 percent in Honduras, 58.3 percent in Nicaragua, 54.8 percent in Guatemala, and 46.4 percent in Salvador—with poverty higher in rural areas (ECLAC 2011). Although poverty in the Latin American region has decreased, more that 167 million people still live under the poverty line.

The close proximity of the Central American region to its largest market, the United States, is a geographic advantage capitalized on by the countries in the region, particularly after the Caribbean Basin Initiative (CBI) and later the Central American Free Trade Agreement (CAFTA) which facilitated market access to the United States from Central America. Support from the United States and other nations, through international development programs, further invigorated the economy and boosted agricultural exports. Crops such as banana, sugar, coffee, rubber, cocoa and coconut were key crops in the region (and some still are the main exported crops), but exports of non-traditional crops are growing in several countries, including Guatemala, Costa Rica, Honduras, and El Salvador.

Climate change is expected to result in severe water shortages in eastern Central America, the plains, Motagua Valley, the Pacific slopes of Guatemala, eastern and western regions of El Salvador, and the northern, central, and western inter-mountain regions of Honduras (IPCC 2007). Effects of future climate scenarios on yields of maize and beans were recently studied by Schmidt et al., (2012) by downscaling global climate models to a local scale. The outputs of the downscaled models indicate that temperature is predicted to increase while precipitation will be slightly reduced. Soil water holding capacity and fertility conditions will be highly affected by climate change, reducing crop yield capacity by up to 50 percent under poor soil conditions.

Monterroso (2009) analyzed the land distribution in Guatemala, and indicated that, in 2003, (Censo Nacional Agropecuario, INE 2004) 45 percent of the farms had less than 0.7 hectares, and represented 3 percent of the country. Forty seven percent of the farms were between 0.7 and 7 hectares, representing 18 percent of the country. Only 8 percent had more than 7 hectares, but represented 78 percent of the national territory. An analysis of the census from Guatemala in 1950, 1964, 1979, and 2003 showed a trend towards smaller farm sizes in the country.

1.1.2 HORTICULTURAL PRODUCTION AND TRADE

Since the mid-1980s, the Central American countries and the Dominican Republic have embarked on agricultural diversification activities to offer non-traditional agricultural products to the market. Their goal was to focus production efforts to offer tropical and subtropical fruits to the export market. Fruit production accounts for 34 percent of the agricultural production in the region, and represents about $2.438 million. Between 2004 and 2008, the fruit export sector increased 48 percent. The main crops exported from the region are bananas (47.2%), pineapples (21.5%), melons (13.5%), juices and concentrates (7.6%) and other fruit derived products (4.3%). This growth in exports has occurred by targeting both intra-regional and international markets. Factors like the increased demand for healthy foods has helped to increase the market share of fruits and vegetables, and the increased per capita consumption of fruit in the region (111 kg/person/y) has boosted the intraregional markets. Within the region, Belize has the highest per capita consumption of fruits (260 kg/person/year), and the lowest is observed in Nicaragua (36 kg/person/year). Horticultural production in Honduras increased from 407,000 tons in 2004 to 500,000 tons in 2009 (23%) (FAOSTAT 2011). In Guatemala, total vegetable production grew from 1,110,500 tons to 1,639,600 tons (48%) during this same time period (FAOSTAT 2011).

In Central America, the majority of horticultural producers are small farmers, although some production is carried out by larger growers and companies. This is more evident in the case of vegetable production, where the normal size of a production operation is less than a hectare and in many cases less than an acre. Because of

Table 1a. Regional Vegetable Imports and Exports: Central America 2007-2009 (millions USD)

	Potato imports	Potato exports	Tomato imports	Tomato exports	Onion/garlic imports	Onion/garlic exports
Guatemala		4.8-12		2.1-6.3		2.2-4.9
El Salvador	4.9-12.6		10.7-15.8		1.9-4.5	
Honduras				1.3-4.2	0.1-0.5	
Nicaragua	1				0.5-1	0.2-1.2

Table 1b. Regional Fruit Imports and Exports: Central America 2007-2012 (millions USD)

	Banana imports	Banana exports	Citrus imports	Citrus exports	Melon/papaya imports	Melon/papaya exports
Guatemala		5.9-12.9	3.8-6			2.3-3.6
El Salvador	10.1-16.5		0.7-1.9		4.6-6.0	
Honduras	2.8-4.5			0.5-6.0		0.9-2.6
Nicaragua		1.8-4.3		3.1- 9.0		
Costa Rica		1.1-8	4.3-10.1			

(SEICA 2012)

the small size of individual operations, in Guatemala alone there are 50,000 small-scale farms involved in the export of vegetables. The top 20 (ranked by value) food and agricultural products produced in Honduras and Guatemala include a lot of horticultural crops. In Honduras, this includes coffee, bananas, tomatoes, oranges, pineapples, plantains, mangos, and guavas, and in Guatemala this includes bananas, coffee, tomatoes, melons, potatoes, pineapple, mangos, guava, avocado, and papayas.

Central America is a net exporter of fruits and vegetables. The trade of horticultural products is vibrant in Central America. The export of non-traditional horticultural crops such as snow peas and green beans has exploded in Guatemala in recent years, growing 541 percent between 1999 and 2008 (Feed the Future 2011). According to official figures from the Central American Economic Integration Secretariat, the total amount of vegetable imports from all origins was $145,359,389 while the total of exports to all countries was $302,489,934 (SIECA 2012). In the case of fruits, Central America imported $190,193,797 and exported $2,468,256,757 total.

1.1.2.1 NATIONAL

Small-scale fruit and vegetable farmers in Honduras produce mostly for local markets, be it supermarkets or wholesale informal markets. Internal market sales estimates indicate that the share of supermarkets in overall food retail is increasing rapidly, from 10 percent in the 1990s to between 30-40 percent by 2005 (Reardon et al. 2005). Wholesale informal markets still account for the majority of products sold domestically (USAID 2012). Such published information was not found for Guatemala or El Salvador. This "two-tiered" system identified by USAID, ACDI/VOCA and FHI 360 in a field report from 2012 highlights both opportunities and challenges within the Central American horticulture value-chain (Chalmers et al. 2012).

1.1.2.2 REGIONAL

There is an active trade of fruits and vegetables within Central America. Currently the region is the main commercial ally for Guatemala, followed by the United States and Europe (SIECA 2012). In general, trade statistics show that El Salvador is a large buyer of fruits and vegetables in the region, whereas Guatemala and Honduras, and to a lesser extent Costa Rica and Nicaragua, are key exporters of fruits and vegetables (Table 1).

1.1.2.3 EXPORTS OUTSIDE THE REGION

As for exports of fruits and vegetables outside the Central America region, Honduran smallholder farmers export mostly Asian vegetables as well as some fruits. In contrast, Guatemalan farmers export mostly snow peas, carrots and cucurbits, in addition to some fruits.

From 2001 to 2011, Central American countries have increased exports of fruits and vegetables to the United States, the main export market, at variable rates per year (1% to 11%). For instance, Costa Rica exported $621 million in 2001 and $1.012 billion in 2011, reaching a 5 percent U.S. market share of fruits and vegetable imports through pineapples, bananas, orange juice, melons, other tropical fruits, and preserved fruits/vegetables. The change achieved by Guatemala is even more striking, having export sales of $331 million in 2001 and $947 million in 2011. Guatemala currently holds a 4 percent share of the U.S. import market (bananas, pineapples, tropical fruits, preserved and frozen fruits/vegetables, melons, tomatoes, beans, and berries). Honduras is moving forward but more slowly, and exports to the United States increased from $165 million in 2001 to $293 million in 2011, holding 1 percent of the US market via bananas, melons, pineapples, cucumbers, beans (Johnson 2012).

The region is opening new market venues for fruits and vegetables as competition increases for the U.S. market. Exports to Asian countries and increased exports to Europe are being considered by large export companies in Guatemala.

1.1.2.4 EXPORTS OF PROCESSED FRUITS AND VEGETABLES

In the case of processed fruits and vegetables, in 2012 the Central American region imported $321,309,189 while it exported a total of $443,743,896 (SIECA 2012). Again, even in processed fruits and vegetables, the Central American region is a net exporter. However, more can be done in processed products as the difference between import and export is not as large compared to fresh fruits and vegetables.

In 2012, Guatemala exported to the Mercado Común Centro Americano (MCCA) about $331 million as food presented in diverse forms, and El Salvador and Honduras absorbed about 72 percent of these exports. El Salvador is not a fresh food producer, but clearly is becoming more focused on processing and exporting. Exports of juices doubled from 25 million tons to 50 million tons between 2004 and 2008. In January to October 2012, exports of processed fruits from El Salvador amounted to $59 million, 13 percent higher than in 2011 (PROESA 2012).

1.1.3 RECENT EVALUATIONS AND INITIATIVES OF THE HORTICULTURAL SECTOR IN CENTRAL AMERICA

Assessments of various aspects of the horticulture sector in Central America have been made over the last 20 years. Following is a brief summary of the key findings.

1.1.3.1 PICHA 1992

In 1992, Picha conducted an assessment of the needs of the horticultural sector and identified several issues within pest management, crop production and management, and postharvest technologies as the most

limiting factors for growth of horticulture in the region. The study made specific recommendations on limiting diseases. The recommendations were supported by the experience of the author of the study, as well as a limited number of surveys. Specific recommendations included:

1. characterization and epidemiology of the sweet potato whitefly;
2. integrated pest management, with special emphasis on the sweet potato whitefly, viruses of melons and papaya, cherry mites, anthracnose on mango, root rot caused by *Phytophthora*, powdery mildew and fruit rot caused by *Botrytis*;
3. breeding for resistance to viruses on melon and papaya;
4. regulation of flowering and fruiting of mango;
5. storage and controlled or modified atmospheres during transport;
6. in vitro propagation of ornamental plants and tropical fruits; and
7. chemical residues and degradation of pesticides.

Picha focused mainly on aspects of crop production. However, the current vision indicates that the problems and solutions must be conceptualized at the level of the value chain, which includes other approaches and solutions as well as the purely investigative and technological. The problems identified by Picha still represent serious constraints, and with a level of relevance similar to 1992, although progress has been made in technologies and processes to tackle them.

1.1.3.2 GLOBAL HORTICULTURE ASSESSMENT

In 2005, USAID funded a study on the needs of horticulture worldwide. This assessment, led by the University of California, Davis and supported by Michigan State University, Purdue University, the University of Hawaii at Manoa and the World Vegetable Center (AVRDC), included a series of consultations in Asia, Africa and Latin America. Consultation workshops were held in the Central American region. This study clearly showed that it is not only essential to generate enough technical knowledge to develop the potential of horticulture to alleviate poverty, but that many other factors must act in synchrony to function efficiently and effectively in a successful horticultural value chain. The Global Horticulture Assessment emphasized the fact that research in horticulture has received little attention and international funding, despite its great capacity to alleviate problems of malnutrition, nutritional imbalances and poverty. The document called on the international community to fund research in horticulture, and especially to promote gardening as a vehicle to reduce rural and urban poverty. After the assessment, USAID initiated and funded the Horticulture Innovation Lab (as Horticulture CRSP) in 2009, but funding of horticulture research and development in emerging countries has remained limited.

1.1.3.3 REGIONAL PROGRAMS

In response to growing interest and opportunities identified by Central American countries to invest in the horticultural sector, several regional programs have been implemented in the last few years. The Mesoamerican Fruit Program (Proyecto Mesoamericano de Fruticultura) PROMEFRUT (2009-2011), a BID-supported initiative that generated Regional Public Goods was implemented by IICA, SECAC, OIRSA and OIMA. The objective of this program in its first phase was to improve the competitiveness of the fruit sector in Central America.

One of the products derived from PROMEFRUT was a regional agreement among the Central American countries to become competitive in fruit production and marketing. The regional agreement named PRO-FRUTA, promotes actions that will have better impact if applied regionally rather than on a national basis. The program described clearly the current challenges and instruments to overcome them, and identified six axes on which to focus regional actions and mechanisms.

- A1: Trade, promotion and market intelligence
- A2: Health, safety and quality
- A3: Promote competitiveness
- A4: Technological innovation and knowledge generation
- A5: Institutional strengthening and development of technical and business skills
- A6: Cross-cutting themes: risk management, environmental management, food and nutrition security and equity

PROMEFRUT generated action plans for market intelligence, knowledge generation and a health, safety and quality platform.

National programs to promote fruits and vegetables have been implemented as well. For instance, PROFRUTA increased areas devoted to fruit production from 2,500 hectares to 30,500 hectares between 1995 and 2004. The PINFRUTA program, a successor of PROFRUTA, increased areas planted with fruits by an additional 10,191 hectares from 2005 until 2011.

In 2010, an IICA study to prioritize fruits in Guatemala within a MAGA/PROFRUTA program used a set of parameters to assign weight to each fruit species. These parameters included: positive externality index (how good for the environment the crop is), potential to generate employment, potential for income generation (Qz/hectare/year), internal return on investment (TIR%), internal market Index (imports), potential for market diversification (how many countries import this crop), export value, and competitiveness of Guatemala producers. This methodology produced the following list of priority fruits for the country: papaya, lime, strawberry, avocado, plantain, rock melon, mango, macadamia, passion fruit and peach.

Two recent studies have evaluated USAID-funded aspects that are relevant to the horticultural sector in the region and specifically for Honduras and Guatemala. The first study by Segura Consulting (USAID 2011) provides a detailed look at the regulatory aspects of governance, financial, environmental (climate change), security and corruption, food security, competitive markets and infrastructure in Guatemala.

This study identified the following areas of high relevance to the sector:

- **Markets and competitiveness:** The report concludes that despite the success of Guatemala in export markets, it is essential that the country develop skilled labor by offering training and education opportunities and offering competitive and attractive salaries.
- **Finance, credit and investment:** Guatemala still suffers from supply and demand for finance which affects mostly smallholders in the coffee and horticulture sectors.
- **Climate change and environment:** Lack of attention from the government of Guatemala to environmental issues affects agriculture and agribusiness, resulting in high opportunity costs.

- **Infrastructure:** The country requires large investments in physical infrastructure (small- and large-scale), which could be implemented through public-private partnerships.
- **Security, crime and corruption**: Lack of security in the country increases production costs and discourages investors.
- **Policy and enabling environments:** Past policies have not been very conducive to a growing agribusiness sector.

The second report was based on Honduras, where the Inter-American Development Bank (IDB 2010), identified a number of issues for the horticulture subsector that undoubtedly apply to other countries in the region, including concentration of market power, as markets are dominated by a handful of buyers. Access to credit was also identified as difficult, in part due to massive debt forgiveness programs that were implemented after Hurricane Mitch and to the fact that producing and marketing perishable products entails a high risk, particularly when that is combined with a weak support infrastructure. Access to credit has improved with the help of the Millennium Challenge Account having established an agriculture program that included credit as a main component. An estimated 5,317 horticultural producers were reported to have access to credit. However, it is also true that of these, an estimated $2.2 million in outstanding loans were reported at the time this report was published in 2010.

Another recent study, "Sustainability in Honduran Informal Market System" (Chalmers et al., 2012) evaluated the performance of informal markets in Honduras, how these relate to the producers, and the types of services established by middlemen. The study highlights three main findings:

- Producers that received technical assistance or were engaged in a calendar planting program had the highest likelihood of selling to formal markets, and the highest income per crop/per season.
- To reap the benefits of market access, farmers need to be organized into groups to enhance their negotiation power.
- About 80 percent of smallholders sell to middlemen because they pay cash at the time of sale.

Closing gender gaps and empowering women contribute to improving productivity, increasing efficiency in agriculture, reducing hunger, and achieving food security (FAO 2011). To measure women's empowerment, the Women's Empowerment in Agriculture Index (WEAI) was created in 2012. The WEAI is a tool that measures women's control over their lives in five domains and is based on the Alkire Foster Method which can distinguish between empowered and disempowered people (IFPRI 2012). The WEAI is robust enough to measure changes in empowerment in both men and women over time. It will be used by USAID to measure the impact of development programs on women's empowerment. To develop and verify the WEAI, an extensive pilot study was completed in several countries, including Guatemala. The data from Guatemala illustrate the levels of disempowerment for women in agriculture.

In the Western Highlands of Guatemala, the study indicated that women are less empowered in agriculture than men. In the study, (237 women and 197 men) women were less empowered than men. Only 28.7 percent were empowered compared to 60.9 percent of men. Analysis showed that the areas that contributed most to the disempowerment among women were the lack of leadership in the community (23.7%) and control over the use of household income (23.7%). Women were not empowered, and they lacked access to credit and the ability to make decisions about it. The factors that contributed to men's disempowerment were similar to those encountered by women. However, the lack of control over income was less important for men, but lack of control over resources had a heavier weight for men. The study also showed that age was

highly correlated with empowerment. Women below the age of 26 and in the age group of 56-65 were less empowered as compared to other age categories.

Similar conclusions were reached by a group of 85 women that participated in the "First Conference of Female Horticultural Producers in Honduras 2012." This initiative was led by Centro Agronómico Tropical de Investigación y Enseñanza (CATIE) working in Honduras, Rural Competitiveness Project (COMRURAL), National Program of Food and Agriculture Development (PRONAGRO), Secretary (Ministry) of Agriculture and Livestock (SAG), DICTA, and the Honduran Council of the Economic Sector (COHDESSE).

1.2 OBJECTIVES

Our objective was to assess the capacity of the horticulture sector and support organizations in the region to respond to the following questions and needs:

1. **Constraints:** Which issues related to pests and diseases, crop varieties, fertility, cultural management, postharvest handling, value-added processing, marketing, and/or other constraints (e.g., land tenure) currently reduce either: (a) the quality, productivity, profitability, and income-earning potential of horticultural crops or (b) the ability of a country's horticultural industry to grow on a sustainable basis?

2. **Opportunities:** What are the opportunities for improving income through production of new crops, adoption of improved technologies or varieties, creation of new value chains, and development of new methods for adding value to horticultural crops?

3. **Technologies:** To what extent are on-the-shelf technologies available, appropriate for, and transferable to small-scale producers to address the constraints these producers face?

4. **Research:** To what extent is ongoing research and local capacity to carry out research and training on horticultural crops able to address the constraints that most threaten the ability of a country to grow its horticultural sector and, more specifically, the ability of small-scale producers to profitably and sustainably compete in a country's horticultural industry, especially factoring in climate change? What are the research priorities to address these needs?

2. METHODS

The methodology (Figure 1) used to conduct this assessment of the horticulture sector in Central America consisted of:

- Background research and literature review, including a document review
- Interviews and field visits
- Analysis
- Consultation workshops
- Web survey
- Analysis
- Dissemination workshops
- Final report and dissemination of results

The study was conducted between October 2012 and March 2013 in Guatemala, Honduras, and El Salvador.

2.1 INTERVIEWS AND FIELD VISITS

From October to December 2012, the assessment team visited El Salvador (Oct. 25-26), Honduras (Nov. 11-23), and Guatemala (Dec. 1-15). In Guatemala and Honduras, interviews involved visits to different regions of each country, while in El Salvador interviews were only conducted in San Salvador. In total over 190 individuals were interviewed for this report. At each visit, various actors of the horticultural value chain participated in semi-structured interviews to obtain their views on challenges and opportunities for the horticultural sector. Interviews were conducted with individuals or with groups of 2-10 people representing their organizations, including men and women. Each interview took at least an hour, but occasionally extended up to three hours. There was no specific set of questions used for each interview, and the interviews were open-ended. Interviewers took notes during the interviews and, when given permission to do so, the conversations were recorded and later reviewed by the team. Individual farmers (small and large), researchers (national level, universities, and private sector), NGOs, Ministers and ex-Ministers of Agriculture, wholesale buyers, and heads of farmer organizations and cooperatives all participated in interviews. A detailed list of organizations interviewed is presented in Appendix A.

2.2 CONSULTATION AND DISSEMINATION WORKSHOPS

Two types of workshops were conducted during the assessment: consultation workshops and dissemination workshops.

Consultation workshops: The first workshop was held in Comayagua, Honduras, on Nov. 15, 2012. A second workshop took place in the city of Antigua, Guatemala, on Dec. 6, 2012. Approximately 35 people were invited to each workshop from an extended list of stakeholders; those invited to participate were selected based on the sector they represented, their history and leadership in the horticultural sector of each country, and their capacity to contribute significant information on the challenges and opportunities facing the horticultural sector in Central America. Workshop registration was through the Horticulture Innovation Lab website. The value chain links represented at the workshops included production, postharvest, processing,

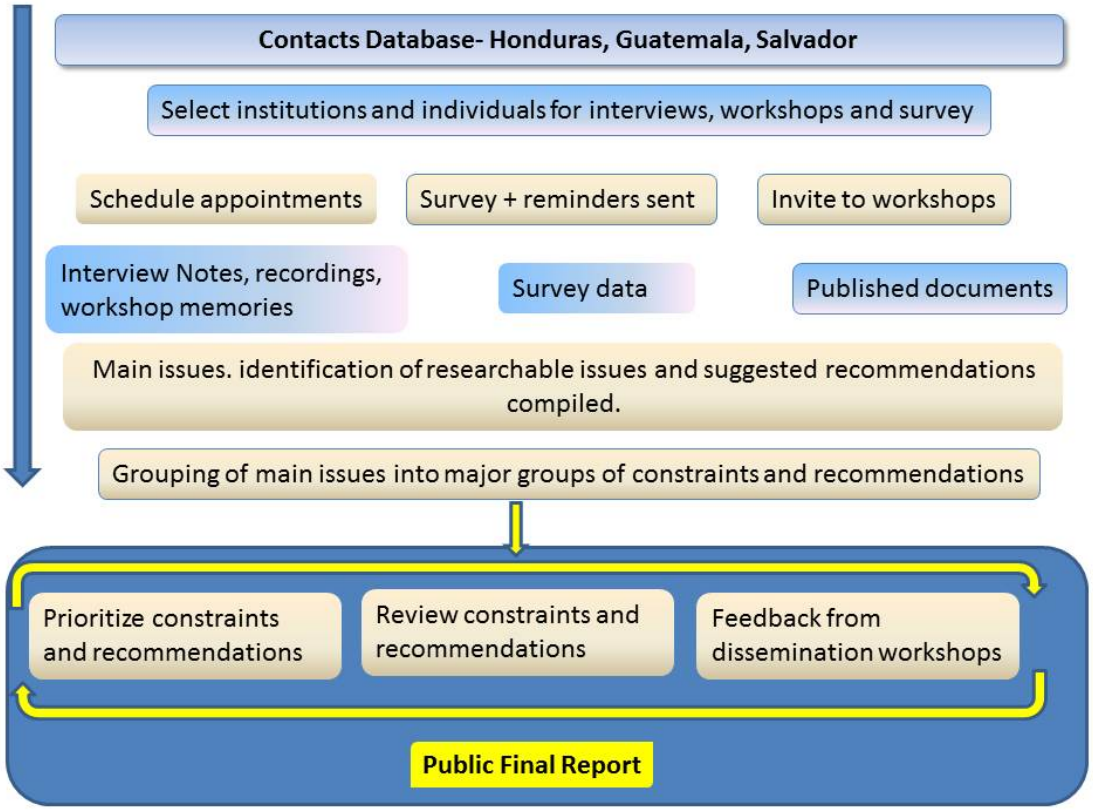


Figure 1. Information flow and analysis of the in-person interviews, workshops and survey information.

marketing, technical services, business development services, international aid, NGOs and government regulators.

Each workshop was divided into two sessions: Session 1 included 15-minute presentations by the assessment team, followed by five presentations from workshop participants. Session 2 included discussion tasks suggested by the assessment team; workshop participants were randomly assigned to groups of 3–5 people. Group discussions happened both in the morning and in the afternoon.

Task one (morning): Workshop participants were divided into groups to work on three tasks:

1. Identify issues and needs of the horticulture sector (production, postharvest management and processing, input providers, availability and quality of technical assistance, traders, and access to formal and informal markets).
2. Identify at least five needs per link in the horticulture value chain and suggest how to address those needs.
3. Sort those needs in order of priority.

Task two (afternoon): Working in small groups, participants were asked to answer two questions:

1. What alternatives and approaches are needed to make small- and medium-size farmers more competitive in a globalized economy?
2. How can we prepare the horticulture industry for the challenges coming in the next 10 years?

Each group reported back to the plenary for an open floor discussion of their findings and recommendations. Each workshop was supported by a note taker.

Dissemination workshops: One-day dissemination workshops were held at the FHIA facilities in La Lima, Honduras, on March 11, 2013, and a second dissemination workshop was held in Ciudad Antigua, Guatemala on March 13, 2013. In these workshops, the assessment team shared information about the main findings of the evaluation, i.e., the limitations that prevent the development of the horticultural subsector and recommendations to meet those challenges. For these workshops, those invited to participate were selected considering their position to influence change in the sector they represented, as well as their history and leadership in the horticultural sector of each country. Participants were asked to form groups to discuss the recommendations that the evaluation team decided needed more feedback from the various stakeholders in the sector.

The groups were asked to provide answers to the following questions:

1. What other actions would you suggest to address the constraints in the horticulture value chain?
2. Choose the two most important actions, according to impact and feasibility, to address those constraints.
3. Tell us how those actions could be implemented, who is responsible, and who should be involved in implementing the actions.

During the workshop in Honduras, groups were asked to work on production, postharvest, processing, and marketing. In Guatemala, groups were asked to work on gender constraints, training and education, and research. Each group worked on a single constraint type, and reported back to the plenary for an open floor discussion. The workshops were supported by a note taker.

2.3 SURVEY

A survey was prepared and distributed online to a wider audience to gather a broader perspective about the horticulture sector in Central America and to rank the constraints previously identified as to their importance. A pilot survey, prepared in Spanish, was given to eight people and then refined before being sent to participants. The survey, prepared and implemented using an online survey tool (SurveyMonkey), was sent to an initial list of 240 players in the horticultural sector in Central America representing Honduras, Nicaragua, El Salvador and Guatemala. The survey was also sent to those who participated in the interviews and workshops, other actors that were suggested during the visits, and others suggested by those who responded to the survey. The survey was distributed electronically in early February 2013 and remained open for 30 days. Email reminders were sent twice during that period to recipients to encourage survey response. Of the 240 people contacted 70 responded and completed the survey, giving a response rate of 29 percent. The survey (see Appendix C) included questions intended to highlight specific limitations throughout the value chain, and to prioritize research needs.

The survey had three sections, and participants could answer one, two or all three sections. This option offered the flexibility of preparing a single survey, instead of three, and allowed participants to respond only to the sections they felt most relevant to their situation. In the first section, the participants provided basic information and were asked to rank various issues from “not limiting” to “extremely limiting” to the horticulture sector. The second section had questions related to markets, and the third section targeted research issues. The issues included in the survey resulted from issues mentioned and ranked as important

Table 2. Constraint type and description of issues mentioned in the interviews and workshops

CONSTRAINT TYPE	DESCRIPTION
Biological	varieties, pests, diseases
Cultural	spacing, pruning, soil management
Food safety	microbial, chemical
Education/Training	access to information, knowledge, university capacity, technical assistance
Economic	financing, input costs, market prices, profitability
Engineering/Technology	irrigation, cooling, processing
Management	budgeting, planting choices and schedules
Physical	climate, soil, nutrients, water, rain, relative humidity
Policy	private or public regulations, actions
Social	gender equity, land tenure, social norms, cooperatives

during the consultation workshops. Questions in the research section included questions that were considered by the Picha (1992) study, plus additional ones generated during the workshops and interviews.

2.4 ANALYSIS

More than 190 people participated in person for interviews and workshops. The composition of participants included a broad range of organizations and stakeholders from within the horticulture value chain, including producers, development practitioners, government representatives, service providers, researchers, educators, marketers, financers and consultants. This assessment uncovered a broad variety of challenges for the horticulture sector; in order to focus the results, a number of strategies were used to identify the most pressing issues.

The evaluation team consolidated the interview notes and conclusions from the workshops, and verified these by reviewing the recordings as needed. The comments made by interviewees were organized by actor or link in the production chain and constraint type (Table 2). The interview text was coded by constraint type (biological, economic, policies, engineering and technology, education and training, crop management, physical, and social); some categories were suggested initially by USAID and from the research team's experience. Within these constraint types, topics were subsequently pooled to capture what respondents expressed as challenges or opportunities for the sector. To develop a mechanism for focusing recommendations, identified problems were prioritized by answering questions such as: If this problem is solved, what may be the impact on the sector and poverty alleviation? Is the solution to this problem long-term or short-term? By answering these two questions, we were able to better understand the importance of a solution in terms of economic impact and scale.

Seventy people responded to the online survey. Respondents represented mostly Honduras (42), followed by Guatemala (24), El Salvador (3), Costa Rica (1) and the United States (1). Eleven women and 59 men responded to the survey.

To analyze the results of the online survey, participants were grouped into one of five industry types based on their responses to the questions: What is your profession? What type of organization do you work for? What area do you work in? The five categories identified were: academic (11), extension (14), government (8) (this group includes those working for their own government or representatives of foreign governments, i.e., USAID staff), grower (10), grower-academic (6) (these individuals worked for academic or research institution but also heavily identified as a producer/grower), and the private sector (18).

All respondents indicated they had a professional degree. Fifty six percent were agronomists, 21 percent economists and administrators, and the remaining 23 percent represented other disciplines (education, biology, biochemistry, industrial engineering, and rural development).

Similarly, when asked what area of the value chain they felt more affiliated with, 45 percent work on production, 21 percent on marketing, 26 percent on research, 18 percent as consultants, 32 percent as extension agents, 13 percent in education, 2 percent from government, 4 percent as input providers, and 12 percent said "other." Multiple responses were permitted. Only 18 percent were most affiliated in a single area, 23 percent in two areas, 16 percent in two areas, 10 percent in four areas, 3 percent in five areas, and 1 percent in all six areas (a commercial laboratory). Out of the 26 people involved in research, 13 were also considered to be involved in extension services.

In both Guatemala and Honduras, 62-65 percent of the people who responded to the questions in the research section were in the field of integrated pest and disease management, followed by crop adaptation to protected agriculture (high tunnels, greenhouses, etc.)(48-57%) and crop management (agronomy and physiology) (48-57%) (Appendix C, Question 14). The lowest representations were in the fields of sociology and rural development, agricultural economics, and policy development, biotechnology and food engineering (16-27%).

3. RESULTS

In the online survey, respondents were presented with three sets of questions where they were asked to rank different factors within each section from not limiting (1) to extremely limiting (5) to the horticulture sector. These sections were production, markets and policy, and climate. All four of the most limiting factors were identified within the markets and policy section; this section was also ranked with the highest average for limiting factors 3.6 compared to 3.3 (production) and 2.9 (climate) (Table 3).

Table 3. Top 10 barriers to horticulture production

Barriers as highlighted in the survey (Summary statistics)	Overall averages*
Access to credit for small producers	4.32
Cost of credit for agriculture	4.23
Cost of agriculture insurance	4.11
Availability of agriculture insurance	3.99
Access to export markets	3.97
Cost of irrigation technologies	3.90
Lack of government programs to support small producers	3.83
Public irrigation district	3.79
Cost of chemicals	3.78
Increased pest populations and diseases	3.76

*Scale of 1 (least limiting) to 5 (extremely limiting)

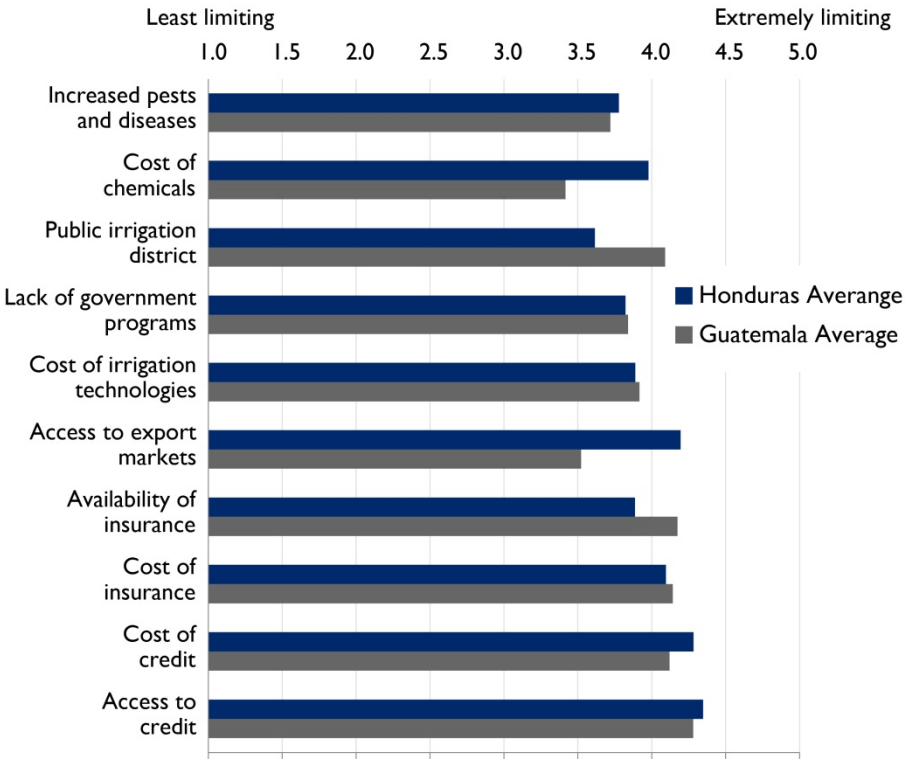
When these results are combined with what was learned during the in-person interviews and workshops, we see a number of parallel constraints. Economic issues include: access to and cost of credit, lack of working capital, little access to markets (more specifically formal markets) and access to and cost of crop insurance. Training and education related barriers also were highlighted as major barriers to the sector. Quality technical assistance, access to research results, extension services, and access to technical information were the most cited examples. The other main constraints identified were biological in nature: pests and diseases, lack of quality planting materials, seeds, lack of or costly biological inputs. Other related concerns came from those quite concerned with changing climate and the possible impacts of this on their production; access to water and irrigation as well as the changing pest and disease profile in specific regions. These three challenges—economic, educational, and biological—represent a broad spectrum of the issues faced by players in the horticultural value chain in Guatemala and Honduras.

While social issues related to under-represented groups were not fully explored in the survey, they were highlighted in the interviews and workshop sessions. Women consistently lack representation and have trouble accessing technical and other services. While access to and cost of insurance and loans were highlighted generally, these tend to be even more challenging to access for women and disadvantaged groups. Technology needs in both production and postharvest were highlighted especially during the interviews; smallholders are unable to invest (or get loans), and there is limited availability of new technologies in markets. Interestingly during the interviews people commented on weak rural health programs, noting that these programs have not been effective in encouraging people to change their diets towards more nutritious foods. Creating new demand for micronutrient-rich fruits and vegetables is key to improving the sector overall.

The major constraints to the horticulture sector identified in this study were remarkably similar between Honduras and Guatemala (Figure 2). This was true of both the survey and the individual interviews. This shows that the challenges faced by the sector are very similar between the two countries with a number of key differences which will be discussed below.

The research capacity of local universities and research institutions was consistently identified as a major limitation to the growth of the horticulture sector. The interviews revealed that there seems to be little connection between research and practice, while in the survey researchers selected results getting to the end user as one of the main factors important to their work. The other critical factor was the availability of funds for research. Within the region many faculty members are teaching and not conducting research, and those who are able to do research are in underfunded labs, in universities that lack infrastructure. All of these challenges were highlighted by groups from both Guatemala and Honduras.

Figure 2. Top 10 barriers to horticulture production, with responses by country



The survey included a set of questions related to specific research needs. The surveys asked respondents about research needs within four broad categories: management of pest and diseases, crop production and management, biotechnology, and postharvest.

The most important themes under pest and disease management were IPM (96%), followed by development and marketing of biological products (70%), and identification and management of viruses (50%). The interest in development of biological products was confirmed in questions related to the focus on biotechnology, where more than 80 percent of respondents indicated that the utilization of microorganisms to control pests and diseases should be a priority, followed by adaptation of tissue culture technologies for low-cost use.

The most important themes to research under crop management were management of integrated production systems and crop management under protected agriculture. Following those, developing new varieties adapted to climate change, sustainable production systems and the availability of certified planting materials were the main management-related research needs.

The most important research themes under postharvest research were related to handling, including cold storage, quarantine treatments, pre-harvest crop management to optimize postharvest quality, and ensuring safety and establishment of maximum residue limits (MRLs).

4. MAJOR FINDINGS AND CONSTRAINTS

The complete list of constraints identified during the interviews and workshops is presented in Appendix B and summarized in Table 4. The assessment team recognizes that all constraints need to be addressed for the horticultural value chain to operate effectively and achieve its goals. Nonetheless, because recent documents had addressed similar constraints, this discussion mainly focuses on those identified during the interviews, not in background reading.

Table 4. Summary of key constraints to growth of the horticulture sector in Central America

	Key constraints	Details
Access to inputs	High cost	farmers cannot invest in needed inputs
	Genetic resources	lack of germplasm for commercial species
		native species can be pushed out by newer varieties
	Water	lack of availability in dry months (Nov-April)
		lack of new technologies, investment in
		lack of any technology or inefficient
Production	Pests and diseases	losses and market rejection
		vegetative materials often infected with viruses
	Food safety (FSMA)	lack of knowledge
	Climate change (resiliency)	lack of new varieties resistant to abiotic or biotic stresses
		changing climate zones within the country
		farmers lack the ability to adapt and make changes and they can be displaced
		need to adapt to new pests and diseases
	Technology and supplies	small farmers are unable to invest or get loans
		lack of infrastructure
		too expensive, not affordable
	Crop insurance	does not cover climate-related events
		difficult to access, especially for small farmers
Postharvest	Lack of technology	small farmers are unable to invest or get loans
	Processing	lack of innovation
		cheaper to import processed produce
		high production costs for processing industries
		low technical and business capacity
Markets	Access to markets	dumping by other countries (seed and product)
		little border control
		wholesale markets disadvantage small farmers (no direct sale opportunities)
	Access to credit	large buyers lend money and charge high interest (30%)
		very slow to get loans through appropriate channels
		few banks provide agriculture-related loans
		farmers have little collateral, especially women and minorities

	Lack of understanding of market needs	small farmers are unable to understand or get information on current market trends	
		little info on quality standards	
	Weak organizational structures	lack of transparency	
		price volatility	
		few contracts to hold parties responsible	
Research education and training	**Low level of education**	growers lack technical capacity	
		students lack interest in studying agricultural sciences	
		few institutions offer Master's or Ph.D. programs	
	Research capacity of universities and research institutions	little connection between research and practice	
		Honduras	lack of research funds
			poor infrastructure at universities
			horticulture faculty are teaching, not doing research
			some researchers have political ties and move in and out with each administration
			researchers do not reach out to producers
		Guatemala	lack of research funds
			research by students not necessarily focused on farmer needs
			funds are for teaching not research
	Extension services	delivered by private sector or NGOs, they lack trust	
		unreliable and transient people	
Socioeconomic	**Lack of opportunities for women**	lack of representation	
		few female extension agents	
		unable to get loans	
	Lack of opportunities for indigenous peoples	land tenure	
	Weak rural health programs (nutrition)	export oriented horticulture has not been shown to improve nutrition or change diets	
		increased production of horticulture crops does not equate to increased consumption	

4.1 BIOLOGICAL

4.1.1. PESTS AND DISEASES

Pressure from pests and diseases is a major concern in the region—even more now that new regulations under the U.S. Food Safety Modernization Act will soon be implemented—and will be especially relevant to export agriculture. The Central America region is already facing several catastrophic diseases, such as Huanglongbing (HLB) in citrus, Lethal Yellowing in coconuts, *Fusarium oxysporum* race IV in bananas, *Fusarium spp.* in pineapple and *Tuta spp.* in tomato. These pests and diseases already represent major challenges for small and large farmers including considerable economic damage. For instance, commercial production of citrus in Belize has been abandoned because of HLB.

When pests affect their crops, farmers absorb severe losses, face market rejections, and consequently suffer restricted market access due to previously unforeseen pest problems in their crops. To avoid losing their crops, farmers in the region often rely on increased agrochemical use with subsequent increased risk of chemical residues that surpass MRLs. This touches on two limitations identified by the survey: lack of access to information on the Food Safety Modernization Act (FSMA) and the high cost of chemical inputs. Through our survey, growers ranked this high cost as their most limiting factor overall and all participants ranked this as the most limiting factor related to production. Although efforts to support export agriculture are on a larger scale and more visible, farmers not involved in export agriculture often feel unprotected, abandoned, and even more vulnerable. As a consequence, their use of crop protection agrochemicals can further increase, with possible health issues for local consumers, farmers, and the environment. The lack of biological control agents and skills for IPM and sustainable production practices intensifies these issues. In some cases, smaller farmers' crops are purchased by larger exporters who need to adhere to the FSMA. This emphasizes the importance of safe use of agrochemicals and safe handling procedures to prevent contamination. All of these issues touch on the identified lack of education and knowledge related to chemical use and export regulations.

Some examples of crops that face these constraints:

- In Honduras, some tomato growers indicated they were looking for new regions in which to grow their crop (plus alternative ways to grow it under protected cultivation) due to the high costs of growing tomatoes in the open field.
- The rambutan industry has good potential as a niche crop for export and local consumption, but is faced with large rejections due to the presence of scale insects on the fruit, despite considerable and costly efforts to wash them off the hairy fruits.
- The avocado industry also has great potential for the region. As is common in many developing countries, avocado seedlings are sold through non-certified nurseries, and commercial varieties are grafted onto rootstocks that are not resistant to important diseases such as *Phytophtora cinnamomi*.
- Expansion of the native fruit species, such as jocote (*Spondias purpurea*) in El Salvador, has been halted because of disease, most likely a phytoplasma (Palmieri et al. 1999).

There is an anticipated increase in the variety and severity of pest populations due to climate change; IPM researchers were especially concerned about the climate-related impacts on pest populations.

4.1.2 FOOD SAFETY MODERNIZATION ACT

The Food Safety Modernization Act (FSMA) was signed into U.S. law on January 4, 2011, and enables the U.S. Food and Drug Administration (FDA) to better protect American public health by helping to ensure the safety of the U.S. food supply. The focus is on prevention. One of the most significant changes that FSMA made to FDA's food safety authorities is in the area of imports. FDA will transition from its historical focus on catching food safety problems at the border to one that builds safety in throughout the supply chain from foreign producers to U.S. consumers.

On July 26, 2013, FDA issued proposed regulations related to imported food. Under the Foreign Supplier Verification Program (FSVP) for Importers of Food for Humans or Animals, importers would be required to perform certain risk-based activities to verify that food has been produced in a manner that provides the same level of public health protection as that required of domestic food producers (FDA 2013a).

In response to changes in the U.S. FDA's function and operation, new rules for imports to the United States are being implemented:

- **Importer accountability:** Importers now have explicit responsibility to verify that suppliers overseas have enough preventive controls to comply with food safety standards. This may include conducting a hazard analysis for every food they import and conduct activities (lot by lot sampling and testing, on site auditing, etc.) that provide adequate assurances that the hazards identified are adequately controlled.
- **Third-party certification:** The FSMA dictates that FDA could establish a third-party certification program that could certify that foreign food facilities comply with U.S. food safety standards. Exporting countries would adopt at least one of the certification programs, to be established by FDA:
    - Certification for known food safety risks
    - Voluntary qualified importer program
- **Authority to deny entry:** FDA will be able to refuse entry of food from a foreign facility into the United States if the facility or the country in which the facility is located refuses to permit entry of FDA inspectors to inspect the facility.
- **Capacity building of foreign governments with respect to food safety:** FDA is now responsible for capacity building of foreign governments and their respective food industries exporting to the United States in the areas food safety.

The implementation of the FSMA could have serious consequences for all produce exporters from Central America, but especially small exporters, or smallholder farmers who sell to exporters. While small farms averaging less than $500,000 per year in sales are exempt from the FSMA regulations, it is not clear if this exemption applies to small farms that export to the United States because most of their product is consolidated by the importer. The proposed rules for Produce Safety under FSMA (FDA 2013b) include regulations around agricultural water quality, use of animal manures, hygienic practices for farm workers, control of domesticated and wild animals, sanitation of farm equipment, and training of farm personnel. The regulations for agricultural water and hygienic practices create the largest challenges for effective implementation in Central America.

Importers that obtain produce from numerous growers should consider implementing a traceback system to allow problem farms to be identified quickly if a food safety incident occurs. Digital tracking and tracing

systems are available that utilize RFID tags to capture the movement of produce from the farm to the packaging area to export.

4.1.3 GENETIC RESOURCES

Progressive farmers and those already engaged in commercial agriculture tend to have access to commercial varieties that are in high demand by buyers. However, there is limited access to a broad range of germplasm for commercial species. This limits the establishment of plantings of the most commercially appropriate varieties or the capacity to change varieties in response to new market windows, new product development, or climate change. Smallholder producers are at a disadvantage when it comes to accessing these newer varieties and others demanded by consumers. Market information is not readily accessible to these farmers and as such they are unable to respond to changes in buyer demand as fast as larger growers. A related issue is the lack of locally-produced potato seed. All potato seed in Honduras is imported from Holland or other countries.

For example, fruit and vegetables grown by small-scale farmers are less likely to have been selected for resistance to abiotic or biotic stresses present in Central America (especially fruit). Many current varieties were introduced into the region more than 30 years ago. Although some testing for disease resistance of commercial vegetable varieties is being conducted in the region (by FHIA in Honduras, and by the Horticulture Innovation Lab with Asian pepper and tomato varieties in Honduras and Guatemala), the testing is far from sufficient against a broad range of diverse pathogens present in the region.

Native plant species and traditional farming systems play an important role in food security and nutrition in remote communities (CGIAR 2012), plus these crops may have considerable potential for the development of niche products. Expansion of commercial agriculture could result in displacement and disappearance of native genetic resources (e.g., jocote, piñón, native vegetables). It was evident from our interviews that in some communities, with the arrival of commercial "exotic" vegetable production, farmers were less interested in native crops for cultivation, choosing instead to engage in contract farming.

4.2 NATURAL RESOURCES

4.2.1 WATER

Irrigation and irrigation equipment were regarded as highly critical for sustainable, successful and year-round crop production. Water availability for consumption and irrigation is an issue in the dry months in both Guatemala and Honduras (as well as in Nicaragua and El Salvador). Dry months are usually November to April, and if water were available through irrigation projects, then crop productivity would increase. The establishment of micro-dams or rainwater harvesting systems has proven very effective in several regions of the world (more recently in Nicaragua), and when implemented, farmers enjoyed higher yields, crop diversification strategies, and income alternatives during the dry months.

Capturing water during the rainy season and then pumping this water to fields would reduce the time farmers dedicate to watering their plots. Simple gas, diesel, and solar systems can very efficiently pump water from a storage pond or tank to fields. In areas of high vegetable production, such in Valle de Almolonga in Guatemala where more than 5,000 farmers cultivate vegetables in 500-hectare plots, water is available at their plots. However, some farmers used shovels and small buckets to irrigate their crops, using many hours of valuable time each day. In such locations, investments in pressurized water delivery systems would relieve farmers from the time- consuming labor of water fetching. When irrigation projects are implemented, the entire distribution system (from source to final use) must be analyzed in order to anticipate any gaps in both infrastructure and knowledge. The cost of irrigation technologies was a major barrier that the survey

highlighted; overall it was the sixth most important barrier to horticulture production. Water management and irrigation "districts" were also highlighted as a concern; as with any shared resources, effective and fair systems and policies must be in place.

In addition to the availability of water for irrigation, the quality of available water is very important. The potential for contaminants in the water, either heavy metals or microbial pathogens, to come in contact with fresh produce during irrigation, application of pesticides, or washing produce after harvest is a concern for human health and market opportunities. The adoption of FSMA will enhance the importance of water quality. However, the issue of water quality or potential contamination of water was not highlighted by participants in the workshops or the survey. This highlights the lack of information and awareness of food safety concerns.

4.2.2 CLIMATE

Central America has been recognized as highly susceptible to variable weather-related events (excess or decreased rain; higher or lower temperatures). The Intergovernmental Panel on Climate Change indicated that some areas of the region would be subject to water shortages in coming years (IPCC 2007). These events affect agricultural production, soil fertility, flowering cycles, and increased vulnerability to pests and diseases. Small-scale farmers are the most at-risk population as their levels of resilience are low. Changes in rainfall and high/low temperatures will have a multitude of impacts on horticulture; some are anticipated, but exact changes and coping strategies are yet to be determined.

Due to changes in weather conditions, the probability is high that the severity and frequency of economic losses caused by pests and diseases will be exacerbated. Indeed, expansion of distribution ranges of pests has been documented in different regions of the world (FAO 2008). In drier and warmer years, the distribution range of pests expands to the highlands, exposing farmers there to new pests, e.g., fruit flies or la roya flies (Hughes et al. 2012).

"In Guatemala the climate has changed, and it is warmer nowadays; the West used to be colder and potatoes, broccoli, cauliflower were sowed. Today, in Chimaltenango we plant snowpeas and lots of tomatoes. Thus, the climate change has had some effects. In addition pests are becoming a problem. We used to say that whitefly could go up to some elevation because the cold weather would be barrier. In other words, whitefly would only be found up to 1,500 meters above sea level. Today, we see that this pest is found all the way up to 2,400 meters above sea level. On the opposite, *Paratriosa* came down. It has acclimated to warmer conditions."

GROWER & RESEARCHER, GUATEMALA

4.3 SOCIOECONOMIC

Throughout Central America there are a number of socioeconomic challenges whose consequences are the underlying barriers to the horticulture sector. The unequal distribution of wealth, educational gaps and lack of programs to support the smallest producers are a few examples of such factors. Access to markets, insurance and credit were some of the most discussed barriers in this assessment, and their importance will be further discussed below.

4.3.1 WOMEN IN HORTICULTURE

Many studies, including the Global Horticulture Assessment, emphasize that women are heavily involved in horticulture, but lack equitable access to many resources. These resources vary from land tenure to sociocultural constraints that limit their participation. Likewise, indigenous peoples are often at a disadvantage when obtaining resources or accessing markets. Because women and indigenous peoples comprise a large number of smallholders and the world's poor, it is important to include recommendations specific to these groups.

We found that women have little input or power when it comes to decision making in community organizations and in farmer organizations. Guatemala has one of the lowest rates of female representation in government, both local and national. There are only 7 female mayors, out of the 333 mayoral races held in 2011. In addition to the political process, women also have a hard time accessing technical and vocational training. Men often take the lead in managing small farms, and women provide much of the unpaid labor. The work of women in agriculture was considered invisible to one group interviewed; women have less access to land, relied on rented land to be able to cover the family needs and finances, and had limited access to finances. Past research by the Horticulture Innovation Lab (as Horticulture CRSP) and the University of Minnesota found that this was due in part to cultural norms around gender roles, and also due to a lack of female extension agents (Collinson et al. 2013).

Still, in some communities, families deny education to daughters, although programs such as SOS Family Strengthening in Solala are in place to reverse this tendency (SOS Children 2011). Although still far from being optimal, it is clear that women's organizations are involved in primary production, as service providers for seedlings, transportation, packaging, and marketing. To gain access to export markets, a group of 400 women in Guatemala formed a cooperative, Mujeres 4pinos, to market their produce through the export channels of the larger Cuatro Pinos cooperative. This is interesting given that companies who contract farmers for non-traditional exports (Asian vegetables) often directly contract with the male head of household; technical training is then offered to the men and not their spouses (Collinson et al. 2013).

4.3.2 INDIGENOUS PEOPLES IN HORTICULTURE

With regards to indigenous peoples (who comprise a large number of people in Guatemala), the government in Guatemala is making provisions so that they achieve land tenure. Access to land tenure can improve access to credit and provide incentives for making improvements to landholdings. For many small-scale farmers, Spanish is their second or third language and understanding complex market and agricultural information is nearly impossible. However, another challenge is the continual subdivision of land among family members making plots smaller and smaller.

4.3.3 ECONOMIC ISSUES

The high cost of horticultural inputs (fertilizer, irrigation equipment, chemical and biological inputs, sorting, packaging, cooling equipment, transportation, storage) negatively affects returns to the investment in the sector, making it less competitive. There is a large variation in prices of inputs in the region, which encourages the unlawful trade of fruits and vegetables from neighboring countries, where products are available more cheaply. This seriously and negatively affects local producers.

4.3.3.1 ACCESS TO MARKETS

For smallholders, accessing markets can be an immediate barrier to production and sale of crops. Lack of knowledge of current prices, market expectations, quality standards, and availability of reliable transportation

all act as disincentives to production and expansion. The cost of fuel and truck use is often a barrier to accessing higher value markets for producers of perishable products.

Small-scale producers do not always grow what markets demand, especially with perennial species. Farmers do not always have access to good information on quality standards or market needs. This makes it difficult for them to sell their produce to larger farmers to satisfy export quotas. Those who identified themselves as a producer said that they sell to a broker because they have no other options and no access to other market channels. Others said that they had a direct contract with a supermarket. Given the rise of supermarkets in Central America over the last ten years it is not surprising to see these comments.

Market prices are difficult to convey to many growers. Several organizations collect market prices (i.e. FASAGUA and FHIA in Honduras) for some products, but this information requires processing, interpretation and effective dissemination. Additionally, this information does not always reach growers in a timely manner and decisions made after the fact could be detrimental to them economically.

Interviews with farmers often surfaced concern that they face "unfair competition" because fruit and vegetable produce imported (possibly illegally) from a neighboring Central American country is sold at lower prices. Farmers sometimes perceive these neighboring countries as providing subsidies for freight and/or local authorities not exercising adequate controls. In some cases, due to inadequate trade controls, trucks with horticultural cargo identified as in transit to another country is sold in the country through which they were supposed to only be transiting, at prices below the prevailing market rate.

We observed a prevalence of weak organizational structures and dysfunctional value chains with undefined rules and roles. There is a lack of transparency in the seller-buyer relationship, and breaches of contract are common by both buyer and seller. The interviews identified that a lack of quality standards, few contracts, little transparency, and limited knowledge of prices and information all feed into a system where the smallest farmers are at a consistent disadvantage. However, other recent research in Honduras has shown that these informal systems provide much needed cash to small-scale farmers and cater to the unpredictable nature of horticulture production (Chalmers et al. 2012). There have been cases where alliances were developed between buyers and sellers. The buyers provided demand calendars to growers, providing them an opportunity to grow for market needs. These comments highlight the two-tiered nature of the horticulture sector in Honduras and to a lesser extent Guatemala. Both formal and informal systems have advantages to producers and fill a niche for consumers.

4.3.3.2 ACCESS TO CREDIT

For smallholder farmers, accessing credit allows them to invest in new technologies, land, and labor to improve their production and income. Current systems in Central America are lacking, and few banks provide loans or credit specifically for agricultural purposes. Poor farmers also have limited collateral to offer and at times the only option is to engage in "under the table" deals that in the end often disadvantage the small farmer. It is especially difficult for women and minority groups to access credit.

The most limiting factor of the 35 presented in the online survey was "access to credit for small producers." Not surprisingly those identified as growers felt the most strongly about this particular limitation and ranked it more limiting than the other groups. The "cost of agriculture credit" was ranked next, with individuals working in extension ranking this the highest.

The high cost of financing constitutes a barrier to the development of horticulture. Loans for agriculture in Guatemala represent slightly more than 5 percent of loans offered by banks. High profitability in banking in Guatemala comes from charging for financial services and not from interest on assigned loans (USAID

2010a). There are diverse financial institutions in Guatemala that offer loans to growers and cooperatives, which handle more than twice the number of loans managed by the banks. Additional sources of financing for smallholders come from export companies, but the interest charged varies 4-5 percent per month (USAID 2010a). When they can be obtained, farm loans through some cooperatives reach interest rates up to 36 percent, which makes the sector less competitive. Farmers who grow beans, maize, sorghum, or potato and also women farmers are less likely to obtain loans. To fill this gap, large buyers and intermediaries take advantage of small-scale farmers' need for cash up front and offer them a high interest loan at the beginning of the season, then take the product and sales at the end of the season to cover the loan.

Banks have high requirements for loan approval; banks often put more weight on the value of collateral (generally urban properties) than of cash flow or profitability of a project, and this becomes a barrier to granting a loan to smallholders (USAID 2010a). Small horticultural producers have difficulty gaining access to low-interest credit lines established in the form of trusts dedicated to horticulture. Banks do not promote products from financial intermediaries, as they favor their own products at much higher rates.

As highlighted in the 2008 World Development Report, Agriculture for Development, these financial market constraints all too often depress productivity and incomes in the small farm sector. At first glance, the continuing relevance of these constraints may seem surprising given that we are more than a decade into the microfinance revolution, which in many instances has relaxed credit constraints, especially for women micro-entrepreneurs and others who lack conventional collateral assets.

According to the director of the BASIS Assets and Market Access Innovation Lab (AMA Innovation Lab), the problem rests in part on the mismatch between the core principal of microfinance (mutual responsibility for loan repayment by groups of geographically proximate individuals) and the reality of agriculture in which all individuals within a small area may simultaneously suffer losses (e.g., from a drought), meaning that mutual payment responsibility fails and lenders suffer considerable portfolio risk (personal communication 2013).

One promising approach to this problem is the interlinkage of microcredit with novel forms of agricultural index insurance that protect lenders—and borrowers—against the risk of simultaneous default. In contrast to conventional agricultural insurance, which has proven to be infeasible for small-scale farmers, index insurance makes indemnity payments based on the performance of an easily measured and verifiable index (e.g., weather conditions) that is correlated with average farmer outcomes. While index insurance and credit interlinkage is a work in progress, a number of microlenders worldwide are keen to harness it as an instrument that will allow them to offer credit at reasonable interest rates to underserved small farm credit markets. For such a system to work, cooperation between numerous sectors including input suppliers, insurance companies, and weather data systems is required. Horticultural crops present a unique set of challenges to the design of interlinked credit-index insurance contracts, but given the potential of these crops to boost small farm incomes, it is clearly time to invest in instruments that promise to relax the key economic constraints that hold back this sector.

4.3.3.3 CROP INSURANCE

Crop losses due to extreme events—either lack of rain, excess moisture (too much rain or flooding) unusually hot or low temperatures—are all common and frequent in Central America. Current climate change models indicate the high risk to which the area is subject and predicts water shortages in coming years (IPCC 2007). Small-scale farmers are the most vulnerable to weather-related events, but larger farmers can also be affected. The cost of crop insurance and its availability were the third and fourth most critical barrier to horticulture as identified through the survey. Strategies to minimize the risk might include planting a diversified group of species; however, such a strategy is less viable in those small areas dedicated to commercial horticulture, and

even more so for farmers with scheduled deliveries to large buyers. The lack of adequate, easily accessible agricultural insurance products was mentioned during the in-person interviews and workshops, and was clearly marked as highly limiting in the online survey. The interlinkage of microcredit with novel forms of agricultural index insurance should be explored as a potential solution.

4.4 ENGINEERING AND TECHNOLOGY

Innovation is the key for agricultural development and is the source of economic growth, job creation, improved productivity, and competitiveness. A combination of effective research, education and extension programs are usually required, but not sufficient, to stimulate needed innovations (World Bank 2012).

4.4.1 PRODUCTION TECHNOLOGY AND SUPPLIES

The need for affordable production technologies was expressed by all groups during the interviews and in the survey. Horticulture can be very technology intensive, and without the availability of proper information and tools, farmers will continue with current practices. The high costs of inputs (fertilizers, agrochemicals, irrigation equipment, bio-pesticides, etc.), lack of services (i.e. reliable transport, tractors for land preparation, mechanized pruning, technical assistance), and pressure from pests and diseases contribute to high costs and reduced competitiveness.

Protected agriculture has proven to be highly effective and is in high demand as a suitable strategy to reduce pests and disease problems, increase productivity, improve production consistency, and improve water-use efficiency (USAID 2008). However, despite some efforts to generate knowledge on the management of crops under small, medium, and large tunnels by local tunnel-supply distributors, additional research and development efforts are required to speed mass adoption of this technology. A major barrier to technology adoption is the lack of incentives, credit and education for small farmers. Without these, farmers will have a very difficult time expanding their production or entering into new markets.

4.4.2 PROCESSING OF HORTICULTURAL PRODUCTS

In Honduras and Guatemala, very little innovation in product development was perceived during the assessment. New product development, in addition to primary production and packaging, should be promoted to capture more of the value of the horticultural value chain.

A small number of processing industries exist in Honduras and Guatemala, and those visited indicated that their utilization of local produce is low because imported, pre-processed materials are cheaper (e.g., tomato paste from Chile and the United States). This might indicate that local production costs are too high for processing industries, and/or that fresh market demands exceed current local production. In addition, processors may be reluctant to source produce from smallholders due to the effort required to ensure consistent product volume to meet processing demands. However, it was also clear that prices collapse during local harvest times, and fresh markets become saturated with crops such as onion, tomato, potato and mango. Therefore, promoting horticultural crop processing could represent a venue for reducing saturation of fresh markets, as long as production costs are competitive for the processing industries. By making more processing varieties available to farmers, the processing industry may grow.

Zamorano University in Honduras and the Instituto de Ciencia y Tecnología Agrícola (ICTA) in Guatemala have facilities and skills for processing and have developed protocols for processing local crops. However, business development skills would be useful to transform those experimental products into new commercial products, perhaps through private-public partnerships that benefit local communities. To promote innovation

among growers of horticultural crops, knowledge of production practices, processing, and postharvest management of local species must be combined with business development skills.

4.5 RESEARCH, EDUCATION, AND TRAINING

4.5.1 EDUCATION AND TRAINING NEEDS

The lack of operational capacity among growers results in low-quality produce, low productivity, inadequate production practices, and reduced access to formal markets. Growers lack training in well-accepted best practices for horticultural crop production and handling.

There is a lack of connection between research projects conducted by local universities and agricultural issues affecting small-scale growers. Some universities have research facilities, but have very little access to funding, and research projects are conducted mainly through undergraduate students and international funds. Universities are focusing more on training students in business development rather than forming new researchers or extension agents. This approach has affected organizations such as ICTA, which relied upon students conducting some research as part of graduation requirements. Training of students with a proper balance and mix of skills, both business and technical, will be beneficial to Honduras and Guatemala, especially in promoting innovation.

It was striking how few institutions in Honduras and Guatemala offer advanced degrees (Master's and Ph.D. levels). This fact alone forces talented students to leave their home country if they want to pursue an advanced degree, reducing the chances that they will return to apply the knowledge gained to advance their country.

Since the elimination of agricultural extension services in the 1990s, technical assistance is mostly delivered by the private sector. The private sector offers technical assistance to growers under production schemes, funded by farmer organizations, through levies collected from sales, or through national and international NGOs. However, several producer organizations expressed their reluctance to accept the questionable quality and scant quantity of technical assistance offered by some NGOs. Occasional technical assistance is available through government programs when supported by international aid. When it exists, a single professional has to serve many farmers, sometimes at a ratio of 1:200. Such assistance disappears when the project ends. In 2013, Guatemala reinstated its extension service.

"There is a lack of education among service and input providers, and producers. Many products are sold without the exact knowledge of how to use it, its purpose, and the associated risks involved in handling these products. There is lack of control of agro-services. Products entering the market are not validated, are freely traded across the border, entering without any control.

"Right now there is no formal technical assistance of high quality. The technical assistance offered by many NGOs is below standards because technicians do not have the experience or background to deal with problems in the production fields."

PARTICIPANT IN WORKSHOP, HONDURAS

The final section of the survey focused on research priorities and needs. The population surveyed had a variety of research backgrounds including IPM, agronomy, physiology, postharvest, and protected agriculture. Those

involved in research were asked to look at a number of factors and assess their importance to performing their work. The most critical was that their work and the results of their research be transferred to the end user; this was followed by the availability of funds to carry out their research. Interestingly, stimulating innovation and addressing rural development issues were also selected as extremely important to their work.

The group was asked to identify research priorities in management of pests and diseases. The areas getting the most support (in terms of times voted for) were integrated pest and disease management, the development of biological control agents, the commercialization and accessibility of biological control agents, and lastly the identification and management of viruses.

Responses around research priorities for production and management were not all that varied, and our analysis didn't show much difference in the responses. Because participants could vote for as many research priorities as they wanted, only two stood out by just a few percent: integrated production systems and management of crops under protected structures (Appendix C for full survey). Participants felt that research priorities for biotechnology should focus on the development of low-cost tissue culture systems, the development of endophytic organisms to counter pests and disease and optimize transformation and regeneration protocols.

In postharvest research, the priority themes were postharvest handling of products indigenous to Central America with export potential, improved crop management to optimize postharvest quality and ensure safety, and defining MRLs for commercial agrochemicals.

4.5.2 RESEARCH CAPACITY OF UNIVERSITIES AND RESEARCH INSTITUTES

4.5.2.1 HONDURAS

Universidad Nacional de Agricultura (UNA). Located in Catacamas in the Olancho Department, UNA has two professors with Master's degrees working in horticulture, one in fruit crops and one in vegetable crops. The school also has field facilities to conduct applied horticultural research, where a germplasm bank for fruit crops is also located. There is a program on genetic resource conservation and the school leads a national network for germplasm conservation. Additionally, UNA has a food technology lab. The main constraints for doing research are a lack of funding and infrastructure. Faculty are involved mostly in teaching, though undergraduate students must write a thesis as a prerequisite to graduate, which could represent an opportunity for generating knowledge.

Escuela Agrícola Panamericana, Zamorano. Situated just 30 minutes from the capital city of Tegucigalpa, Zamorano has two faculty members involved in horticulture, one who has a Ph.D. working on vegetable crops and another with a Master´s degree working on fruit crops. The school has adequate laboratories and field facilities that include a biotechnology lab equipped with basic tools for gene analysis (polymerase chain reaction) and tissue culture. The school also has ample field facilities to conduct applied horticultural research. There is a food technology laboratory, both for student and public training. This is one of the most advanced laboratories for development of processed products (established under a USAID activity) and also conducts analyses needed for food nutrition labels. The faculty´s heavy involvement in teaching and, to a lesser extent, a relative lack of funds for research are the main reasons for not doing research, although some faculty are involved in contract research. Students work on theses as part of their graduation requirement, which represents an opportunity to contribute to horticultural knowledge. However, research by students is only one year in length and does not necessarily respond to the real needs of farmers. There is a perception by the public that Zamorano should reach out more to the national and regional community. The Horticulture

Innovation Lab recently funded its Regional Center at Zamorano, a center with a mandate for the entire Central American region.

Centro Universitario Regional del Litoral Atlántico (CURLA). This regional campus from the National Autonomous University of Honduras (UNAH) is strategically located in La Ceiba on the Caribbean coast of Honduras. The school has two professionals with Master´s degrees, one each working with fruits and vegetables. This campus hosts a germplasm bank for tropical fruit crops. Faculty members are involved in teaching, but not in research, even though students have to work on a thesis to graduate. Students have to not only find a research topic for their thesis and pay for their own research, but also secure a partner institution at which to do their research. Some of these host institutions help cover the research costs. Lack of funds and adequate laboratory and field facilities are the main reason for lack of research. Additionally, as a satellite campus of UNAH, CURLA does not have administrative independence and any interaction between CURLA and other parties for research must be negotiated with UNAH.

Dirección de Ciencia y Tecnología (DICTA). As the country´s national agricultural research institute, DICTA has modest research capabilities. There are three researchers with Ph.D. or Master's degrees working in vegetables, and one dedicated to fruit crops. This research institute has two tissue culture labs, one devoted exclusively to potatoes. DICTA has three applied research stations for fruits and vegetables with minimal infrastructure. Even though this national agricultural research institution has research capabilities, it does not receive enough funding. Additionally, there is a high degree of personnel rotation and trained researchers end up leaving the institution after a new political administration takes office. Another constraint for doing research is that there is neither planning nor focus of the limited resources to do research.

Fundación Hondureña de Investigación Agrícola (FHIA). A private research foundation started by a trust fund from USAID and the donation of research laboratories by Chiquita, FHIA is an institution that works on high-value crops. The foundation has five researchers with Ph.D. or Master's degrees; one working in vegetables, three working in fruit crops/diversification, and one devoted to banana breeding. FHIA has a biotechnology lab with PCR and tissue culture capacity. In addition, this institution has a Horticulture Research and Training Program located in the Comayagua Valley devoted to warm-climate vegetables. The foundation also operates an Agroforestry Center that works on fruit crops intercropped with forestry. FHIA also has a Banana and Plantain Breeding Program with a large research farm devoted to these crops. A Crop Diversification Program works on promoting native and exotic tropical fruit species. Even though FHIA has a Horticulture Research and Training Program, it lacks research in cool-climate vegetables since it closed a research station in the highlands of Honduras because of lack of funding. Some vegetable growers indicate that the research agenda at FHIA is not based on their needs and that the foundation has to reach out more effectively to the Honduran community in general.

4.5.2.2 GUATEMALA

Facultad de Agronomia de la Universidad de San Carlos (FAUSAC). As the main public university in Guatemala, USAC´s agriculture college has 15 faculty members with either Ph.D. or Master's degrees. The college of agriculture has a Master's program in fruit production and good laboratories for research. Additionally, this institution has education and applied research stations in Escuintla and Suchitepéquez. However, the lack of funds for doing research is the main constraint. Additionally, research performed by students is not necessarily linked to farmers' needs.

Universidad Rafael Landívar. With the main campus in Guatemala City and five regional campuses in Escuintla, Quetzaltenango, Cobán, Jutiapa, and Zacapa, this private Catholic university has a large presence in teaching agriculture in Guatemala. There are five faculty members involved in horticulture, all of whom

have Ph.D. degrees. The school has good laboratories for research in the main campus, where research is conducted mostly on environmental issues. This university does some contractual research and has laboratory equipment that enables them to contract laboratory services. However, a constraint to doing research is the fact that the school´s main focus is teaching. It does not have funds for research.

Universidad del Valle de Guatemala (UVG). This university, started in the 1960s with help from the American government, has the best research infrastructure in Guatemala. UVG has five faculty members with a Ph.D. or Master´s degree working on fruit and vegetable crops. The school hosts a Center for Studies in Biotechnology with capacity for PCR and tissue culture. Additionally, its Center for Studies in Agriculture and Forestry has capacity to work on applied research on fruits and vegetables. In addition to the main Guatemala City campus, UVG has two satellite campuses with field research and teaching capabilities, in Escuintla and Sololá. The Guatemala City campus has a research program and good laboratories. The school does contractual research, as well as research in collaboration with USAID Innovation Labs (also known as CRSPs) such as the Horticulture Innovation Lab and IPM Innovation Lab. The school relies on external funds to support research and sells services to utilize their highly equipped laboratories and field stations.

Instituto de Ciencia y Tecnología Agrícola (ICTA). The research institute of Guatemala's ministry of agriculture, ICTA has 64 researchers working in various disciplines with Ph.D. degrees. The institute has 12 experiment stations distributed in five regional centers throughout Guatemala. The main campus in Barcenas, Guatemala City, has a biotechnology lab with PCR and tissue culture equipment and field space for research. As the national agricultural research institute, ICTA lacks sufficient funds for research and as a result of that, the quality of their research has declined considerably. There is no political will to increase the budget of the institute because of a long-standing union dispute with the Ministry of Agriculture. Because of the lack of funding, ICTA focuses its work on basic crops such as corn, beans, and potatoes.

4.5.3 EXTENSION CAPACITY

The need for applied research and strengthened extension programs was a primary finding of the survey of constraints to improving participation of small-scale farmers in Central America in the horticulture value chain. The success of U.S. agriculture is widely agreed to be the result of the unique land-grant university system, which fostered tertiary education in agriculture, provided funds for applied agricultural research, and established a research-based extension system.

In significant ways, this report paints a situation that mirrors that of small farmers in the United States in the second half of the 19th Century. New immigrant farmers, often from impoverished countries, found their traditional subsistence farming techniques to be unsuited to the new market-driven opportunities of the fertile lands that they were settling. Despite the ongoing civil war, the U.S. Congress recognized the need for capacity building to provide farmers with the tools to enter the new agricultural value chains, and in 1862, President Lincoln signed the Morrill Act into law. This act ceded federal lands to the states with the understanding that the land grants would be used to fund colleges focused on providing university instruction in "agriculture, military science and the mechanic arts." In 1887, the Hatch Act provided those colleges with funding to engage in research addressing major constraints to success in agriculture. Lastly, recognizing the disconnect between university researchers and farmers, the Smith-Lever Act of 1914 established the cooperative extension system, in which university employees charged with extension education and research outreach were housed in county offices. Arguably, this last innovation, never replicated in any other country (where extension is typically the function of the Ministry of Agriculture), was the key to the success of the land-grant extension system.

How might the innovative elements of the land-grant extension system be applied to improve agricultural research and extension in Central America? The region has a few universities with faculty and teaching programs addressing agriculture, but connections of their programs to the field and particularly to small-scale and women farmers are weak. There are already a number of extension professionals in the field, some of them political appointees and others funded by NGOs, but many lack adequate training and few are directly connected to universities or other research institutions. We suggest a policy initiative in which the scattered elements of a capacity building/research/extension continuum that already exist in the region are pulled together through a cooperative partnership between governments, donors, and universities. The exact configuration of such a system would obviously require thoughtful analysis, but the essentials could follow the principles of the land -grant extension model, as patterned by U.S. legislation.

The Morrill Act provided funds (through grants of federal lands) to each state to support the establishment of a college focused on instruction in agriculture and other practical disciplines. The LAC countries might be considered as 'states' within a regional land-grant extension system, and a mixture of donor, university, and government resources could be provided to ensure a focused education program in agriculture and horticulture in a select magnet university in each country. The effects of such an initiative would be to build agricultural research, teaching, and extension capacity in each participating country.

The Hatch Act funded the formation of agricultural experiment stations at the already-established land-grant colleges. In its present form, the Hatch Act funding supports the applied research of teaching faculty in the colleges of agriculture. It seems possible that a portion of the donor and government resources presently being applied to a diversity of research programs in the LAC region could be identified as a pool for support of applied agricultural research conducted by the faculty in the agricultural colleges identified or established as suggested above.

The Smith-Lever Act provided federal funds to hire an extension professional for each county in the country. These professionals are hired and administered by the agricultural colleges, but are located and supported by county administrations. The exact way in which this might be replicated in the countries of the LAC region is perhaps the most intriguing question in this proposal. What level of administration would be the appropriate location of these professionals? Is there willingness at that level to provide support (office, clerical, travel) for a university employee charged with extending research-based information to small-scale farmers in the jurisdiction and communicating research needs to relevant university faculty?

It is clear that the participation of small-scale farmers, and particularly women, in agricultural and horticultural value chains in the region depends on technical education, applied research, and national capacity building. Whatever the answers to the many questions that arise in considering this proposal, it is clear that a new approach to providing relevant and timely information is required. Developing and testing a 21st Century version of the land-grant extension model is an innovative and worthwhile approach. Once established, such a system would be the vehicle for implementing the other recommendations of this report.

5. PROPOSED SOLUTIONS AND RECOMMENDATIONS

This assessment was intended to serve as a springboard for new initiatives to address the constraints that limit the success of small-scale farmers in the horticultural industries in the Central America region.

The solutions and interventions suggested below were generated from a synthesis of interviews, surveys, and comments provided by workshop participants, published documents, and the professional experience of each of the assessment team members. The suggested interventions are grouped into regional and national approaches, and are prioritized within each section according to their level of importance. Many of the suggested solutions have been implemented somewhere in the world with differing degrees of success, likely dependent on how they were implemented. There is no silver bullet solution or one-size-fits-all approach. Instead, suggested recommendations will require further elaboration, design, and research to be adapted to local conditions.

5.1 RECOMMENDATIONS

REGIONAL APPROACHES

1. Promote initiatives to **adapt horticulture to climate volatility**. Central America is considered highly vulnerable to weather related events (drought, flooding, freezing, strong winds) which are responsible for major losses in agriculture. These events affect horticultural production, flowering/fruiting cycles and planting dates, increase vulnerability to pests and diseases and often result in severe economic losses. Climate change is expected to result in warmer temperatures in Central America. Short term and long term initiatives are required to reduce risks and vulnerability of growers of horticultural products. Some initiatives that could help are listed below:

    a. National governments should promote the establishment of irrigation infrastructure and rain harvesting technologies. Micro dams have been successfully established in Nicaragua and helped many small growers who were subject to growing crops only during the rainy season. Now, with the establishment of micro dams and drip irrigation equipment, growing has been extended well into the dry season. Availability of irrigation infrastructure should be combined with required technologies such as diesel or solar pumps for drip and low-volume irrigation systems.

    b. Develop clear guidelines to determine production areas with high risk of suffering losses due to chilling damage. This information could be useful to extend the growing season in some areas. In some regions, farmer's fields are not planted because of the risk of low temperatures.

    c. Deploy a weather forecast system that reaches small producers located in remote areas, such as in the highlands of Guatemala where farmers experience chilling and sometimes freezing temperatures during the dry months. Delivery of timely weather forecasts and severe weather warnings could be done through text messages via mobile phones.

    d. Link weather system to crop insurance systems (AMA Innovation Lab, also known as BASIS CRSP, may be of assistance).

e. Support research programs that develop, test and implement strategies and/or recommendations to adapt crops to temperature extremes.

    i. Develop critical information for temperatures/times for chilling or freezing damage and for tolerance to elevated temperatures for each crop/variety. This information will help to identify better adapted varieties and prove useful to develop insurance policies.

    ii. Prevention strategies to avoid high or low temperature impacts on crop productivity might involve active or passive approaches that should be validated under local conditions. Active methods to prevent low temperature damage might include covering the crop before chilling or freezing temperatures occur in the field. Mulching crops to cool roots, use of shade cloth and improved irrigation strategies could be tested to reduce high temperature stress.

2. Establish **regional research programs to address cross-cutting constraints** affecting the region (i.e. HLB, *Tuta* spp., *Fusarium* in musaceas, germplasm banks and variety testing). A Central American initiative led by OIRSA (Organismo Internacional Regional de Sanidad Agropecuaria) could serve as an example so that issues are addressed at the regional level. In 2012, a technical cooperation agreement between the Taiwanese Government and OIRSA was signed to tackle the devastating disease affecting citrus around the world, under the project "Fortalecimiento de la Región del OIRSA en el control del Huanglongbing (HLB) y la implementación del manejo integrado de plagas en cítricos." As part of this agreement, a centrally located germplasm bank would be established to distribute healthy seedlings and bud wood for all countries in the region (except Mexico and Costa Rica). In addition, greenhouses will be built and technical training will be provided to produce grafted material. Additionally, laboratories to grow the parasitoid *Tamarixia* will be established as part of an IPM effort. Demonstration plots were being planned in 2013 when a group from Taiwan visited Central America. Concrete examples of crop-specific needs are presented in Appendix F. Regional activities to support efforts to tackle pests and diseases affecting horticulture crops will benefit from:

    a. A regional IPM program to address major pests, diseases and weeds. Within this program, efforts could be directed towards research and innovation to develop and promote the adoption of non-chemical control methods (i.e. antagonistic fungi, entomopathogenic fungi and bacteria and endophytes, among other approaches). Such an effort will reduce the current trend of pesticide overuse, which results in chemical residues and export rejections. In addition, such technologies could contribute to adherence to new regulations under the new Food Safety Modernization Act. Some of this work could be conducted in collaboration with the IPM Innovation Lab.

    b. Establishment of a regional platform with key players in Guatemala, Honduras and the other country's institutions in the region, to do research with a regional focus or mandate.

        It would be best if such an effort was led by a regional institution. Possible candidates include the CATIE, the Inter-American Institute for Cooperation in Agriculture (IICA), or an international institution from the CGIAR such as Bioversity International or the International Potato Center (CIP). Other CGIAR centers that could contribute to research topics directly relevant to the constraints affecting the horticulture sector are: CIAT (i.e.

climate change adaptation and mitigation, market related research, diversification of agroforestry systems), and ICRAF (agroforestry work). Either of these entities could lead a regional project to manage cooperative research partnering with national organizations.

Another approach to capacity building for these research institutes and universities is to support a partnership with a complementary U.S. university to engage in work on curriculum development and improvement, faculty training, and targeted and effective collaborative research projects. Such an effort can be supported through the Feed the Future Innovation Labs (particularly Horticulture, AMA and IPM) model.

c. Training in diagnostics and management of pests and diseases. One such initiative is The Plant Clinic (http://www.plantwise.org), a CABI led initiative, which already operates in Honduras and Nicaragua and which has established 300 plant clinics in 24 countries around the world. The Horticulture Innovation Lab has also trained numerous individuals in Latin America in *Phytophthora* diagnostics, and created a network of such expects to share information across the region. The enhancement of databases with information about the distribution, diagnosis and control of pests and diseases affecting regional crops will help to control pest problems in Central America.

d. Agricultural technology development and transfer that is led by a regional organization that can be stable over time even with changes in national agricultural organizations. The goals of the Horticulture Innovation Lab's Regional Center at Zamorano match well with this concept. Other regional organizations could also be involved.

e. Identification of alternative crops for small scale coffee growers who may no longer able to profitably grow coffee due to the coffee rust (la roya) crisis.

   Coffee farmers affected by the coffee rust crisis and increased global production of robusta coffee may be in need of alternative, high value crops. Horticulture crops provide a good opportunity. IICA conducted a study in 2010 to determine the most promising fruit crops for Guatemala. A similar study should be conducted for vegetables in Guatemala and for fruits and vegetables in Honduras and other places in the region, as appropriate to identify the most promising, high-value crops for these growers.

f. Develop and support a research agenda focusing on sustainable production systems in the region. Production systems could be evaluated for social, economic and environmental sustainability, and should include modern technologies whenever possible. FHIA, CATIE and IICA, as well as other CGIAR centers (CIAT and ICRAF) focusing on a systems approach for agriculture are active in the region and have accumulated considerable experience in the subject.

   i. Evaluate, demonstrate and support research on agroforestry alternatives to be utilized as part of a strategy to increase resilience, diversify agriculture, minimize risks against climate change, enhance biodiversity conservation, and environmental services (i.e. Quesungual agroforestry system).

   ii. Promote research to evaluate mixed cropping systems.

   iii. Facilitate access to technologies suitable to promote adoption of green manures and composting technologies.

3. Promote regional and national **training and education programs on appropriate technologies to reduce postharvest losses** and comply with the Food Safety Modernization Act (FSMA) throughout the horticultural value chain.

   Postharvest mishandling accounts for more than 30 percent of productivity losses in many horticultural crops. Lack of knowledge and appropriate technologies are the biggest constraints. Implementation of the FSMA increases the importance of using appropriate handling practices in the field and after harvest. The following approaches are recommended to address this need:

   a. Strengthen postharvest and food safety capacity and training at universities in the region.

   b. Conduct trainings on best practices for producing and marketing safe, high quality produce, including attention to the principal routes of microbial contamination (agricultural water; biological soil amendments of animal origin; worker health and hygiene; equipment, tools, buildings and sanitation; and domesticated and wild animals).

   c. Highlight economic incentives to eliminate barriers for the adoption of postharvest technologies and methods.

   d. Reduce tariffs on import of postharvest equipment and supplies or develop local manufacturing facilities.

   e. Promote development and utilization of appropriate infrastructure.

      i. Simple shaded packing sheds

      ii. Small-scale coolers near growing locations

      iii. Standardized rigid plastic containers for produce

      iv. Insulated or refrigerated transportation units

4. Promote regional initiatives to conserve, characterize and facilitate access to diverse and **improved germplasm of horticultural species** (commercial crops as well as native fruits, vegetables, and ornamentals). Such programs could involve national agricultural research systems (NARS) as official repository of genetic resources in many countries, local and international universities and a regional organization as regional coordinator. Given the rate of expansion of commercial horticulture, deforestation, and environmental degradation of the Central American region, native genetic resources are at risk of being lost. With a goal to diversify horticultural production, increase resilience and food security, and develop new products, a series of alternatives could be considered:

   a. Support national strategies and events that promote conservation, and exchange of genetic resources between communities, such as **seed fairs**.

   b. Develop strategies to support **germplasm banks** at the regional level, to facilitate evaluation and characterization (i.e. resistance or tolerance to biotic and abiotic stresses, nutritional quality, and consumer acceptance), exchange and distribution of genetic material across countries in the region.

   c. Evaluate and promote strategies for local seed production schemes that are sustainable and provide year-round production (Horticulture Innovation Lab is currently training women's groups in Honduras and Guatemala to produce and market seed of improved vegetables).

d. Develop branding for indigenous crops. Promote innovative strategies to add value to indigenous crops, aiming to develop branding to position unique products from the region. More about the development case for adding value through branding can be found at www.iied.org/pubs. Branding will increase revenues for growers, if properly implemented.

NATIONAL APPROACHES

1. Reduce the economic risks to horticultural farmers though availability of **effective crop insurance** programs.

    a. Design a sustainable crop insurance system or risk management tool on a regional scale, suitable but not exclusively for small scale farmer's groups (i.e. cooperatives or even a given region with a high concentration of small farmers) to provide a safety-net for farmers. When weather-related events occur, they tend to affect several countries simultaneously, therefore concurrently affecting millions of farmers in Central America. Such crop insurance could be a public-private partnership, including the insurance companies, governments and farmers. Such systems have been recognized as the most sustainable and effective crop insurance programs for developing countries (Herbold 2011).

2. Design and test an **interlinked microcredit-index insurance** product. A promising approach to the lack of both credit and crop insurance is the interlinkage of microcredit with novel forms of agricultural index insurance that protects lenders—and borrowers—against the risk of simultaneous default, as proposed by the AMA Innovation Lab. In contrast to conventional agricultural insurance, which has proven to be infeasible for small-scale farmers, index insurance makes indemnity payments based on the performance of an easily measured and verifiable index (e.g., weather conditions) that is correlated with average farmer outcomes. While index insurance and credit interlinkage is a work in progress, a number of microlenders worldwide are keen to harness it as an instrument that will allow them to offer credit at reasonable interest rates to still underserved small farm credit markets. Horticultural crops present a unique set of challenges to the design of interlinked credit-index insurance contracts, but given the potential of these crops to boost small farm incomes, it is clearly time to invest in instruments that promise to relax the key economic constraints that hold back this sector.

3. **Improve national extension systems** to ensure research information, best practices and technologies are delivered to smallholder farmers. A number of models could be tested, including the land-grant extension model utilized in the United States under the Smith-Lever Act. We suggest a policy initiative in which the scattered elements of a capacity building/research/extension continuum that already exist in the region are pulled together through a cooperative partnership between governments, donors, and universities. The exact configuration of such a system would obviously require thoughtful analysis, but the essentials could follow the principles of the land-grant model, as patterned in U.S. legislation.

    A pilot system could be tested initially in Feed the Future provinces of Honduras and Guatemala. Such systems could benefit from policies that:

    a. Maintain a horizontal approach and the independence of the members.

    b. Provide a significant government role, but without political interference.

c. Promote/facilitate a prominent role(s) for women, including leadership roles.

d. Facilitate collaboration/cooperation among members to eliminate redundancies.

e. Promote sustainability of the system. For example, provide incentives for the participation of the private sector through a tax break if technical assistants are fully trained using private sector resources.

f. Provide incentives for collaboration/cooperation among different projects and organizations, linkages between universities and other institutions such as NGOs and industry (Link extensionists with research professionals in universities and other research institutes).

g. Provide access to technology and new technology delivery means (i.e. use cell phones as the primary platform) to a broader range of farmers, especially small ones. Such systems could consider these characteristics:

    i. Local language

    ii. Text-free systems (agricultural TV channel, YouTube, tablets)

    iii. Visual media, especially video: The proliferation of inexpensive tablets, smart phones or digital recording devices would facilitate the production of professionally produced farmer-to-farmer videos using language familiar to the target farmer audience. Best practices could be recorded to be shared among farmer's groups during, for instance, farmer movie nights. It has been shown that web-based videos do not reach individual farmers as easily as other agencies (NGOs, universities, research organizations) that are better connected to the web (Agro-Insight 2011).

h. Foster training in participatory research/technology for testing production innovations and adoption methodologies, such as Local Research Committees (Comités de Investigación Agrícola Locales http://webpc.ciat.cgiar.org/metodologias_ca/investigacion/cials.html). This methodology has been found suitable for work in communities where technical assistance is almost non-existent or not likely to exist.

4. Develop trusts or other microfinance means for **financing smallholder farmers**, particularly women and indigenous peoples. Financing is restricted and less accessible to smallholders, which limits the investment by small growers in inputs to enhance their crops (fertilization, crop protection inputs, packaging, shipping). For example:

    a. Microfinance has been successful in Asia as a vehicle to increase women's access to financial capital. Moreover, in Central America, many women's groups implement a savings model called the tanda, a scheme that enables them to save money for expensive purchases. Efforts like these could be formalized to support small farmers. This type of intervention could be researched by economists (AMA Innovation Lab, various NGOs) and implemented by governments or the private banking sector.

    b. The development of a policy for agricultural financing which facilitates the use of trusts by producers, and is designed and adapted to the horticultural sector, including rules that the banking institutions remain committed to mainly use low-interest funds for horticultural producers. An example is found in Honduras for the citrus industry. Producers deliver fruit to a processing plant that keeps a small percentage of the price to feed a trust fund that is

used to train farmers and technical personnel from both the private and public sector in disease control, particularly about the much-feared Huanglongbing disease that threatens the citrus industry in the region. The trust fund also pays for pest control efforts. The government has one member on the board that oversees the fund, which is managed by a private bank, and the government also contributes to the trust fund.

5. Develop national policies to support **well-funded, long-term national agricultural research systems** (NARS), including training of graduate students (i.e. Sistema Nacional de Investigación y Transferencia de Tecnología Agropecuaria, SNITTA in Honduras). The national systems should not only include the NARS, but should include a broader array of research and technology transfer organizations focused on supporting the development of the horticulture industries at the national and regional levels. The National Agricultural Research Systems could have the following characteristics:

    a. **Funding could derive from public-private partnerships.** A funding scheme might include tax incentives to the private sector so that it invests in research to generate public goods. Such policies exist in other countries, and become an additional source of funding to promote research and innovation. Successful programs have been implemented in many countries. For example, a program in Colombia that is managed by Colciencias (equivalent to the U.S. National Science Foundation, but much smaller) accepts proposals for funding from the private sector together with research organizations (universities, NARS, private research centers, etc). In this case, if the private sector contributes $100, then the government provides a tax deduction based on $125. Therefore, the capital funds they provide are tax free plus 25 percent, which is a win-win for everyone.

    Also in Colombia there are specialized research centers, called CENIs. Each center is dedicated to a particular industry and is supported by an industry levy of ~2.5 percent of revenue. For instance, Cenipalma focuses on research on palm oil and is supported by that industry. The industry is able to direct the research program.

    Another fiscal fund for fruits and vegetables is administered by the Asociación Hortifrutícola de Colombia. For every commercial transaction where an invoice is generated, 1 percent of that value is collected as a tax. The resources are used to support research, marketing, and technical assistance.

    In Australia, a levy system is used to raise an equivalent fund by the government. For every dollar provided by the private sector for research, the government uses the fund to allocate another dollar (1:1 match). The industry decides on the type of research that is supported by the fund.

    The suggestion of tax breaks or tax incentives have not been validated with fiscal policy makers in Honduras or Guatemala, and therefore the feasibility of this approach in these countries remains to be determined.

    b. **Develop a national horticulture research and innovation plan**. Such plan should derive from a broad and inclusive consultation with different actors and sectors. It could be created by promoting linkages between research/higher education institutions with farmer groups/federations, service and input providers and other value chain actors to provide

needed focus on solving critical issues affecting horticulture and agriculturally related activities (water quality, environment, biodiversity, technologies, finances, etc.).

c. **Develop partnerships between U.S. and Central American region institutions** to work on research activities in support of regional needs under the auspices of the Horticulture Innovation Lab. Such an activity will serve to build the capacity of local institutions to do research and outreach while addressing key needs of the region. These collaborative research activities could be designed to address many of the recommendations in this report, with funding from the Bureau for Latin America and the Caribbean or country missions. Two specific examples are given below:

   i. In partnership, assess the potential of alternative crops for small-scale coffee growers.

   ii. The Horticulture Innovation Lab, in partnership with Central American institutions, can assist in implementing the action plans previously developed by PROMEFRUT for the LAC region, particularly in the area of knowledge generation— developing online resources of information about plant health, quality platforms, germplasm and safety.

6. Develop mechanisms to **coordinate and enhance the marketing of horticultural products** from smallholder growers. Smallholders sell their produce through different venues, including direct sales in local markets, selling to intermediaries, or contract sales through formal markets (wholesale or supermarkets). A Participatory Market Chain Analysis (PMCA) could be used to gain cooperation and participation of various sectors of the horticultural industry. Such a program might include the following characteristics:

   a. Work with supermarket chains domestically to connect smallholders to formal markets with contracts and transparent systems.

   b. Support PMCA of various supply chains in regions rich with smallholder farmers to encourage communication and relationship building with traders and buyers through establishment of business centers. Foster agribusiness linkages among such groups by training farmers in business skills. NGOs could play a role in providing agribusiness training.

   c. Promote local government initiatives to enhance conditions in local markets (i.e. seed fairs, wet markets) so they become attractive to a broader range of customers and also so that small farmers can sell their produce locally.

   d. Promote producer associations who can market cooperatively with more power and assist them to develop successful and sustainable business models for all of their members.

   e. Provide information about demand and prices through radio, TV programs and cell phones where daily prices of fruits and vegetables are reported for major markets.

   f. Deliver training about quality and safety requirements, and postharvest handling to farmers, transporters and buyers (especially related to FSMA).

   g. Support initiatives for planned planting, consistency in delivering of volume and quality for smallholders as well as close coordination with local, national and regional buyers.

   h. Develop incentives that influence private policies to ensure fair access for small growers.

i. Influence private policies for prompt payment and support sustainable business development (i.e. fair trade approaches for local markets).

j. Implement national programs for promoting agribusiness linkages between growers and buyers that favor formal agreements for buyers to purchase horticultural products, and for producers to access horticultural supplies. An exemplary case is Multiverdur, a farmers company in Guinope, El Paraíso, Honduras. A buyer provided collateral for a US $250,000 bank loan, which was used by the farmers to purchase horticultural supplies in bulk to produce onions at lower cost and, ultimately, the onion harvest was used to repay the loan.

7. Create incentives (e.g. tax breaks) and enabling environment to **develop horticulture-oriented business services**, especially those that are suitable for smallholders. Some of those services could include:

    a. **Protected cultivation technologies** (row covers, tunnels and houses). Adoption of these technologies can be seen in the field already, as they are viable options to reduce losses from adverse weather events as well as from major pests and diseases, and are technologies adaptable to small scale growers.

    b. Facilitate the establishment of commercial laboratories, be it national or regional ones, to test fruits and vegetables for chemical residues and human pathogens. Some commercial laboratories offer analyses of up to 250 active ingredients per sample. Although analyses are still costly and therefore not affordable to individual growers, they might be more cost-effective than testing for individual molecules in traditional less equipped testing facilities. Cooperatives engaged in export markets could be in a better position to negotiate deals with commercial laboratories.

    c. Modern irrigation, packaging, small-scale cold rooms, and small scale processing technologies.

8. Develop policies to **facilitate the participation of indigenous peoples, smallholders and women in value chains**. Such policies could be developed independently or jointly between the public and the private sector.

    a. Support policies that provide access to land and resources that minorities are often denied. Reduce barriers and the financial cost of these transactions to facilitate the participation of disenfranchised groups.

    b. Empower women to participate within the horticulture value chain in more dynamic ways. Ownership of land and small businesses provide women with the financial independence needed to make decisions and take control over their own resources and future.

        i. Agribusiness training, focusing on the steps needed to enter new markets.

        ii. Train women to process and sell horticultural products to increase the end value of their production.

        iii. Farmer field schools directed towards women.

        iv. Female extension workers are more able to connect to female farmers, especially in rural areas.

c. Establish mentorships for young women and indigenous peoples, who are regularly less empowered.

d. Find a way to increase women's participation in cooperatives and their own organizations by involving both sexes in meaningful training that empowers women to make decisions while improving the livelihoods of men.

e. Develop specialized training materials and delivery means (ICTs) to speed skills development and improve understanding of quality standards and adoption of production technology.

REFERENCES

CITED AND CONSULTED LITERATURE

Banco de Guatemala. 2012. "Estadisticas comerciales de Guatemala." http://www.banguat.gob.gt/inc/ver.asp?id=/estaeco/comercio/por_producto/prod0207DB001.htm&e=104827

Berdegue, J.A., F. Balsevich, L. Flores and T. Reardon. 2005. "Central American Supermarkets' Private Standards of Quality and Safety in Procurement of Fresh Fruits and Vegetables." *Food Policy* 30, no. 3:254-269.

Consejo Agropecuario Centroamericano. 2012. *Política regional de desarrollo de la fruticultura (POR-FRUTAS) 2011 – 2025.* San Salvador: Consejo Agropecuario Centroamericano.

Chalmers, G., M. Haidara, E. Alvarez and G. Chiriboga. 2012. *FIELD Report No. 14: Sustainability In The Honduran Informal Market System.* http://www.microlinks.org/library/field-report-no-14-sustainability-honduran-informal-market-system

CGIAR. 2012. "Packing a Punch: Targeting Native Foods and Improving Nutrition and Health." *CGIAR Consortium News.* http://www.cgiar.org/consortium-news/packing-a-punch-targeting-native-foods-and-improving-nutrition-and-health/

Cleaver, K. 2012. "Investing in Agriculture, Rural Development and Nutrition." *Scaling Up in Agriculture, Rural Development and Nutrition.* Edited by Johannes Linn, Focus 19, Brief 2. IFPRI. http://www.ifpri.org/sites/default/files/publications/focus19_02.pdf

Collinson, E., N. Habeel, F. Jawaid, L. Jean, and K. Williams. 2013. "Growing Potential: An Analysis of Legal and Policy Barriers Faced by Women in Horticulture in Guatemala, Nepal, Tanzania, & Zambia." Master's Professional Paper, Hubert H. Humphrey School of Public Affairs, University of Minnesota. http://purl.umn.edu/149584

Coon, J., A. Campion and M. Wenner. 2010. "Financing Agriculture Value Chains in Central America", Technical Notes No. IDB-TN-146, June 2010. Washington, D.C.: Inter-American Development Bank. http://www.iadb.org/wmsfiles/products/publications/documents/35243971.pdf

Díaz, A. 2004. "Prioridades en Ciencia y Tecnología: Honduras." Proyecto (ATN/NS-8226-RS) http://www.slideshare.net/monicaguerra/prioridades-en-ciencia-y-tecnologia-para-honduras-proyecto-atn-ns-8226-rs1-presentation

Docherty, C. 2012. "Branding Agricultural Commodities: The development case for adding value through branding." *Topic Brief for New Business Models for Sustainable Trading Relationships project.* IIED. http://pubs.iied.org/pdfs/16509IIED.pdf

ECLAC. 2011. *Economic Survey of Latin America and the Caribbean: International integration and macroeconomic policy challenges amid global economic turmoil.* New York: United Nations ECLAC.

Eitzinger, A., P. Laderach, B. Rodriguez, M. Fisher, L. Riso and S. Ocon. 2012. *Tortillas on the roaster (TOR) Central American Maize-Bean systems and the changing climate.* Cali, Colombia: CIAT.

http://dapa.ciat.cgiar.org/wp-content/uploads/2012/04/TOR_Final_CIAT-technical-report_23-April-2012.pdf

Encuentro de Mujeres Productoras de Hortalizas en Honduras. 2012. "Mujeres indispensables para la calidad en la cadena hortícola." Nov 2012.

FAO. 2008. "Climate-related transboundary pests and diseases, including relevant aquatic species." Expert meeting at High-Level Conference of World Food Security: the Challenges of Climate Change and Bioenergy. http://www.fao.org/foodclimate/expert/em3/narrative-em3/en/

FAO. 2011. *The State of Food and Agriculture: Women in Agriculture: Closing the Gender Gap for Development.* Rome: FAO. http://www.fao.org/docrep/013/i2050e/i2050e.pdf

FDA. 2013a. "FSMA proposed rule for foreign supplier verification programs (FSVP) for importers of food for humans and animals." US Food and Drug Administration. http://www.fda.gov/food/guidanceRegulation/FSMA/ucm361902.htm

FDA. 2013b. "Overview of the FSMA proposed rules on produce food safety standards and preventive controls for human food." US Food and Drug Administration. http://www.fda.gov/food/guidanceRegulation/FSMA/ucm334120.htm

Feed the Future. 2011. *Guatemala FY 2011-2015 Multi-Year Strategy.* http://www.feedthefuture.gov/sites/default/files/country/strategies/files/GuatemalaFeedtheFutureMultiYearStrategy.pdf

Gaynor, T. 2009 "U.S. migrant money pools thrive in the recession." *Reuters*. July 2, 2009.

Gabre-Mahdin, E.Z. and S. Hagglade. 2003. "Successes in African Agriculture: Results of an expert survey." *Markets and Structural Studies Division Discussion Paper No. 53.* Washington D.C.: IFPRI.

Gamboa, H., W. Gómez, and M. Ibrahim. 2009. "Sistema agroforestal Quesungual: una buena práctica de adaptación al cambio climático." In:*Políticas y sistemas de incentivos para el fomento y adopción de buenas prácticas agrícolas: como una medida de adaptación al cambio climático en América Central.* Serie Técnica. Informe Técnico (CATIE). no. 377. 47-68 Turrialba, Costa Rica: CATIE.

Herbold, J. 2010. "Crop insurance in developing economies – the insurers' and reinsurers' perspective." *Rural 21.* Focus. April 2010. http://www.munichre.com/app_pages/www/@res/pdf/reinsurance/business/non-life/systemagro/rural_21_crop_insurance_developing_economies_en.pdf

Hughes J., A. González, D. Keatinge, K. Wyckhuys, W. Álvarez and K. Luther. 2012. "Eco-efficient research to provide a safe, profitable, and environmentally sustainable approach for the production of fruit and vegetables". In *Eco-Efficiency: From Vision to Reality,* edited by C. Hershey. Cali Columbia: International Center for Tropical Agricultural (CIAT), www.ciat.cgiar.org/publications/Documents/chapter_12_eco_efficiency.pdf

IFPRI. 2012. *Women's Empowerment in Agriculture Index*. Accessed 17 December 2013. http://www.ifpri.org/sites/default/files/publications/weai_brochure.pdf

IICA. 2010. "Priorización de cultivos para el Plan de Desarrollo de la fruticultura de Guatemala: Una propuesta metodológica y resultados iniciales". Powerpoint presentation for IICA Guatemala, PROFRUTA, and MAGA. November 22, 2010.

IPCC. 2007. *Climate Change and Water.* IPCC Technical Paper IV. http://www.ipcc.ch/pdf/technical-papers/climate-change-water-en.pdf

Johnson, R. 2012. "The U.S. Trade Situation for Fruit and Vegetable Products." Congressional Research Service Report for Congress 7-5700, RL34468 http://www.fas.org/sgp/crs/misc/RL34468.pdf

León, J., H. Goldbach and J. Engels. 1979. *Crop Genetic Resources in Central America*. Turrialba, Costa Rica: CATIE.

MAGA. 2002. *Identificación de áreas aptas para el desarrollo de cultivos promisorios a nivel nacional*. Laboratorio SIG-MAGA. http://www.sigmaga.com.gt/pdfs_sigmaga/011-%20Areas%20aptas%2030%20cultivos.pdf

Minot, N. and M. Ngigi. 2003. "Are Horticultural Exports a Replicable Success Story? Evidence from Kenya and Cote d'Ivoire." EPTD Discussion Paper No, 120, MTID Discussion Paper No. 73. Washington, D.C., IFPRI. http://www.ifpri.org/sites/default/files/publications/eptdp120.pdf

Monterroso, O., and J. A. Carrera. 2009. "Evaluación de la Seguridad Alimentaria y la Agricultura en Guatemala: Diagnóstico y Propuestas de Acción." Documento de trabajo 03-2010 Guatemala: URL-IARNA.

NORC. 2012. *Impact Evaluation of the Farmer Training and Development Activity in Honduras.* Report to Millennium Challenge Corporation. September 25, 2012. http://www.oecd.org/countries/honduras/report-100512-evaluation-hon-farmer-training-and-development.pdf

Palmieri, M., F. Mejia, and I. Donis. 1999. *Estudios del amarillamiento letal del cocotero y otras enfermedades causadas por fitoplasmas.* Revista Universidad del Valle de Guatemala. 15:90-99.

PICHA. 1994. *Final Report for LAC Tech.* Chemonics: Agriculture and Rural Development Technical Services Project.

PROESA. 2012. "PROESA." http://www.proesa.gob.sv

RIMISP. 2011. *Poverty and Inequality: the Latin America report.* Santiago, Chile: RIMISP. http://www.ifad.org/pub/pl/informe_e.pdf

Salguero, N., VE., García T., ME., Maldonado D., W. 2012. "Agenda de Investigación e Innovación para atender problemas fitosanitarios y diseño de dos protocolos en el marco del Programa Integral de Protección Agrícola y Ambiental PIPAA."

SEICA. 2012. "Secretaria de Integración Económica Centroamericana." http://www.sieca.int

SOS Children. 2011. "Steps towards Gender Equality in Guatemala." *SOS Children's Villages.* June 30. http://www.soschildrensvillages.org.uk/news/archive/2011/06/steps-towards-gender-equality-in-guatemala

Stads, G-J., F. Hartwich, D. Rodríguez, and F. Enciso. 2008. *Agricultural R&D in Central America: Policy, Investments, and Institutional Profile.* ASTI Regional Report, November 2008. Washington, D.C.: IFPRI. http://www.asti.cgiar.org/pdf/ASTICentralAmerica-En.pdf

Subramanian, S., S. Varadarajan and M. Asokan. 2000. *Dynamics of Vegetable Production and Consumption in Asia,* edited by M. Ali. Shanhua, Taiwan: Asian Vegetable Research and Development Center (AVRDC).

USAID. 2008. *Protected Agriculture in Jamaica: A Reference Manual.* http://hightunnels.org/wp-content/uploads/2013/06/Training_Manual_Endorsed.pdf

USAID. 2009. *Agriculture Diversification Program: Final Report 2009*.

USAID Guatemala. 2009. *Gender Assessment: USAID/Guatemala.* http://pdf.usaid.gov/pdf_docs/pnado177.pdf

USAID. 2010a. *Alcanzando la seguridad alimentaria en Guatemala: oportunidades y retos.* USAID Programa de Comercio y Competitividad (ABT).

USAID. 2010b. "The USG Guatemala GHI Team." *The United States Global Health Initiative Guatemala Strategy Revision*: December 11, 2010. http://www.ghi.gov/whereWeWork/docs/GuatemalaStrategy.pdf

USAID. 2011. *Doing Agribusiness in Latin America and the Caribbean*.

USAID Central America. 2011. *Regional Integrated trade and food security strategy 2011-2017*.

Van Mele, P. 2011. *Video-mediated farmer-to-farmer learning for sustainable agriculture: A scoping study for SDC, SAI Platform and GFRAS*. Ghent: Agro-Insight. Accessed October 21, 2014. http://agroinsight.com/downloads/articles-divers/Farmer-to-farmer-video-FINALREPORT-Van-Mele-2011.pdf

Vorley, B., M. Lundy and J. MacGregor. 2008. "Business models that are inclusive of smallholders." Paper prepared for Global Agro-Industries Forum, New Delhi, April 8-11, 2008. http://pubs.iied.org/pdfs/G02340.pdf

World Bank. 2013. *Shifting Gears to Accelerate Shared Prosperity in Latin America and the Caribbean.* http://www.worldbank.org/content/dam/Worldbank/document/LAC/PLB%20Shared%20Prosperity%20FINAL.pdf

Wu, H.-W., T-A. Yu, J.A. J. Raja, S. J. Christopher, S.-L. Wang, and S.-D. Yeh. 2010. "Double- virus resistance of transgenic oriental melon conferred by untranslatable chimeric construct carrying partial coat protein genes of two viruses." *Plant Dis.* 94:1341-1347.

APPENDICES

APPENDIX A: LIST OF PEOPLE INTERVIEWED AND THEIR CORRESPONDING ORGANIZATION, BY COUNTRY

List of people interviewed in Honduras

Segment	Organization	Position
DP	EmprendeSur	Director
DP	FINTRAC	Director
DP	FINTRAC	Sub Director
DP	FINTRAC	Mercados
DP	FINTRAC ACCESO	Gerente Depto Intibucá
DP	FINTRAC ACCESO	Asesor Politicas, ex ministro SAG
DP	Pronegocios Rurales	Director
DP	COMRURAL	Director
ET	Zamorano- Escuela Agrícola Panamericana	Director Agronegocios
ET	Zamorano- Escuela Agrícola Panamericana	Profesor Hortalizas
ET	Zamorano- Escuela Agrícola Panamericana	Profesor Frutales
F	Banco BANADESA	ex presidente
G	ex Ministro de Agricultura	
G	Ministro Agricultura	
G	Secretaría Industria y Comercio SIC	Jefe Negociación Comercial
G	Secretario FEHPROH	
G	SENASA	
IC	IICA-Agronegocios	
IC	Representante FAO Honduras	
IC	USAID	Agricultural Recovery Advisor
IC	USAID	Senior Agriculture Advisor
IC	USAID Honduras	Sub Director Desarrollo Econ
IC	USAID Honduras	Oficial Programa
IC	USAID Honduras	Asist Programa
IC	USDA APHIS Honduras	Técnico
IC	USDA FAS Honduras	Mercados
M	Central Abastos Sula	Comercializador
M	Central Abastos Sula	Comercializador
M	Corp Dinant	Gerent Planta Alimentos

M	Corp Dinant	Gerente Empaque
M	Corp Dinant	Gerente Cultivos Protegds
M	INALMA procesador	Gerente Operaciones
M	Hortifruti Walmart Honduras	Gerente Compras
NGO	OCDIH Organismo Cristiano p el Des Integral	Monitoreo y Eval
NGO	ODECO Organización p el Des d Corquín	Coord Incid Política
P	Agricola ANTAR	Gerente Propietaria
P	Agricola ANTAR	Gerente Tecnico
P	APRHOFI	
P	ASOFAIL (Asociación de Familias Agricolas de Intibucá Ltda)	
P	Coop Productrs Mango COPETROL	Directivo
P	FENAPA (Federación de Productores Papa)	Presidente Directiva
P	FPX Federación de Productores y Exportadores de Honduras	Gerente General
P	FRUTELA	Directivo
P	FRUTELA	Directivo
P	FRUTELA	Gerente
P	FEHPROH	Presidente
P	Proyecto Horizontes Norte	
P	Red Hortícola de Intibucá	
R	FHIA	Director General
R	FHIA	Director Investigacion
R	FHIA Comayagua	
SP		
SP	FUNDER-Fundación	Jefe Centro Agronegocios
SP		
SP	CENOC (Centro Empresarial y de Negocios de Ocotepeque)	Miembro
SP	Empresa Asociativa Campesina Chululan	
SP	Fundación Jicatuyo	Gerente Finanzas
SP	Fundación Jicatuyo	Gerente Gestión Empresarial
SP	Fundación Jicatuyo	Gerente General
SP	Fundación Jicatuyo	Directivo
SP	Fundación Jicatuyo	Presidente Directiva

List of people interviewed in Guatemala

Segment	Organization	Position
ET	Universidad Rafael Landívar	Decano Facultad de Ciencias Ambientales y Agrícolas
ET	Universidad del Valle de Guatemala	Director Centro de Estudios Agricolas y Forestales
ET	Universidad del Valle de Guatemala	
ET	Universidad del Valle de Guatemala	Decano, Facultad de Ingenieria
ET	Universidad del Valle de Guatemala	Directora, Ingenieria en Ciencias de Alimentas
G	MAGA-CONADEA (Consejo Nacional de Desarrollo Agropecuario)	Secretario Ejecutivo
G	Gobierno de Guatemala, Ministerio de Agricultura, Ganaderia y Alimentacion	Jefe de Oficina Normas y Procedimientos
G	MAGA-CONADEA (Consejo Nacional de Desarrollo Agropecuario)	Asesor
G	CONPRODAN	Secretaria de Cadenas
G	MAGA-CONADEA (Consejo Nacional de Desarrollo Agropecuario)	Director CONPRODAN
G	PROFRUTA/DEFRUTA	
G	DEFRUTA MAGA	Director
IC	IICA	Coordinador Innovacion para Competitividad y Productividad
IC	IICA	Representante IICA en Guatemala
IC	IICA	Division Hortalizas y Frutas
IC	FAO	Oficial de Alianzas
IC	USDA	Especialista Internacional
IC	USDA	Coordinador Programa Internacional
IC	USDA	Consejero Agricola
IC	USDA	Especialista Fitosanitario
IC	USDA	Especialista Agricola
IC	USAID USDA?	Coordinador Regional MSF y SIM
IC	USAID	Consejero Agricola
IC	USAID/GUATEMALA	Subdirectora Oficina Desarrollo Economico
IC	FAO-PESA	Tecnico Nacional
IC	FAO-PESA	Tecnico Nacional

IC	FAO	Experto Comercializacion
IC	FAO	Coordinador AUP
IC	FAO	Agrocadena Papa
DP	ANACAFE	Director del Proyecto
DP	ANACAFE	Experto en Desarrollo Rural
DP	ANACAFE	Monitoreo y Evaluación
M	Asociacion Guatemala de Exportadores (AGEXPORT)	Director Division Agricola y Pesca
NGO	Save the Children	Especialista Agronegocios
NGO	CARE Guatemala	Directora Nacional de Programas
P	Productor Independiente	
P	FASAGUA	
P	FRUTASA (Fruticultores Asociados del Altiplano)	Administrador
P	Assoc. Prodesarrollo de la Familia Ixil	Presidente y Representante Legal
P		
P	Finca San Juan Bautista	Dueno
P	MAM, Retalhuleu	Representante de Comunidad
P	Assoc. de Fruteros, Genoa	
P	Assoc. de Fruteros, Genoa	
P	Comunidad La Reina	Presidente
P	Comunidad La Reina	Vigilancia
R	ICTA	Subgerente General
R	ICTA	Bioquimica y Biotecnologa Laboratoria de Biotecnologia
R	ICTA	
R	UCDavis	Especialista Post Cosecha
R	ICTA Quezaltenango	Administradora
R	ICTA Chemaltenango	
R	ICTA Chemaltenango	Especialista Agroindustria
R	ICTA Chemaltenango	Especialista Agroindustria
R	ICTA Chemaltenango	
SP	Vista Volcanes S.A.	Ex Gerente General
SP	Vista Volcanes S.A.	Director
SP	Vista Volcanes S.A.	Gerente Administrativo
SP	Agroexpertos	Director General
SP	OIRSA	Representante
SP	OIRSA	Fitosanitario
SP	Fundacion Juan Francisco García	

SP	Cooperacion Agricola Integral (Los Cuatro Pinos)	Proyectos Productivos
SP	Cooperacion Agricola Integral (Los Cuatro Pinos)	Coordinador Logistica de Contenedores
SP	Grupo DUWEST	Aseso Tecnico de Ventas
SP-M	Frito Lay Central America	Asesor Programa Agricola

List of people interviewed in El Salvador

Segment	Organization	Position
G	PROMEFRUT	Directora Proyecto PROMEFRUT
ET		Profesor fruticultura
G		Coord Programa Invest Frutales
IC	FOMILENIO	ex Dir Proyecto FOMILENIO (Cuenta Desafío Milenio)
IC		Directora Econ Growth
IC		Econ Growth
IC		Value Chain Centro América
IC		Coordinador Programa Agric Familiar

ET = Education and Training (Local and International Universities)
G = Government
IC = International Cooperation (international support agencies)
DP = Development Project
M = Markets (informal, formal, processors)
NGO = Non-government organization
P = Producer, Producer organization
R = Research
SP = Service providers (finances, technologies, analysis)

APPENDIX B: LIST OF ALL ISSUES MENTIONED DURING THE IN-PERSON INTERVIEWS AND CONSULTATION WORKSHOPS

List of all aspects considered as limiting factors, mentioned during the interviews and workshops.

ECONOMIC

LACK OF ADEQUATE FINANCIAL SUPPORT FOR HORTICULTURE AND LACK OF CAPITAL FOR SMALL PRODUCERS

- Annual interest rates on loans for horticulture can be as high as 36%.
- The banking sector does not promote low interest loans, only those with the bank´s own funds and at high interest rates.
- Loan approval is a slow and cumbersome process, generally requiring the loan be mortgage-secured.
- Financial products—with grace periods taking into account growing cycles—are not commonly available for horticulture cropping.
- Development projects do not include funds for working capital.
- The banking sector provides financing services mainly to large producers.
- Low-interest, public financing for agriculture is used for other ends; political influence is required to access credit.
- Small producers do not have access to foreign funds because of the type of crops they produce (beans, sorghum, maize, rice, potatoes). (Guatemala)
- Access to credit is difficult for women horticulture producers. The women´s cooperative "*Cooperativa de Mujeres 4 Pinos*" was created to address this issue. (Guatemala)
- Banks establish excessive requirements for approving a loan (demanding guarantees worth five times the value of the loan). (Guatemala)
- Producers do not own the appropriate vehicles or resources to transport their produce. (Guatemala)
- Small producers do not have the resources to purchase inputs, equipment, infrastructure, etc. Fertilizers are purchased only when the harvest is sold.

LACK OF TRANSPARENCY IN BUYER-SUPPLIER RELATIONSHIPS

- Buyers make loans to producers at 30% interest rates, and apply product rejection policies of as much as 50% when there is surplus.
- Sometimes exporters do not pay farmers, but keep the produce.
- Breach of contract is common, producers are paid on an irregular schedule, and price volatility is high.
- During periods of surplus, farmers sell their produce for less than production costs.

DEPENDENCY CULTURE GENERATED BY DEVELOPMENT PROJECTS

- Farmers rely on projects or institutions for marketing and transporting their produce, thus generating dependency on these institutions or development projects.
- External aid serves the same areas and same farmer leaders. Scope of coverage needs to be broadened.

AFFORDABLE AGRICULTURAL CROP INSURANCE UNAVAILABLE

- Small producers do not have easy access to affordable agricultural crop insurance.

MARKET ISSUES

- There is little negotiating power by small farmers and a high degree of distortion of markets by both wholesalers and growers due to speculation on both parts.
- Imported seeds (onions and potatoes) come from countries with high subsidies, and contraband from neighboring countries affect local producers.
- Farmers have limited access to new markets and there is little help from the Ministry of Commerce to address this and other trade issues.
- The local market is underdeveloped with no true farmers' markets, which are instead run by business people from the informal wholesale markets in many cases.
- There is a generalized lack of prompt payment or a practice of late payment to growers and no willingness by buyers to sign contracts.
- Overall, producers lack information on markets.
- Access to formal markets, such as supermarkets, is difficult for small farmers, and they do not have direct contact with traders in wholesale markets.
- Small farmers relate mainly with intermediaries.
- Mechanisms are not in place for producers to sell directly to consumers, or in local or national markets.
- Contraband from neighboring countries is an important limiting factor since producers cannot compete in prices with illegal imports.
- Processing plants are required in order to maintain good prices. There is a growing tendency to process vegetables in other countries.
- There is not enough surplus for processing (as is the case with papaya).

LACK OF PROTECTION AGAINST FREE-TRADE AGREEMENTS

- Small/poor countries are at a disadvantage in free-trade agreements (FTAs)
- Inequitable marketing relationships among countries signing the FTAs.

HIGH COST OF PRODUCTION (SUPPLIES, SEEDS, EQUIPMENT/EQUIPMENT IMPORT TARIFFS, ETC.)

- Agricultural inputs (seeds, pesticides, etc.) are expensive in comparison to their costs in other countries in the region, reducing competitiveness of national production.
- Duties on imported processing equipment are high.

- Locally produced raw materials for processing are expensive (plantains, tomatoes for paste, etc.).
- Processes for complying with international sanitary export requirements are expensive and will be even greater when new standards are enforced (U.S. Food Safety Modernization Act).
- Competitiveness of horticultural cropping is low.
- Horticultural production costs are high due to the high cost of labor involved.
- Some horticultural products are no longer profitable to produce because of the high cost of production or overproduction.
- Organic products are not well known, nor are buyers ready to pay a higher price than for conventional produce, acting as a negative incentive for organic farming.
- Productivity of horticultural cropping is low.
- Low salaries in horticultural farming discourage labor supply.

LACK OF INCENTIVES FOR PRODUCTION

- There is a marked absence of programs for promoting organized vegetable and fruit production.
- Initiatives are missing for staggering production and reducing seasonality, resulting in producers taking their harvests to the market all at the same time.
- Lack of serious consideration of native and other potentially profitable crops.

CROP MANAGEMENT

PLANTING CHOICES

- Production is not diversified, concentrating mainly on growing staple crops, especially subsistence crops in low productivity maize and bean production systems.
- Product supply in the market is not diversified. Farmers are reluctant to innovate, for example to grow colored potatoes or potato varieties fit for processing.
- Production of traditional species (such as blackberries, saisoco *[Asplundia utilis]*, asparagus, pacaya *[Chamaedorea costaricana]*, chichicuilote, capuca, caña de palmera *[Sabal umbraculifera]*, loroco *[Fernaldia pandurata],* pendant amaranth, giant yucca, pito *[Olyra latifolia]*, etc.) is not being exploited.
- Specialized planning—with a territorial approach taking into account the different agroecological zones—has not been implemented.
- Even though agroclimatic conditions in Honduras are optimum for banana production and demand is high, area planted to this crop has reduced considerably in the country. An opportunity for alternative crops?
- Large producers are reluctant to experiment with vegetable and fruit production—which remain as opportunities for small farmers.
- Suppliers of inputs sell seed of varieties that are not adapted to local agroclimatic conditions.

PLANNING

- Since cropping activities are not well planned, harvested crops sometimes reach the market when prices have dropped.
- Lack of planning and scheduling of cropping activities result in deficiencies in supply of produce to the market.
- Distortion in production is the result of traders distributing seed arbitrarily to promote production and stock up on produce.
- Due to lack of crop planning and organization, when market prices increase for a specific product and year, area planted to this crop increases the following year, resulting in supply exceeding demand and prices dropping.
- Concentration of demand reduces the bargaining power of farmers.
- Export opportunities are wasted due to lack of production organization. (A mango processing plant operates in Comayagua, Honduras, but producers only exported during 2 years.)
- Honduran farmers have not taken action to control neighboring country vegetables from flooding the market.
- Products do not have a certificate of origin ("Honduras" branding) to promote sales of national production.
- Farmers do not have control over their harvests after delivering produce to traders.

ENGINEERING/TECHNOLOGY

AVAILABILITY OF WATER AND IRRIGATION INFRASTRUCTURE

- Overall lack of irrigation infrastructure and equipment.
- Low investment level in irrigation infrastructure.
- Current irrigation systems and methods are often inefficient.
- Availability of irrigation districts and equipment is not sufficient and farmers, especially women, spend hours carrying water for home consumption and irrigation.
- The higher altitude zones experience a deficit in vegetable production during the period between November and March due to frosts and lack of water.

POSTHARVEST

- Lack of adequate packing and transportation means.
- Actions are missing to promote value-added products, and very few enterprises are dedicated to processing agricultural products.
- Donor funds, often redundant, are invested in vegetable and fruit wholesale/distribution centers which later become "white elephants."
- Lack of vegetable postharvest equipment, such as portable washing equipment that can be easily transported in a pick-up truck.

- Training is required on handling perishable products in order to maintain their quality and prolong their shelf life.

PROCESSING

- Lack of fruit and vegetable processing infrastructure.
- Little processing of second-rate quality fruits and vegetables.
- Lack of advanced/simple training on fruit and vegetable processing.
- Fruit and vegetable processing facilities are isolated in academic, professional training and government institutions.

PRODUCTION TECHNOLOGY AND SUPPLIES

- Lack of technology for protected agriculture.
- International organisms do not prioritize certain horticultural products (e.g., Harvest Plus does not include bananas and plantains in its priorities).
- Training and technologies—in the form of specific and necessary products/services, such as stakes, strings, meshes, plastics, substrates—are not available for vegetable cropping.
- Small farmers do not have diagnostic services to detect chemical or biological residues.
- Even though Guatemala´s institute of agricultural technology (*Instituto de Ciencias y Tecnología Agricolas*, ICTA) has a processing research program, they have not been able to develop many processed commercial products due to lack of resources and knowledge on agro-enterprise development issues.

INFRASTRUCTURE

- Roads are in very poor condition, a major infrastructure issue.
- Secondary road infrastructure in poor conditions, hampering transportation of produce to markets.
- Difficulties in transporting produce due to poor conditions of roads. (For example, 13 hours are spent traveling over the stretch of road between Choluteca and San Pedro Sula due to mounds of dirt and potholes.)

EDUCATION AND TRAINING

LACK OF CAPACITY OF GROWERS AND PERSONNEL OFFERING TECHNICAL ASSISTANCE

- The lack of operational capacity among growers results in low-quality produce, low productivity, inadequate production practices, and incomplete production costs analyses.
- Technical assistance offered by some local NGOs and representatives of agrichemical companies is not a guarantee of updated information, new approaches to solve old issues, old approaches to solve new issues, and free of conflict of interest when selling a product.
- Technical service providers are not certified, and there is no regulatory system in place to oversee its functions.
- Rural schools do not offer education related to agriculture.

- Farmers have limited financial analysis capacity to establish production costs.
- Some practices like re-packaging agrochemicals allow inferior/ineffective or fake products to be sold to growers.
- Limited training of rural nutrition promoters aiming to enhance diets in rural communities result in limited impact.
- Although natural resources could be available (i.e. water) limited operational capacity such as irrigation infrastructure limits their production potential.

LIMITED RESEARCH CAPACITY, ACCESS TO RESEARCH AND INCENTIVES TO ENROLL IN AGRICULTURE-RELATED CAREERS

- Research capacity at the country level is very limited, although several universities and organizations are present in Honduras and Guatemala.
- Funding and time allocated to conduct research is limited, if available.
- There is a disconnect between research projects and agriculture issues, and a lack of focus on real needs.
- DICTA is focused on food security based on basic grains, and horticulture crops are neglected.
- Occasionally, laboratories are well equipped but do not have qualified personnel to operate equipment/instruments.
- Laboratories to diagnose pests, diseases and chemical residues do not exist and are critically needed.
- Research on native species (issues, domestication, cultivation practices, and genetic resources) is limited.
- Agriculture is no longer attractive to new generations, and universities are focusing more on training students in business development rather than forming new researchers or extension agents.
- Fruits with export potential do not have export protocols and risk analyses.
- Postharvest technologies and innovations are limited.

LACK OF REGULAR/STABLE EXTENSION SERVICES

- Producers are aware of restrictions, yet take the risk of applying chemical products right before harvesting.
- Technical assistance as a primary government strategy is lacking: it is in the hands of development projects (NGOs) and private companies.
- Large producers and some producer cooperatives offer limited technical assistance to producers.
- Chemical sales representatives are not always well trained nor well informed, and offer biased technical assistance to make a sale.
- Technical assistance offered by several NGOs is of low quality, limited coverage and not always coordinated.

- Multiple, often redundant, sources of technical assistance, without coordination or integration = "silos."
- Small farmers use mixtures of agrochemical products, risking surpassing the maximum residue limit (MRL).
- Technical assistance to famers involved in development projects ceases when project funds are no longer available (e.g., Danida´s agronomists).
- Technical assistance to famers involved in government projects lasts as long as the government of the day is in office.
- Implementing of preventive agrochemical residue analyses is uncommon.
- Guatemala´s agricultural and environmental protection program (*Programa Integral de Protección Agrícola y Ambiental,* PIPAA) is located in AGEXPORT (the Guatemalan association of exporters) and mainly provides support to exporters, offering no protection to farmers that do not export.
- ICTA provides agricultural technology extension and transfer services, following the learning-by-doing approach in the classroom and in the field; however these programs are ineffective due to their low operating budget.
- Frequency of technical assistance provided by producers' associations (cooperatives) is very low (1 technician for 200 plots).

LACK OF DIALOGUE AND COORDINATION AMONG DEVELOPMENT PROJECTS IN THE REGION

- Several projects/agencies are tackling similar regions/problems, but do not coordinate actions to maximize impact; instead, they tend to compete for farmers groups to complete indicators required for their projects = silos, redundancy, and wasting of limited resources.

LANGUAGE AND CULTURAL BARRIERS AFFECT ACCESS TO INFORMATION AND TRAINING

- As a multicultural and multi-lingual country, Guatemala is faced with more serious challenges than other countries in the region, especially considering that small producers of horticulture goods. Producers belong to those communities.

LACK OF AVAILABILITY AND ACCESS TO INFORMATION (CROP SPECIFIC, PRODUCTION PRACTICES, MARKETS)

- There is a lack of access to information related to markets and windows of opportunity, product quality standards, and technical and financial services information.
- Market information is centralized and managed by SIMMPA-Infoagro, not always the required real-time information regarding the offer and demand of horticultural products.
- Market intelligence systems are essential.
- There is not an agricultural policy for horticultural products.
- Research organizations (i.e. FHIA) cannot transfer information due to lack of financial resources, plus it is not within their mandate or budget.
- Growers lack business-oriented approach to horticulture.

- Lack of innovation in horticulture/agriculture.
- Several programs engaged in collecting market price data and planting schedules do not result in the information being generated actually being useful to growers and buyers.
- Updated information (research and training materials) is not available and easily accessed by end users. ICTA only implemented their digital information system until 2003, when finances ceased.
- ICTA offers training to large NGOs but the generation of new technologies is limited due to scarce operational capacity and funding.
- Available weather data is not transformed into weather forecast systems that could minimize/prevent crop damage due to climate events (i.e. freezing in the highlands).
- Practices and methods that result in sustainable production systems (i.e. organic matter incorporation into soils, carbon sequestration strategies, conservation of biological diversity) are not known by farmers, nor are they implemented due to lack of tools/knowledge.
- Proper postharvest handling of produce is not known by small growers or transporters; appropriate handling of product after leaving farm gate is not guaranteed.
- Market quality standards are not always known by growers, which limits linking to larger farmers for export markets.
- Lack of information of price and trends of local and regional markets keeps small growers at a disadvantage.

PHYSICAL

CLIMATE CHANGE RELATED VARIABILITY

- Central America has been recognized as highly susceptible to variable weather-related events such as excess or decreased rain, higher or lower temperatures. These events affect agricultural production, flowering/fruiting cycles and planting dates and increase vulnerability to pests and diseases.
- Small farmers are the most at risk population as their resiliency is low.
- Available insurance policies do not cover climate related events.
- Evidence has been documented that changing climate has forced growers to change crops and cropping systems. For example, FASAGUA indicated that tomato growers are now being displaced to other locations due to pests and diseases, as a consequence of changing climate.

LAND TENURE AND LAND ACCESS ISSUES

- Small growers in Honduras and Guatemala suffer from insufficient suitable land for cultivation, with a 1/2 ha average size; this limits volume and crop expansion. Industrial crops (sugar cane, banana and oil palm) use large areas of agriculture suitable land.

HIGH RISK IN THE HIGHLANDS DUE TO FREEZING TEMPERATURES

- Freezing temperatures during the dry months restrict agricultural activities; however, farmers take the risk and plant vegetables. When freezing occurs, economic losses are absorbed.

WATER AVAILABILITY AND IRRIGATION INFRASTRUCTURE IS LIMITING

- Prolonged dry spells reduce vegetable production and affect fruit production. Water quality, including both microbiological and chemical contaminants, is a serious issue.
- Availability of clean water sources during the dry months is limited.
- Irrigation systems are costly to operate because of clogged pipes and sprinklers.

SOIL EROSION AND LOW FERTILITY ISSUES

- Soil management and conservation are important for controlling erosion problems. Lack of guidelines and education.
- Pressure for land is resulting in more deforestation in the highlands of Guatemala.

SOCIAL

WEAK RURAL HEALTH PROMOTION PROGRAMS

- The issue of undernourished families generally does not seem to be corrected by export-oriented agriculture. In fact, locals sometimes do not know and/or like to eat exported crops.
- Interest in cultivation and consumption of native crops is losing ground to commercial crops.
- Long-term presence of development projects has created dependency of small farmers and their families and communities.

LACK OF KNOWLEDGE OF SOCIOECONOMIC IMPACT OF TECHNOLOGIES AND DEVELOPMENT PROGRAMS

- The socioeconomic impact of technologies developed by ICTA, as well as financial services offered by some organizations, are not known to government bodies, development organizations and the general public.

WEAK ORGANIZATIONAL STRUCTURES AND DISFUNCTIONAL VALUE CHAINS WITH UNDEFINED RULES AND ROLES

- Value chains are not well structured and supported, with clear rules and roles.
- Small farmers are not organized, have low production volumes, and disperse, unscheduled/uncoordinated production
- Small farmers face illegal competition from subsidized imports (onion and potato seeds).
- There is lack of transparency in the value chains, including claims that fair trade does not always benefit the small farmers; intermediaries reap the benefits.
- There is a lack of business attitude approach among farmers with buyers, and producers often fail to abide by contracts.
- National food security policy perpetuates poverty.

LACK OF DIVERSIFIED AGRICULTURAL ACTIVITIES

- Single crop focus (dedication to export agriculture) results in several months without cash flow.

LACK OF WOMEN PARTICIPATION IN COMMERCIAL AGRICULTURE

- Some communities discourage women participation in commercial agriculture, and relegate them to the role of invisible workers.
- Commercially successful enterprises had set rules against women becoming members of the male dominated cooperative.
- In rural areas, some families do not promote/allow education of daughters.

RURAL MIGRATION

- Rural migration to urban centers and to other countries affects labor and families in rural areas.

ILLEGAL MARKET COMPETITION

- Illegal imports of subsidized products displace local produce.
- Potatoes cannot be legally sold in Honduras due to quarantine issues, but are sold illegally, negatively impacting the Honduran market.
- Entrance of imported products (such as pre-cooked potatoes for McDonalds coming from the United States or Canada) has further reduced the market for local produce.
- Not all small farmers have the possibility of selling to Walmart's chain of local supermarkets.
- Deferral of payment (> 45 days) is excessive and some products are rejected when there is surplus.
- Price of fertilizers has increased in the last 2 years, affecting capacity to purchase it, resulting in declining productivity and profitability.
- Contraband coming from Mexico floods the markets, displacing local production.

EXCESSIVE PAPERWORK TO IMPORT/EXPORT AND BUSINESS DEVELOPMENT

- International regulations limit export possibilities; U.S. regulations include labor requirements.
- Paperwork for production and environment permits is excessive, expensive and time-consuming.
- Farmers consider that the regulations of the Ministry of Livestock and Agriculture (MAGA) hamper instead of promoting production.
- Obtaining product certification is difficult; fewer than 150 sanitary operating permits for more than 1 million farmers.

INOPERATIVE AND INEFFICIENT GOVERNMENT OF GUATEMALA (GOG)

- Corruption in GOG. The new government names another person from the party for a position previously held by someone else.
- Corruption in government hiring: the profile only requires the person be unemployed and be associated with the party in office.
- Labor instability: Lack of career positions in government due to changes with administrations following election.
- Extension agents do not have a formal labor contract nor any kind of job security. New extension agents have been hired but their salary has not been paid.

- All extension agents need to be re-hired when the government goes through a change of office.
- The country does not have a national development plan.
- It is not clear how to implement the government´s integrated rural development policy.
- Extension agents got involved in political propaganda activities.
- Even though a sectorial policy has been approved, development projects do not take it into account and the policy itself has not been fully implemented.
- Extension agents do not receive training.

LACK OF STIMULUS THAT PROMOTE PRIVATE SECTOR INVOLVEMENT IN PUBLIC RESEARCH

- The country lacks a public-private model for financing public research. (In Chile, for example, the state pays 40% of the salary of inspection agents.)

BIOLOGICAL

- Limited local capacity for potato seed production.
- Imported seed potato in November causes overproduction some months later.
- Small producers do not produce what the markets demand.
- Vegetative material available to growers is often affected by viruses.
- Lack of sufficiently adequate germplasm bank of fruit varieties that allow variety replacement.
- Pressure from pests and diseases is a major concern in the region, as production costs, productivity, market access and food safety are affected due to this factor.
- There is a limited supply of biological products to control pests and diseases, and when available, are costly.
- Few vegetable seed suppliers; current situation is becoming a monopoly.
- Biannual production cycle of some commercial fruit varieties is not suitable for small farmers; they need alternatives and complementary crops/enterprises.
- Home orchards do not produce local species. Late harvest varieties affect their market opportunities (i.e. rambutan) as other producers (Mexico) enter the market.
- Native crops have received limited attention, and updated information that will be required to make such investment choices is limited.
- Pressure from pests and diseases is a major concern in the region, as production costs, productivity, market access and food safety is affected due to this factor.
- No known rootstocks (i.e. avocado) exist which are tolerant to major diseases.
- Commercial nurseries have not been established for distributing avocado trees grafted onto rootstock exhibiting tolerance to the major root rot diseases.

- Several catastrophic diseases are already affecting the region (HLB in citrus, Lethal yellowing in coconuts, *Fusarium oxysporum* race IV in bananas, *Fusarium* spp. in pineapple, *Tuta* spp. in tomato) and will represent major challenges for small and large farmers.
- Several fruit fly species, which are not included in quarantine barriers, cause major losses for growers but receive little research attention.
- Export crops (rambutan) limited by scale of production capacity.

FOOD SAFETY AND PHYSTOSANITARY CONTRAINTS

- The region is vulnerable to pests and diseases from different sources, and phytosanitary issues of quarantine character, and food safety still affect exports.
- Need for the development of a national program to promote GAPs among small farmers, and provide incentives for updating facilitates.

APPENDIX C: QUESTIONS USED IN WEB SURVEY

(This document has been translated from Spanish to English for the purposes of this report.)

Evaluation of the Horticulture Sector in Latin America

Introduction and justification

Evaluation of constraints to the growth of the horticultural sector

PROJECT JUSTIFICATION
Since the mid-1980s, USAID has made significant investments in Latin America and the Caribbean (LAC) to develop agricultural industries exporting non-traditional products, including investments in production, pest management, postharvest handling, and processing and marketing of horticultural products with added value. As a result of these investments, the export of high value crops and product value added has generated an increased volume of international trade and contributed to growth of GDP. This has given producers and other agricultural business more opportunities to generate jobs with higher incomes. With the adoption of free trade agreements between countries in the LAC region and the United States, an urgent need has arisen to develop sustainable cropping systems (including best strategies for pest management). Such systems should focus on increasing production, improving postharvest management, and increasing fruit and vegetable crop processing so as to add value and facilitate marketing. The goal of these objectives is to increase the competitiveness of countries prioritized by the "Feed the Future" initiative giving them greater access to regional and international markets. To achieve this level of growth and competitiveness, in the horticultural sector, however, immediate investment is needed in two areas: (a) Generation and dissemination of the technologies and horticultural knowledge required to overcome factors limiting sustainable production and profitability for horticultural crops, (b) An institutional support system that facilitates the delivery of resources and services required producers to produce quality crops and products that meet the demands market and regulatory standards of that market.

Elizabeth Mitcham,
Director
Horticulture Collaborative Research Support Program
U.C. Davis

Assessment of the Horticulture Sector in Central America
Basic information
Questions 1 through 4 provide information on your role

1. Basic Information about the Respondent
Full name:
Sex: M F
City / Town:
State / Prov.:
Country:
E-mail

2. Basic information on your background. Select the most appropriate and complete the underlined space
Professional in_____
Extension agent in_____
Technician in_____
Student of_____
Distributor and trader of_____
Producer of_____
Other_____

3. Which type of organization do you belong to. You can mark more than one if necessary.
NGO___
Government___
Academia___
National or International Research Institute ___
Producers Organization___
Consultant___
Agency for International Development___
Independent___
Other___
Horticulture Sector Assessment in Central America

4. What area do you work in?.
Agricultural production____
Marketing____
Research____
Consulting____
Extension and training____
Education____
Government regulatory organization____
Supplier (agrochemicals, seeds, sprinkler systems, etc.) ____
Other____

5. Of the following factors related to horticultural production, assign a value that describes whether it is a limiting constraint to horticulture in your geographic area. 1 is the least limiting and 5 is extremely limiting.

	1	2	3	4	5	Don't know
Technical capacity of producers	[____]	[____]	[____]	[____]	[____]	[____]
Quality of technical assistance offered to producers	[____]	[____]	[____]	[____]	[____]	[____]
Availability of chemicals	[____]	[____]	[____]	[____]	[____]	[____]
Cost of chemicals	[____]	[____]	[____]	[____]	[____]	[____]
Availability of biological control for pests and diseases	[____]	[____]	[____]	[____]	[____]	[____]
Cost of biological control of pests and diseases	[____]	[____]	[____]	[____]	[____]	[____]
Access to new varieties resistant to pests & diseases	[____]	[____]	[____]	[____]	[____]	[____]
Availability of certified planting material	[____]	[____]	[____]	[____]	[____]	[____]
Availability of irrigation technologies	[____]	[____]	[____]	[____]	[____]	[____]
Cost of irrigation technologies	[____]	[____]	[____]	[____]	[____]	[____]
Public irrigation district	[____]	[____]	[____]	[____]	[____]	[____]
Illegal entry of agricultural products	[____]	[____]	[____]	[____]	[____]	[____]
Lack of time for production, marketing, and family	[____]	[____]	[____]	[____]	[____]	[____]

Other (specify)_____

6. Of the factors related to markets and policies, assign a value that describes whether it is a limiting constraint to horticulture horticulture in your geographic area. 1 is the least limiting and 5 is extremely limiting.

	1	2	3	4	5	Don't know
Lack of government programs to support small agricultural producers	[____]	[____]	[____]	[____]	[____]	[____]
Access to credit for small producers	[____]	[____]	[____]	[____]	[____]	[____]
Cost of credit for agriculture	[____]	[____]	[____]	[____]	[____]	[____]
Availability of agricultural insurance	[____]	[____]	[____]	[____]	[____]	[____]
Cost of agricultural insurance	[____]	[____]	[____]	[____]	[____]	[____]
Trust and transparency in the value chain	[____]	[____]	[____]	[____]	[____]	[____]

Welfare culture of development programs in the region	[____]	[____]	[____]	[____]	[____]	[____]
Producer associations	[____]	[____]	[____]	[____]	[____]	[____]
Access to market information	[____]	[____]	[____]	[____]	[____]	[____]
Access to informal markets	[____]	[____]	[____]	[____]	[____]	[____]
Access to formal markets	[____]	[____]	[____]	[____]	[____]	[____]
Access to export markets	[____]	[____]	[____]	[____]	[____]	[____]
Payment policies in formal markets	[____]	[____]	[____]	[____]	[____]	[____]
Availability of land suitable for agriculture	[____]	[____]	[____]	[____]	[____]	[____]
Security of land tenure (invasions, expropriations)	[____]	[____]	[____]	[____]	[____]	[____]

Other (specify)_____

7. In relation to weather-related factors, assign a value that describes whether it is a limiting constraint to horticulture in your geographic area. 1 is the least limiting and 5 is extremely limiting.

	1	2	3	4	5	Don't know
Prolonged periods without rain	[____]	[____]	[____]	[____]	[____]	[____]
Increased rainfall	[____]	[____]	[____]	[____]	[____]	[____]
Flooding of production areas `	[____]	[____]	[____]	[____]	[____]	[____]
Landslides blocking access to growing areas	[____]	[____]	[____]	[____]	[____]	[____]
Effects of high temperatures on the crops	[____]	[____]	[____]	[____]	[____]	[____]
Low temperature extremes (frost) ``	[____]	[____]	[____]	[____]	[____]	[____]
Increased pest populations and diseases	[____]	[____]	[____]	[____]	[____]	[____]
Presence of new pests and diseases	[____]	[____]	[____]	[____]	[____]	[____]

Other (specify)_____

Questions 9-12 are related to aspects of markets and marketing of horticultural products. Questions 14 through 19 are related to research aspects. You have the option to answer one section, both sections, or to exit survey.

8. Do you want to answer the questions on marketing and markets?
If
[____] Yes

[____] I wish to respond to questions on research

[____] I want to exit the survey

9. • Select market channels you use to sell your products. Select all that apply to you.
[____] I sell to a broker directly, because it is important for me and he treats me fairly.
[____] I sell to the broker directly, because I have NO other marketing channel.
[____] I am a member of a cooperative and we sell our product as a cooperative
[____] I sell my products directly in farmer's markets or green markets in the suburbs
[____] I sell my own products in wholesale markets.
[____] I have contract with large-scale supermarkets
[____] I sell to larger producers who have better contacts with marketers.
Other (specify)_____

10. Of the mechanisms listed below, which you consider would result in a fair and stable price for producers in informal markets. Select the one that you think is most appropriate:

[____] Staggered plantings to avoid seasonal gluts
[____] Forming producer associations to market cooperatively
[____] Establish commercial companies to sell products.
[____] Establish agreements or contracts with vendorsin the wholesale markets.
[____] Use the marketing services of non-governmental organizations

Other (specify)_____

11. To improve business relations between producers and marketers of fruits and vegetables, do you think the state could: (select the answer you consider most appropriate).

[___] Implement policies ensuring prompt payment to the producer.
[___] Establish stricter price control laws.
[___] Establish more collection centers.
[___] Establish business centers to facilitate contact between producers and marketers
[___] Provide training in agribusiness for producers and marketers.
Other (specify)_____

12. • Do you think that non-governmental organizations could improve relations between producer and distributor, by offering: (Select the answer you consider most appropriate)
[____] Agribusiness training for various segments of the distribution chain (producer, intermediary, carrier, wholesale buyer, supplier of inputs).
[____] Market intelligence to producers.
[____] Marketing services to producers.
[____] Improved relationships btween producer and marketer through trade fairs, business conferences, etc.
Other (specify)_____

13. Do you want to answer questions 14-19 related to research topics?
[____] Yes
[____] No

The next section (questions 14-19) will identify research needs in various subjects relevant to horticulture. Please select relevant responses for each question

14. Identify your area of research. Select all that apply to you

[___] Breeding
[___] Crop management, agronomy and physiology
[___] Water management in plant production
[___] Adaptation and management of protected agriculture crops
[___] Integrated management of pests and diseases
[___] Optimization of production systems
[___] Management of soil and nutrients
[___] Tissue Culture / Biotechnology
[___] Postharvest handling
[___] Food Engineering
[___] Sociology and Rural Development
[___] Agricultural Economics
[___] Policy Development
[___] Business Development / Market Access
[___] Extension and knowledge management
Other (specify)_____

15. Please rate the factors below in terms of importance to perform their work

	1	2	3	4	5	Don't know
Availability of funds for research	[____]	[____]	[____]	[____]	[____]	[____]
National system of research funding	[____]	[____]	[____]	[____]	[____]	[____]
Requests for research proposals	[____]	[____]	[____]	[____]	[____]	[____]
Ability to establish collaborative projects with advanced						

research institutes	[___]	[___]	[___]	[___]	[___]	[___]
Allocation of time by your institution for conducting Research	[___]	[___]	[___]	[___]	[___]	[___]
That your research addresses the rural development program for the region	[___]	[___]	[___]	[___]	[___]	[___]
That the results of your research are transferred to the end user	[___]	[___]	[___]	[___]	[___]	[___]
That your research stimulates innovation	[___]	[___]	[___]	[___]	[___]	[___]
That research is funded by private industry	[___]	[___]	[___]	[___]	[___]	[___]

Other (specify)_____

16. In your view, research priorities in management of pests and diseases should be. Select all that apply.
[___] Integrated pest and disease management
[___] Alternative methods for control of fruit fly (export crops)
[___] Alternative methods for control fruit fly (indigenous fruit and vegetable species)
[___] Population dynamics of introduced or migratory species
[___] Virus identification and management
[___] Thrips palmi
[___] Biological control of palm weevil (R palmarum)
[___] Lethal Yellowing of coconut
[___] Development of biological control agents
[___] Commercialization and accessibility of biological control agents
[___] Registration of pesticidess for fruits and vegetables
[___] Effect of mixed farming systems on pests and diseases
[___] Management of Fusarium in banana and plantain
[___] Anthracnose management alternatives
[___] Avocado root rot (Phytophthora cinnamomi)
[___] Rambutan Scale
Other (specify) _____

17. In your view, research on issues of Crop Production and Management should include:
[___] Management of crops under protected agriculture
[___] Development of new varieties adapted to climate change
[___] Development of an early warning system for climate changes
[___] Conservation and optimal management of soils
[___] Integrated Production Systems
[___] Sustainable production systems
[___] Availability of certified planting material
[___] Regulation of nurseries and seed distribution systems
[___] Optimization of irrigation and plant nutrition
[___] Resilience of production systems to climate change
Other (specify)_____

18. Biotechnology is conceptualized as the ability to develop useful products from biological organisms or derived from biological processes. In your view, research in Biotechnology should be directed to:

[___] Optimizing transformation and regeneration protocols
[___] Somatic embryogenesis in tree and palms species
[___] Development of genetically modified organisms (GMOs)
[___] Development of endophytic organisms to counter pests and diseases
[___] Development of low-cost tissue culture systems
[___] Developing bioles (sic)
[___] Use of microorganisms to control pests and diseases (fungi, bacteria, viruses)
Other (specify)_____

19. In postharvest research, the priority themes should be:
[___] Postharvest handling (cold chain, quarantine treatment, controlled atmosphere) of products indigenous to native to Central America with export potential
[___] Managing the cold chain for export products
[___] Low cost quarantine treatments
[___] Optimizing crop management to optimize postharvest quality
[___] Ensuring safety and defining Maximum Residue Limits for commercial agrichemicals
[___] Radiation treatments for export agriculture
[___] Development of processed products using native species
Other (specify)_____

20. These people might also be interested in taking the survey.
Name
Mail (email)
Name
Electronic Mail (email)
Name
Electronic Mail (email)
Name
Electronic Mail (email)
Name:
E-mail (email):

Dear colleagues, thank you very much for your time and dedication in completing the survey. Remember the results of this study will be available on the website of the Horticulture CRSP (Http://hortcrsp.ucdavis.edu/LAC/) in early April, 2013.

End of Survey

APPENDIX D: ANALYSIS OF WEB SURVEY

Análisis de los resultados de la encuesta.
7 personas solo contestaron las preguntas básicas
15 personas respondieron las preguntas de mercado
Sin discriminar por país, las variables que fueron consideradas como Extremadamente Limitantes se listan de mayor a menor:

Factors considered as extremely limiting by those surveyed

Acceso a crédito para los pequeños productores (as)
Costo del crédito para la agricultura
Disponibilidad del seguro agrícola
Costo del seguro agrícola
Acceso a mercados de exportación
Falta de programas del gobierno que apoyen la agricultura del pequeño productor (a)
Ingreso ilegal al país de productos agrícolas

Factors considered as very limiting by those surveyed:

Acceso a mercados formales
Falta de acceso a nuevas variedades resistentes a plagas y enfermedades
Acceso a información de mercados
Incremento de las poblaciones de plagas y enfermedades
Costo de tecnologías de riego
Calidad de asistencia técnica ofrecida a productores
Costo de productos biológicos para control de plagas y enfermedades
Distrito de riego público
Confianza y transparencia en la cadena de valor
Presencia de nuevas plagas y enfermedades en el cultivo
Asociatividad de productores (as)
Disponibilidad de tecnologías de riego
Disponibilidad de material de siembra certificado
Disponibilidad de productos biológicos para control de plagas y enfermedades

Factores considered as limiting by those surveyed:

Incremento en las lluvias
Períodos prolongados de falta de lluvias
Capacidad tecnica de los productores
Inundaciones en los campos de producción
Deslices de tierra y bloqueo de vías de acceso
Costo de insumos químicos
Disponibilidad de tierras aptas para la agricultura
Cultura asistencialista de programas de desarrollo en la región
Politica de pago de los mercados formales
Seguridad en la tenencia de la tierra (invasiones, expropiaciones)

Those surveyed were asked to rank the factors that were most relevant for them to perform their work.

Factors ranked as extremely important by those surveyed:

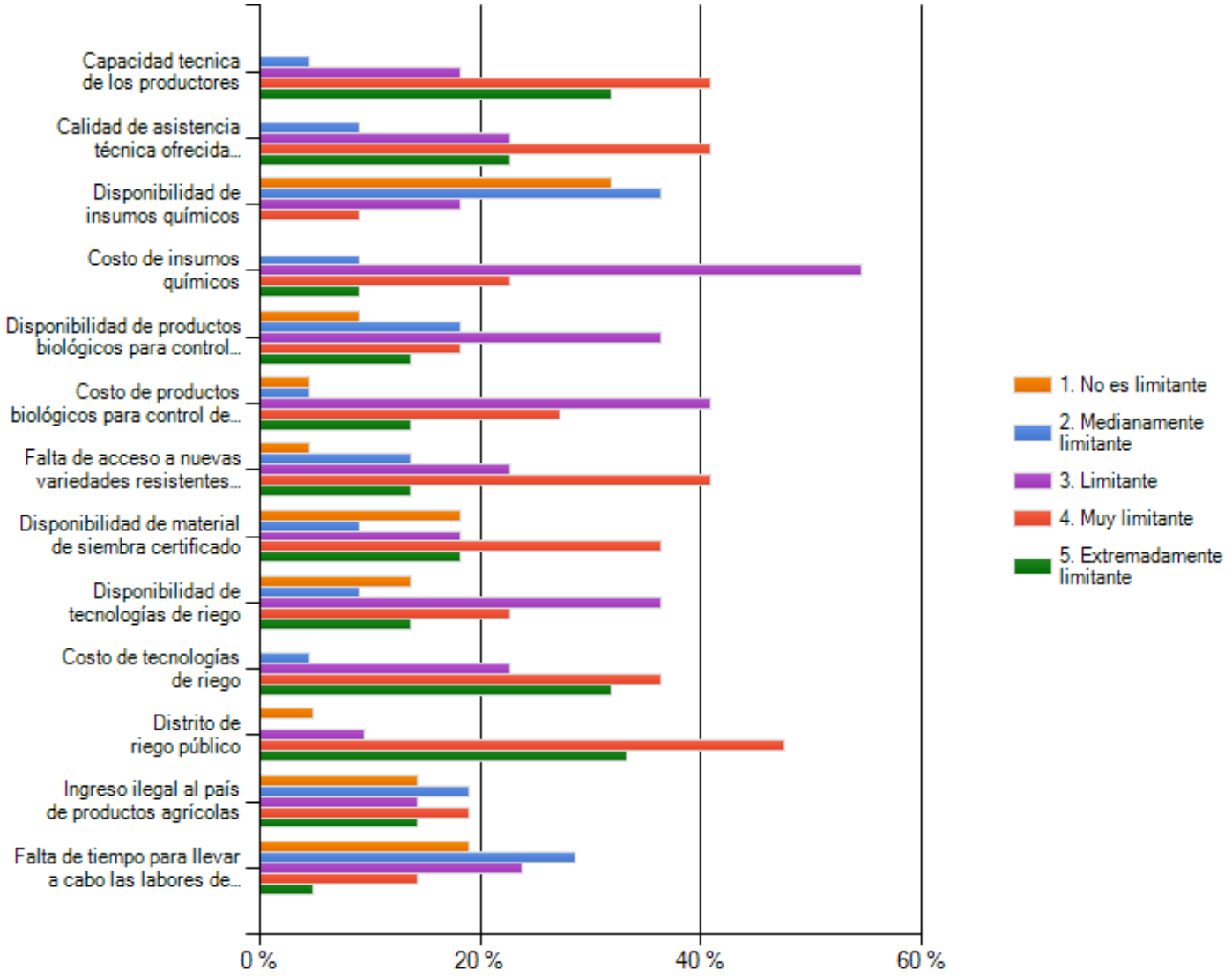
Que los resultados de su investigación sean transferidos al usuario final
Disponibilidad de fondos para la investigación
Que la investigación que realiza de origen a procesos de innovación
Que la investigación que realiza responda a los programa de desarrollo rural en la región
Sistema nacional de financiación de la investigación
Asignación de tiempo por parte de su institución para realizar investigación

Factors ranked as very important by those surveyed:

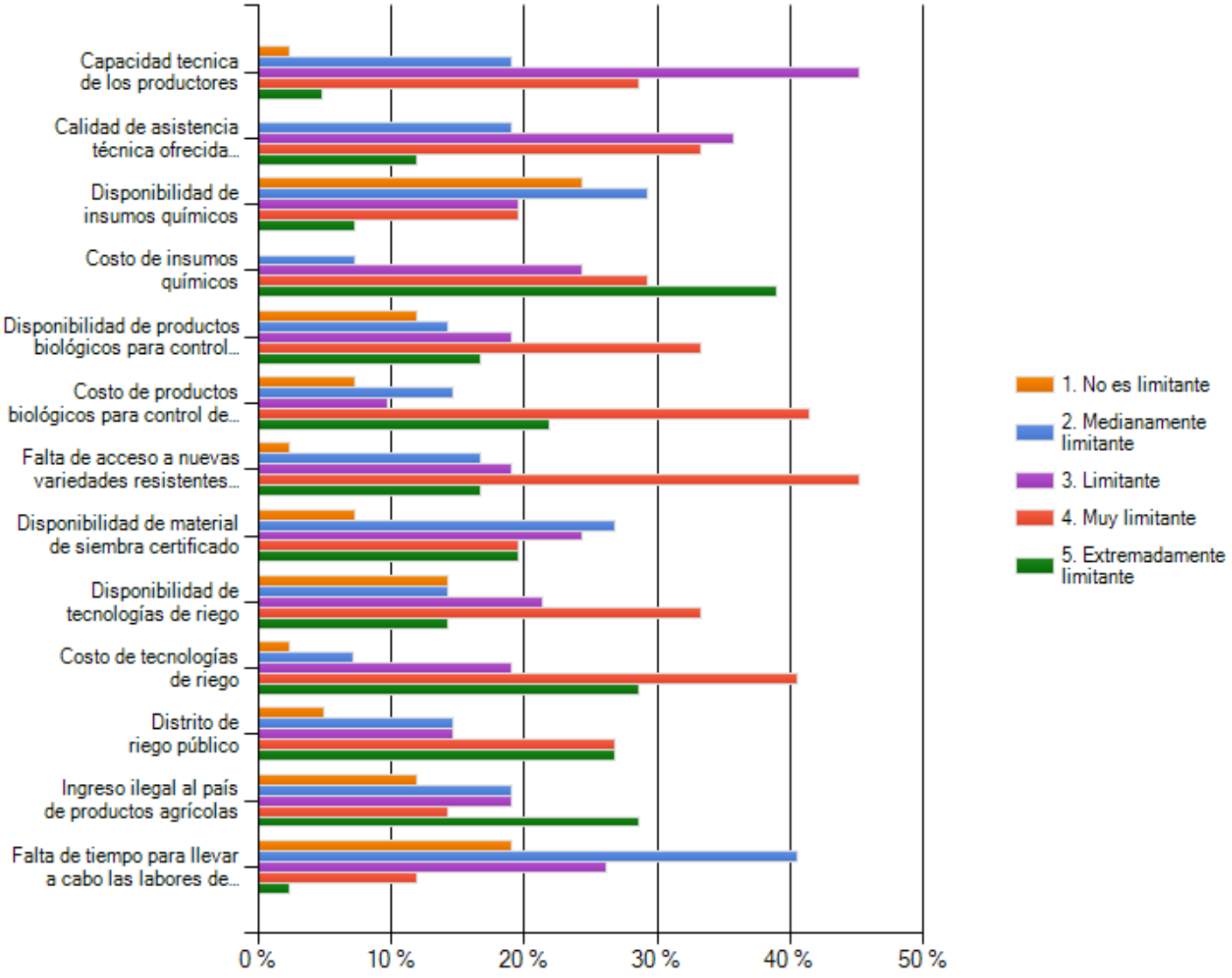
Llamadas a financiación de proyectos de investigación
Capacidad para establecer proyectos colaborativos con institutos de investigación avanzada

APPENDIX E: SURVEY RESPONSES

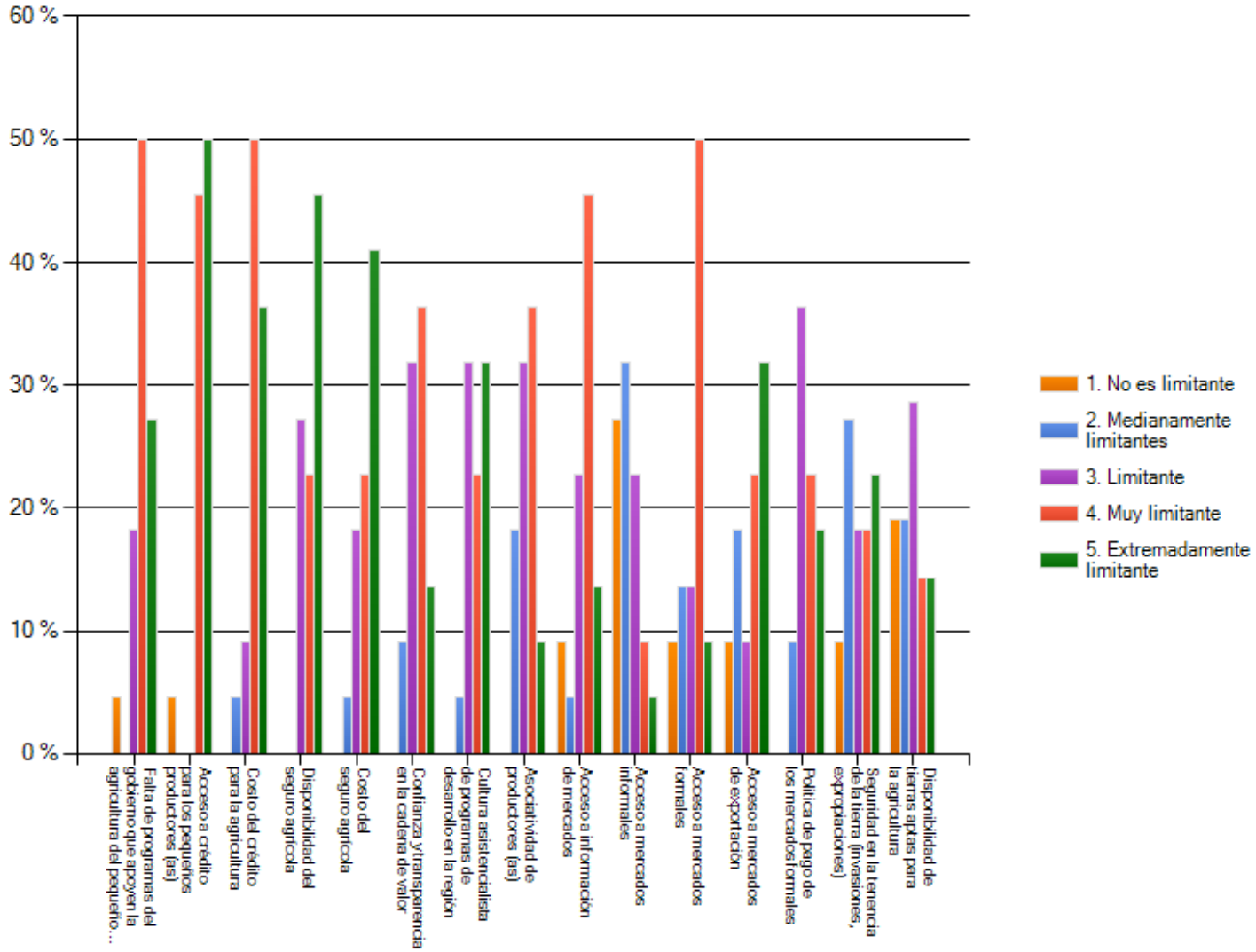
Q5 Guatemala



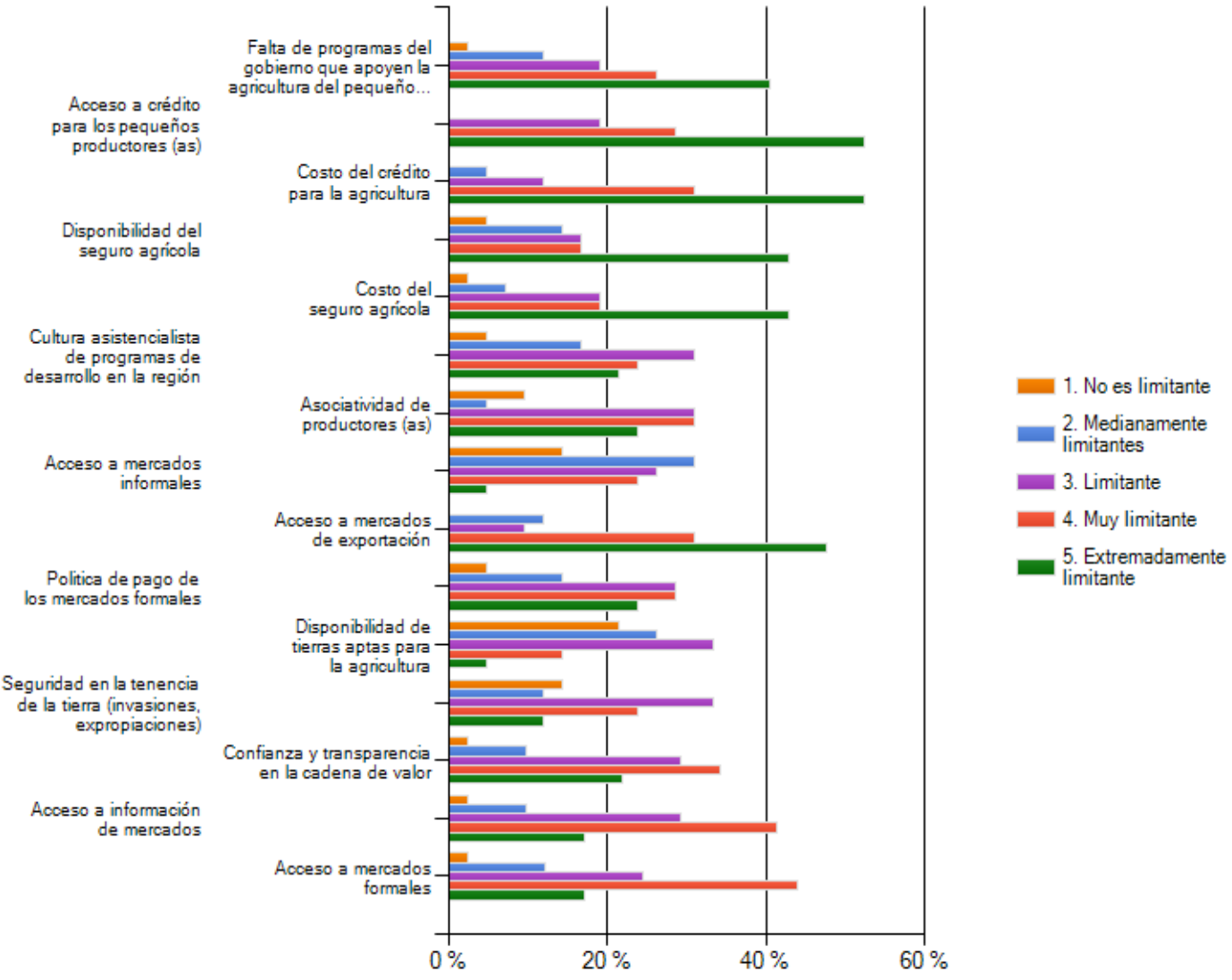
Q5 Honduras


Capacidad tecnica de los productores
Calidad de asistencia técnica ofrecida...
Disponibilidad de insumos químicos
Costo de insumos químicos
Disponibilidad de productos biológicos para control...
Costo de productos biológicos para control de...
Falta de acceso a nuevas variedades resistentes...
Disponibilidad de material de siembra certificado
Disponibilidad de tecnologías de riego
Costo de tecnologías de riego
Distrito de riego público
Ingreso ilegal al país de productos agrícolas
Falta de tiempo para llevar a cabo las labores de...
0 %
10 %
20 %
30 %
40 %
50 %
1. No es limitante
2. Medianamente limitante
3. Limitante
4. Muy limitante
5. Extremadamente limitante

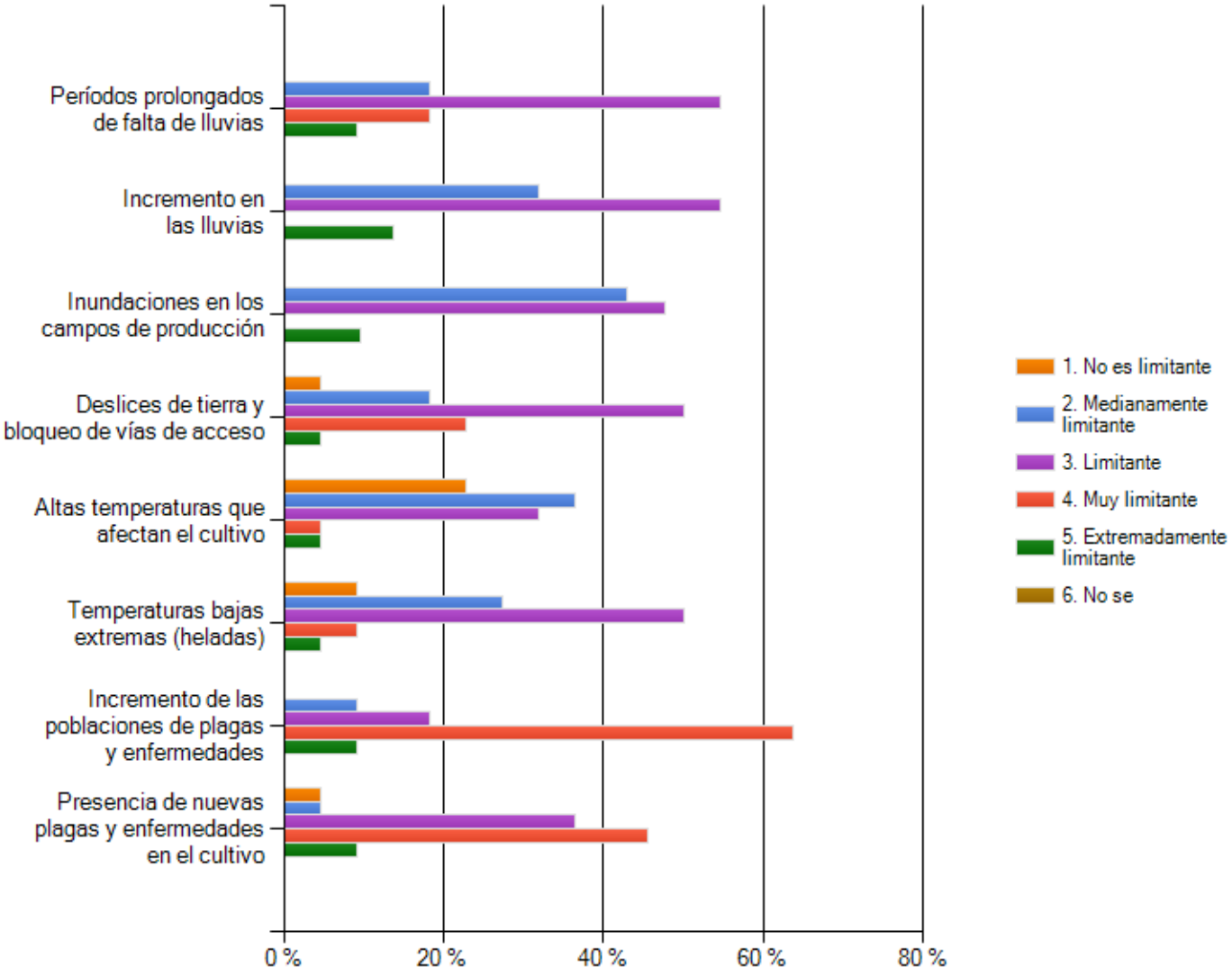
Q6 Guatemala



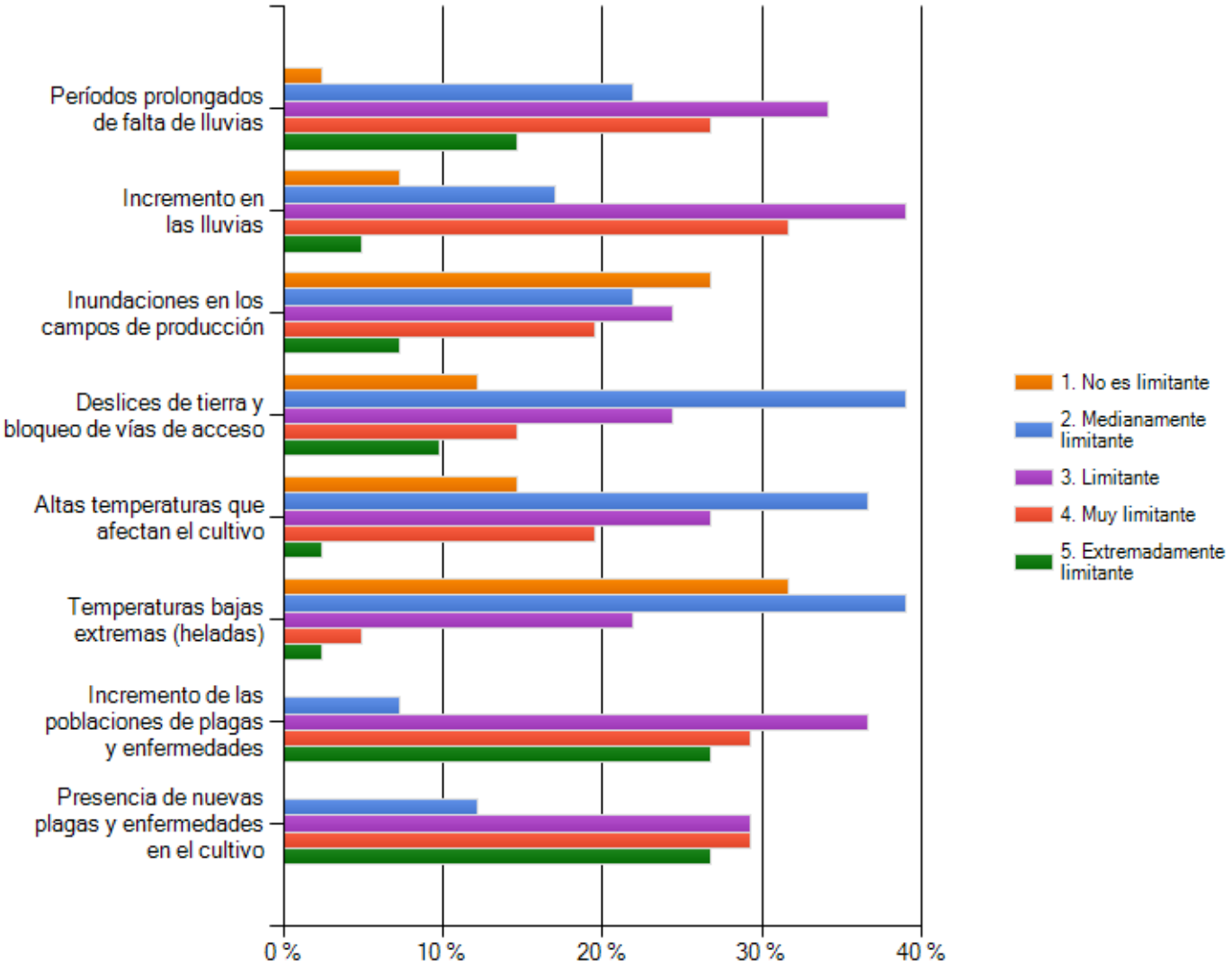
Q6 Honduras


Falta de programas del gobierno que apoyen la agricultura del pequeño...
Acceso a crédito para los pequeños productores (as)
Costo del crédito para la agricultura
Disponibilidad del seguro agrícola
Costo del seguro agrícola
Cultura asistencialista de programas de desarrollo en la región
Asociatividad de productores (as)
Acceso a mercados informales
Acceso a mercados de exportación
Política de pago de los mercados formales
Disponibilidad de tierras aptas para la agricultura
Seguridad en la tenencia de la tierra (invasiones, expropiaciones)
Confianza y transparencia en la cadena de valor
Acceso a información de mercados
Acceso a mercados formales
0 %
20 %
40 %
60 %
1. No es limitante
2. Medianamente limitantes
3. Limitante
4. Muy limitante
5. Extremadamente limitante

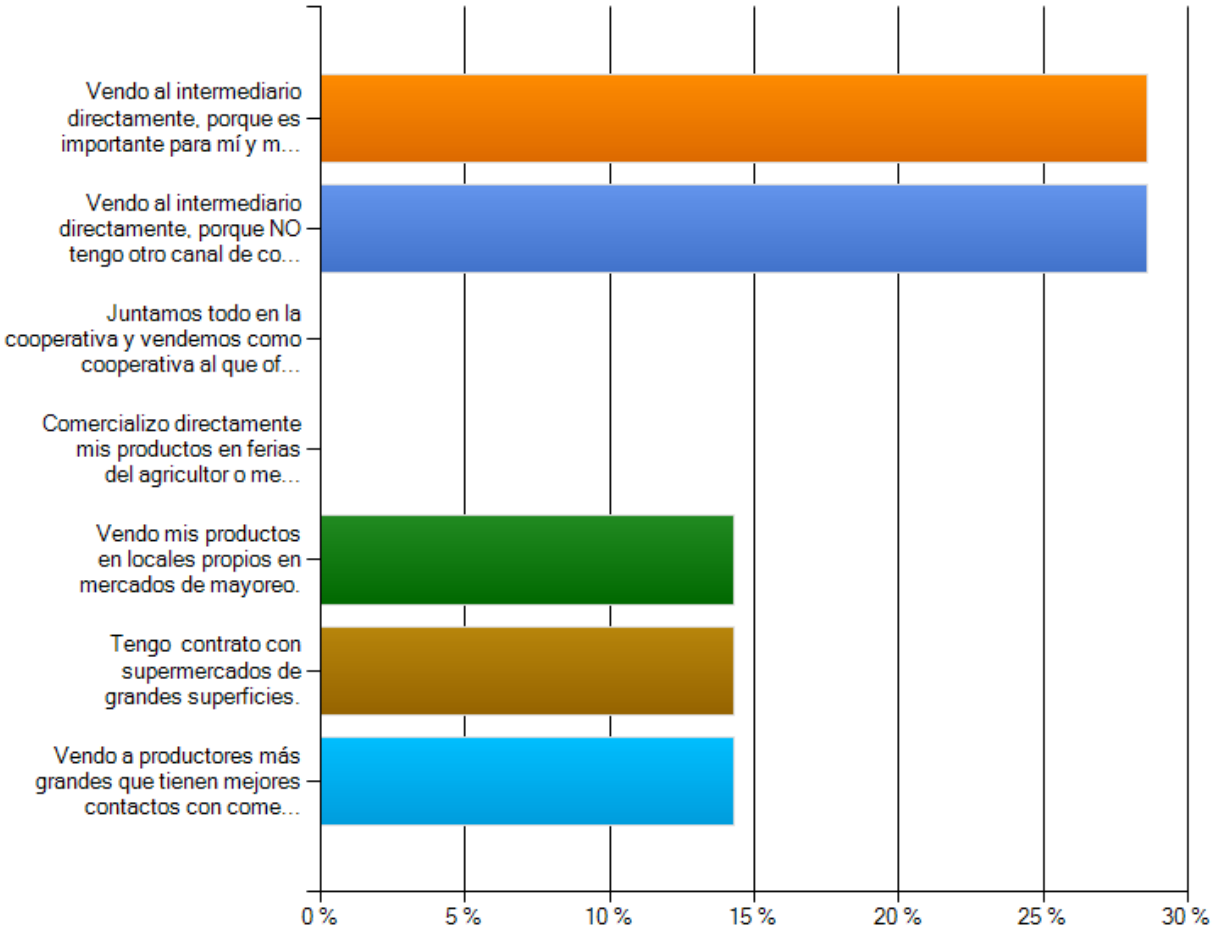
Q7 Guatemala



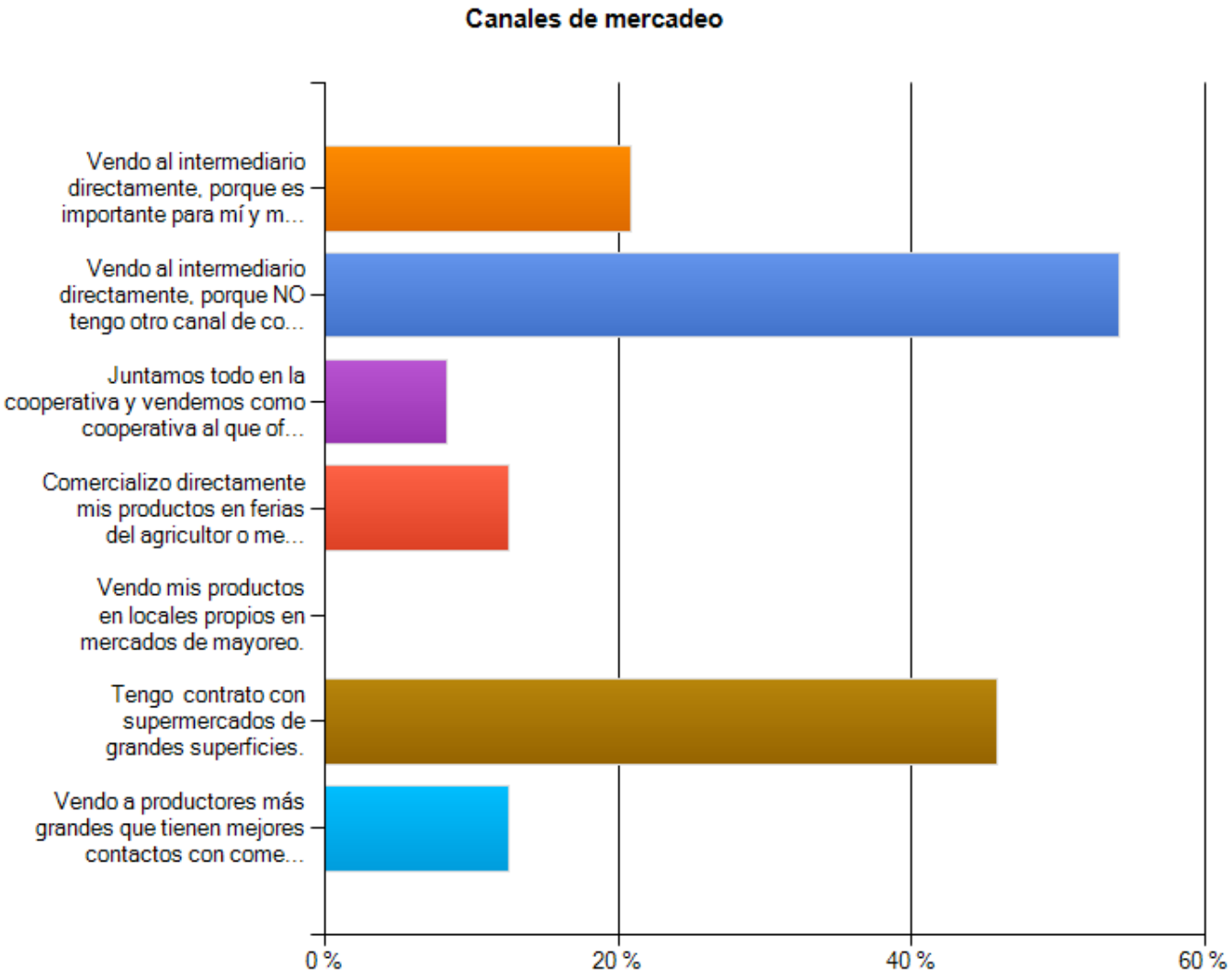
Q7 Honduras


Períodos prolongados de falta de lluvias
Incremento en las lluvias
Inundaciones en los campos de producción
Deslices de tierra y bloqueo de vías de acceso
Altas temperaturas que afectan el cultivo
Temperaturas bajas extremas (heladas)
Incremento de las poblaciones de plagas y enfermedades
Presencia de nuevas plagas y enfermedades en el cultivo
0 %
10 %
20 %
30 %
40 %
1. No es limitante
2. Medianamente limitante
3. Limitante
4. Muy limitante
5. Extremadamente limitante

Q9 Guatemala

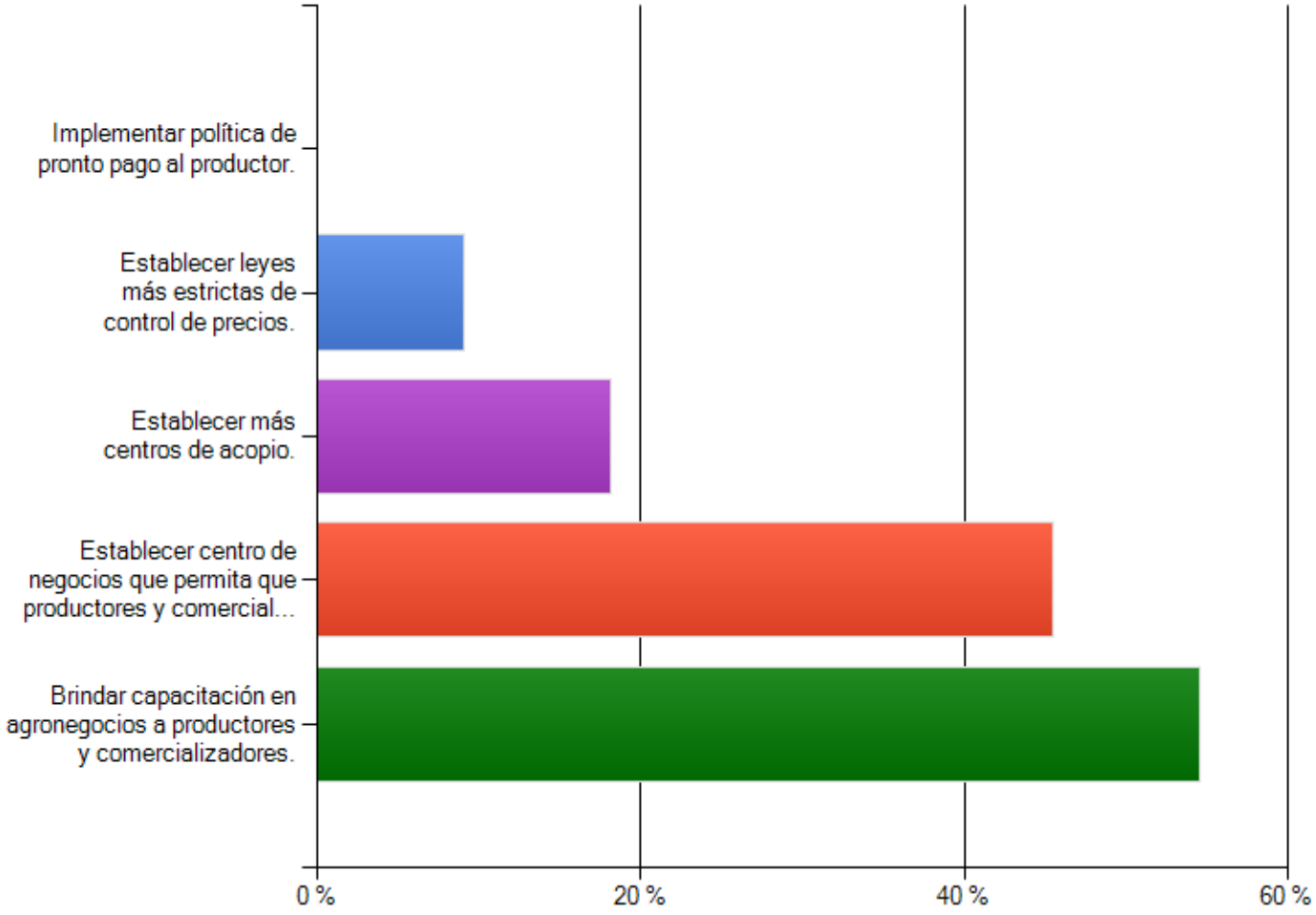


Q9 Honduras

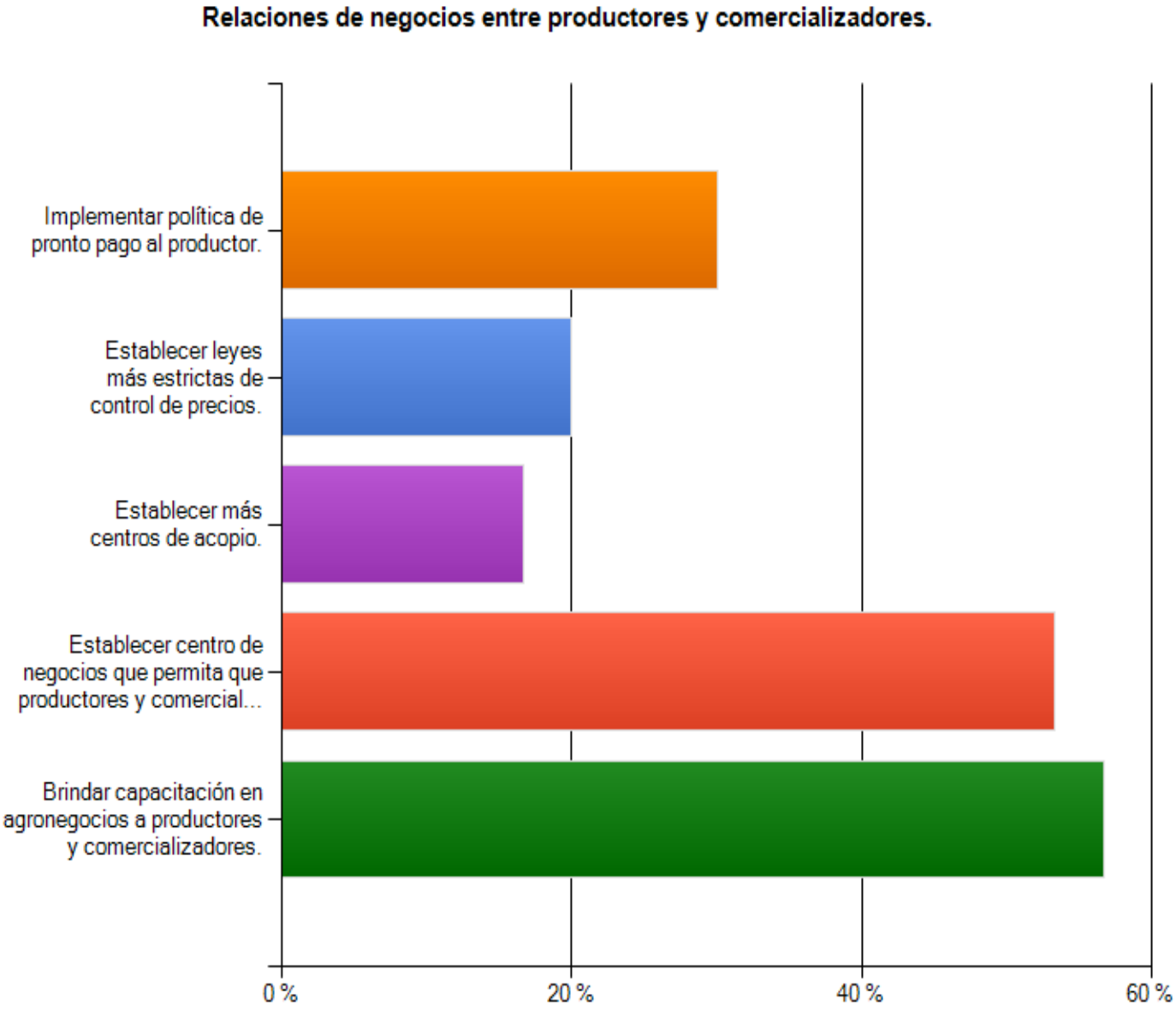

Canales de mercadeo
Vendo al intermediario directamente, porque es importante para mí y m...
Vendo al intermediario directamente, porque NO tengo otro canal de co...
Juntamos todo en la cooperativa y vendemos como cooperativa al que of...
Comercializo directamente mis productos en ferias del agricultor o me...
Vendo mis productos en locales propios en mercados de mayoreo.
Tengo contrato con supermercados de grandes superficies.
Vendo a productores más grandes que tienen mejores contactos con come...
0 %
20 %
40 %
60 %

Q11 Guatemala

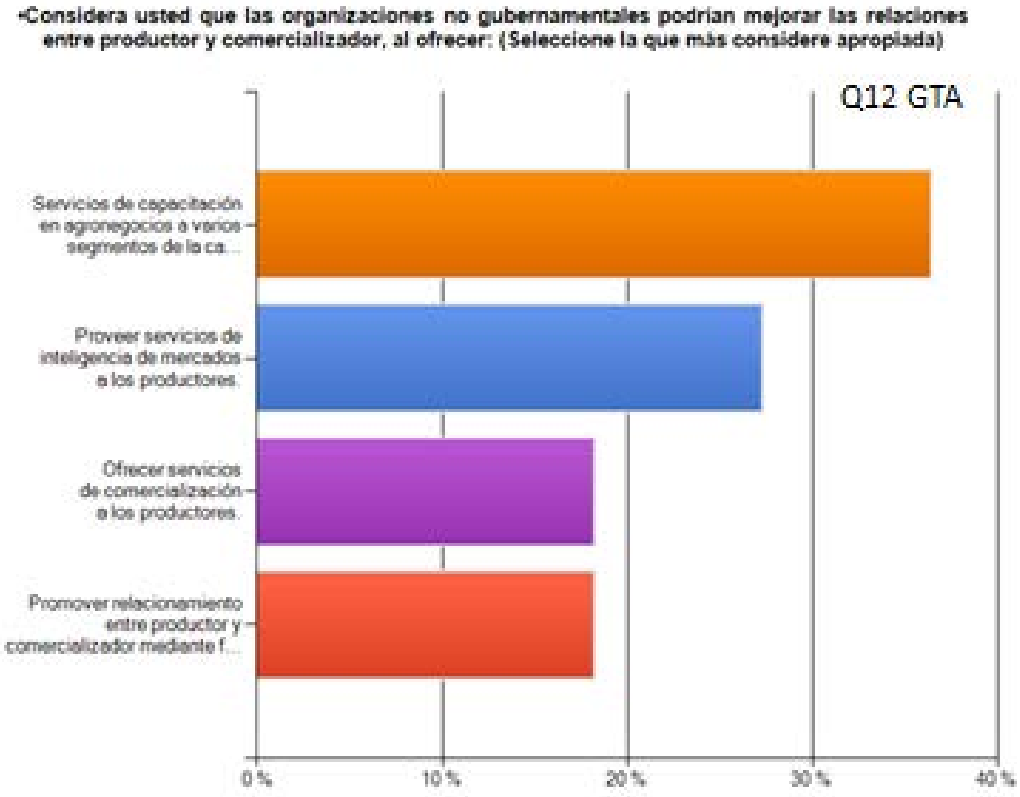
Para mejorar las relaciones de negocios entre productores y comercializadores de frutas y hortalizas, cree usted que el Estado podría: (Seleccione las respuestas que considere apropiadas).



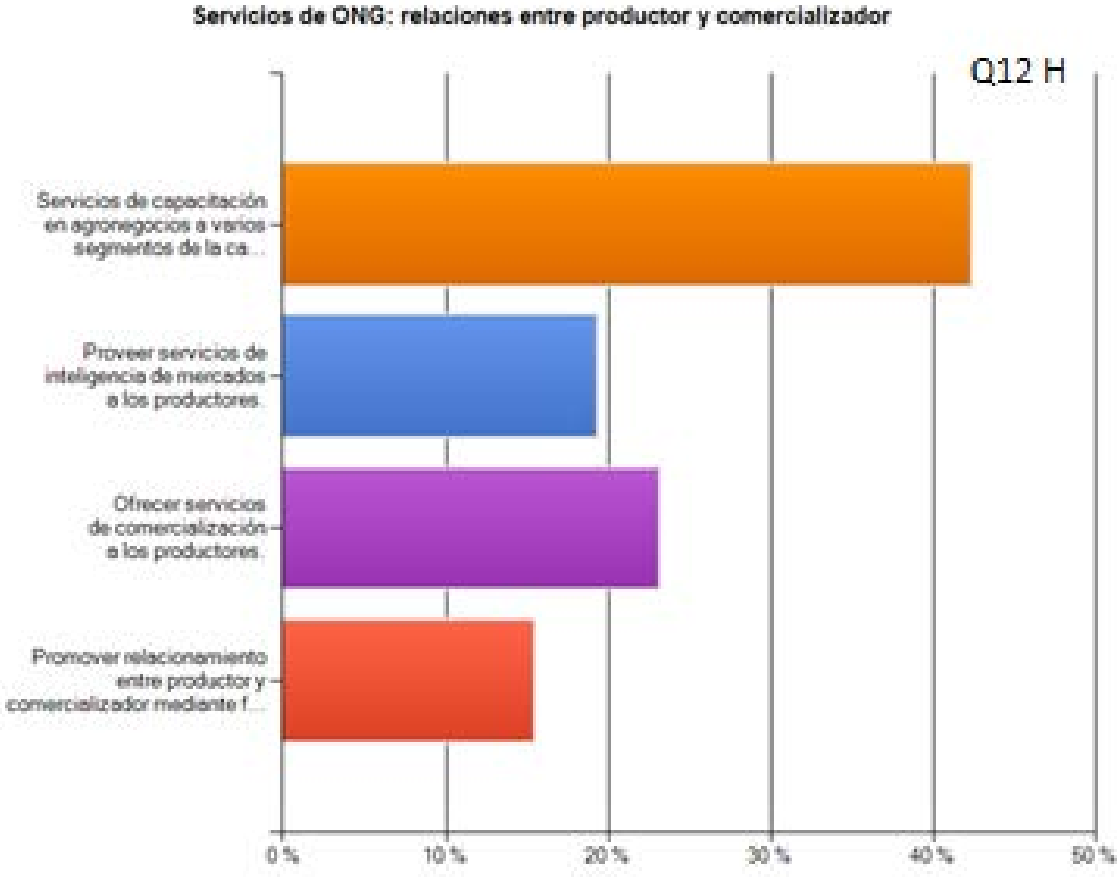
Q11 Honduras



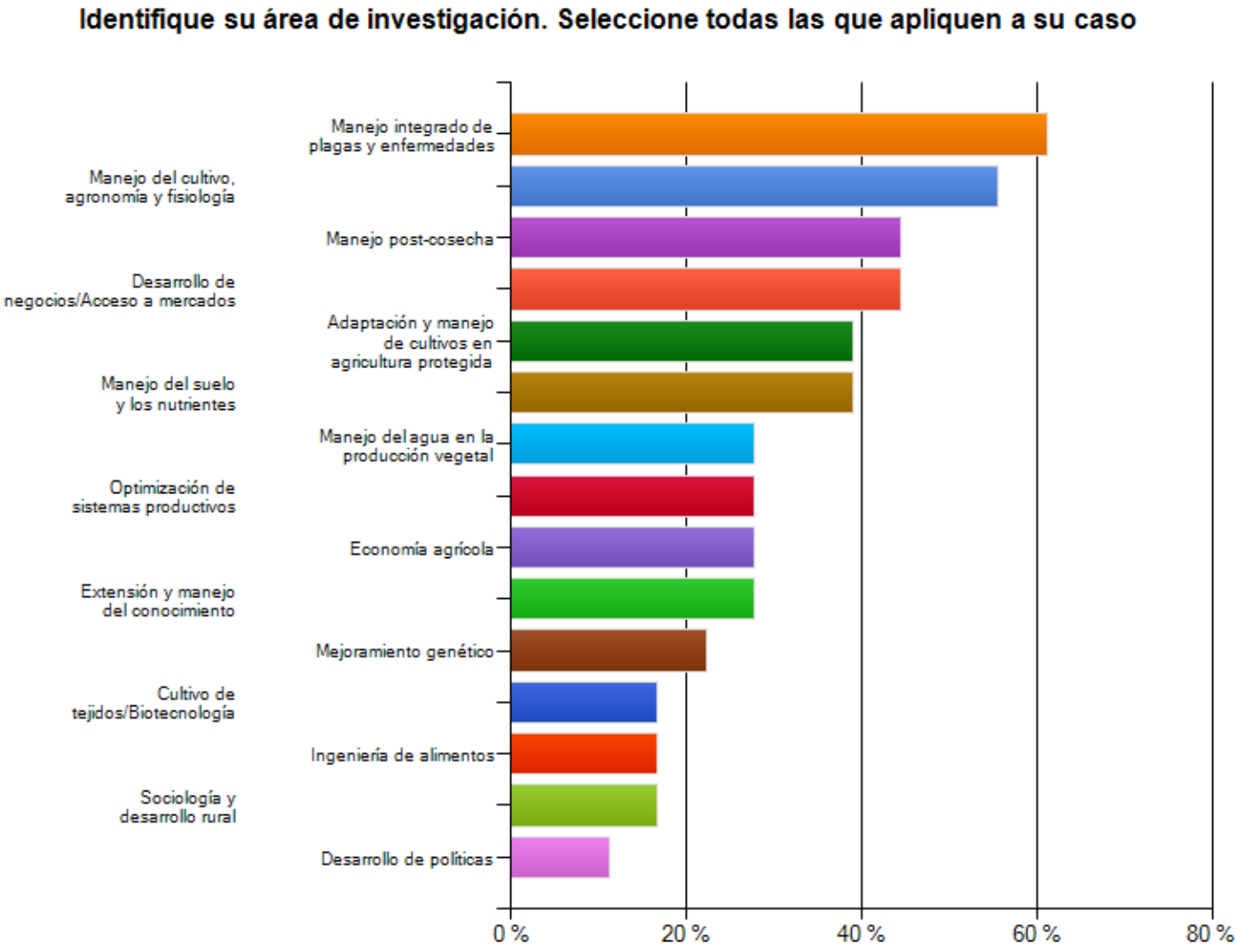
Q12 Guatemala



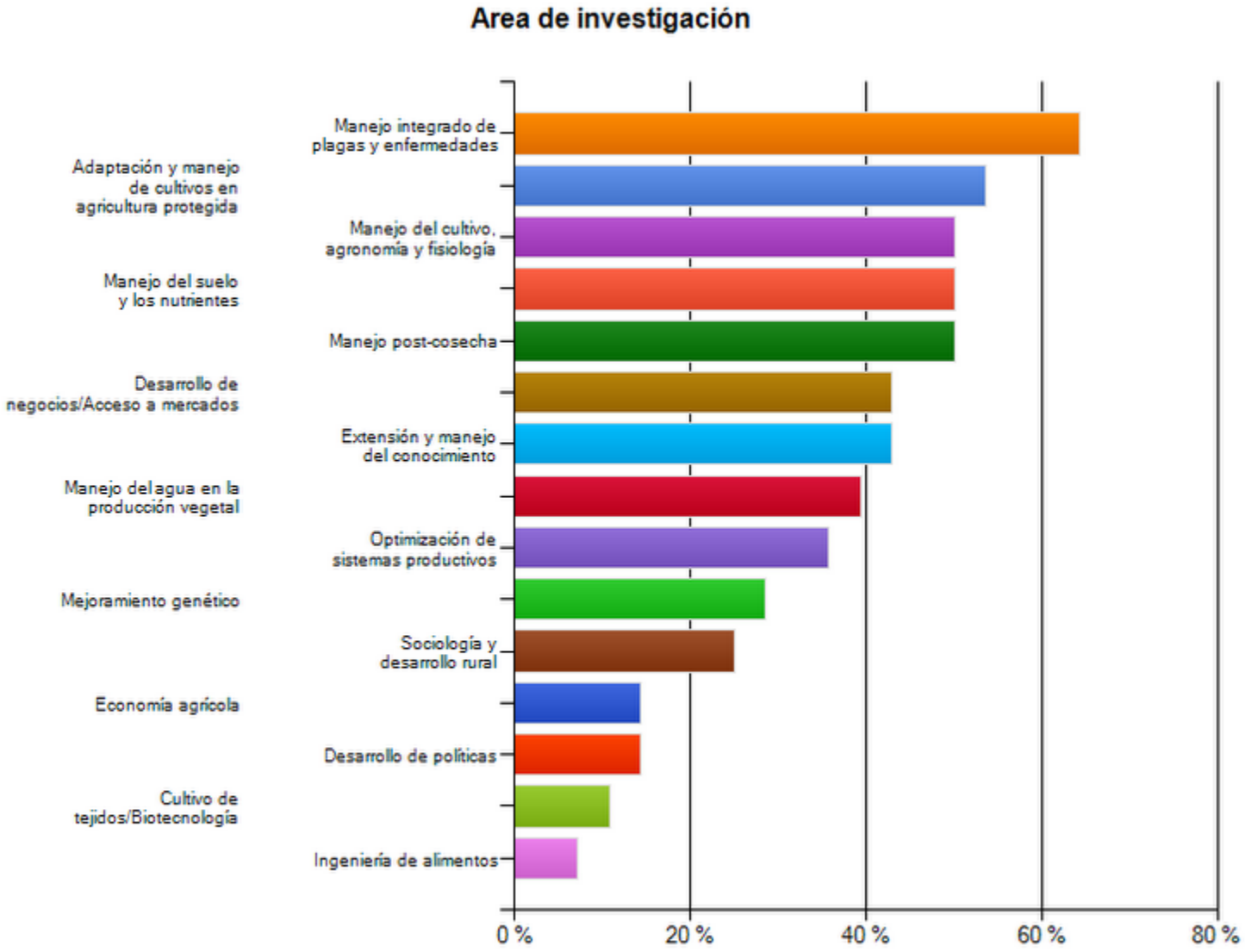
Q12 Honduras



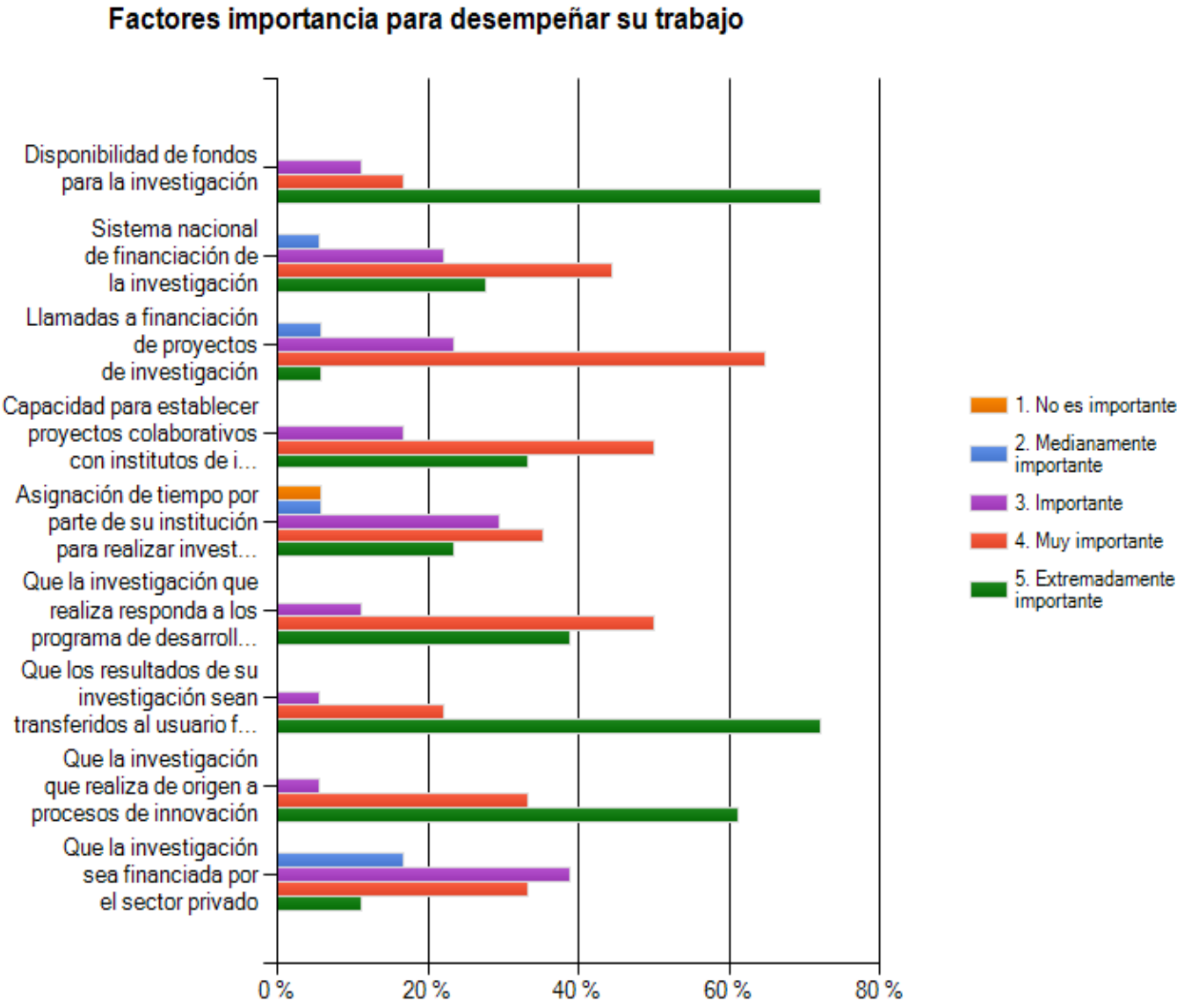
Q14 Guatemala



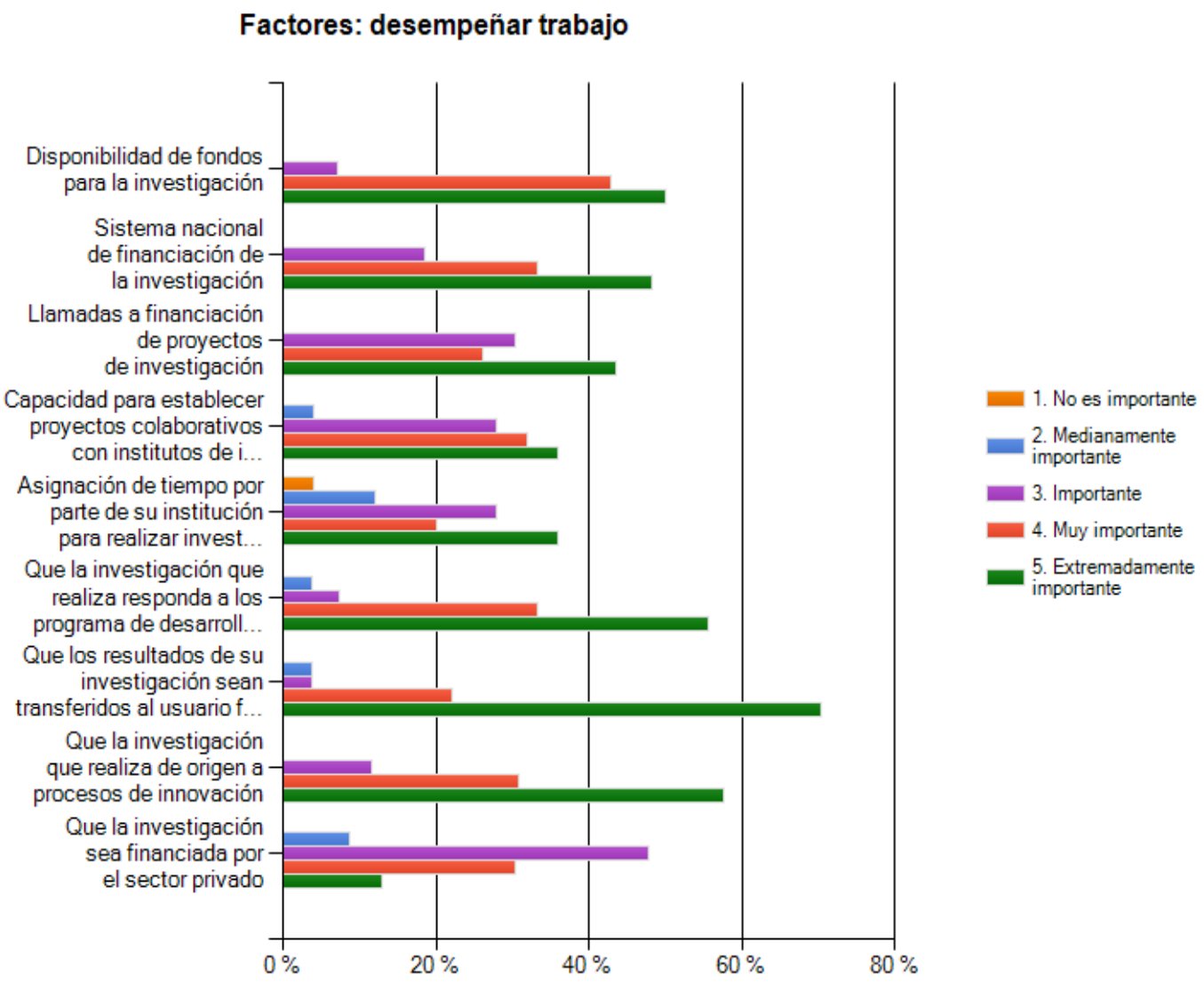
Q14 Honduras



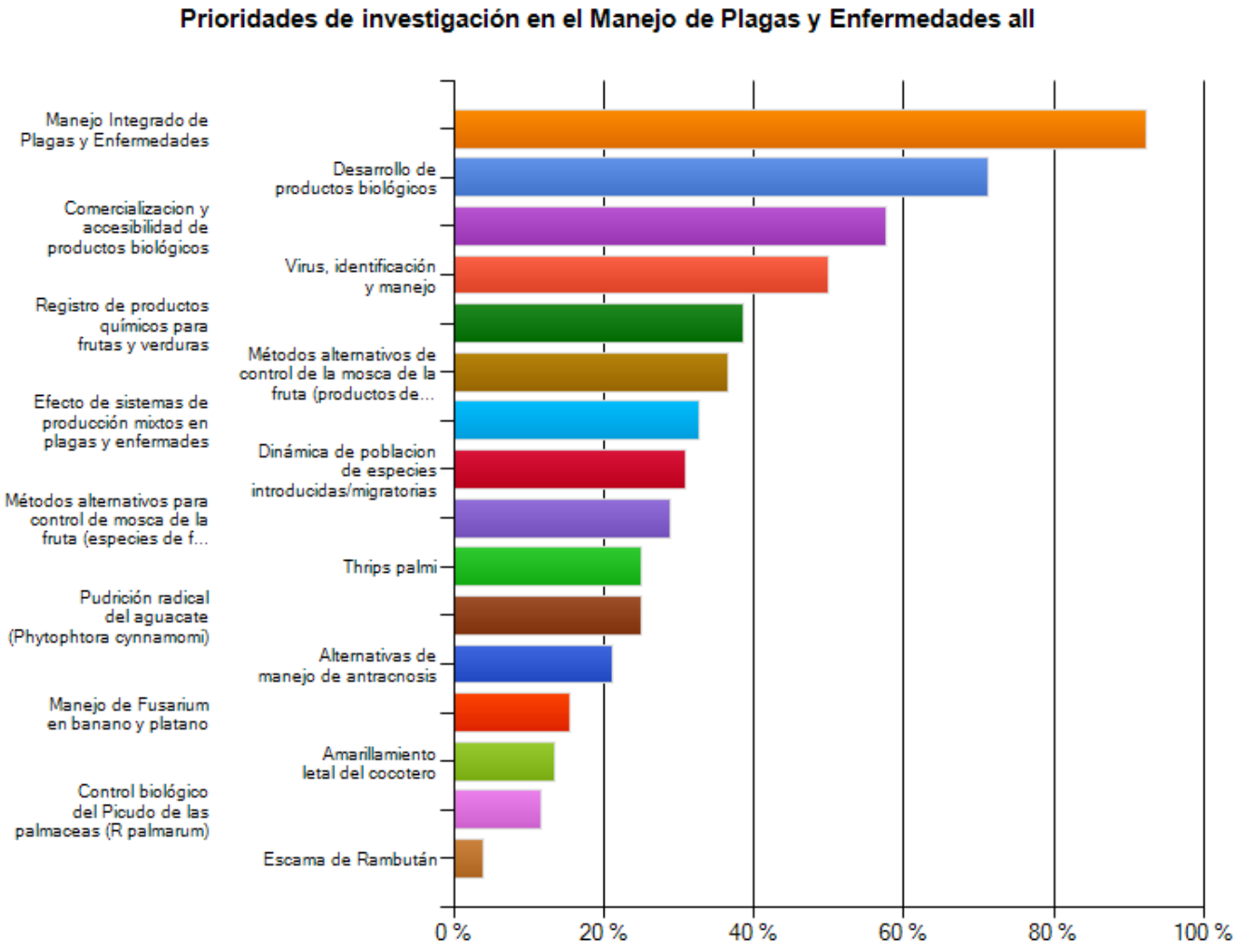
Q15 Guatemala



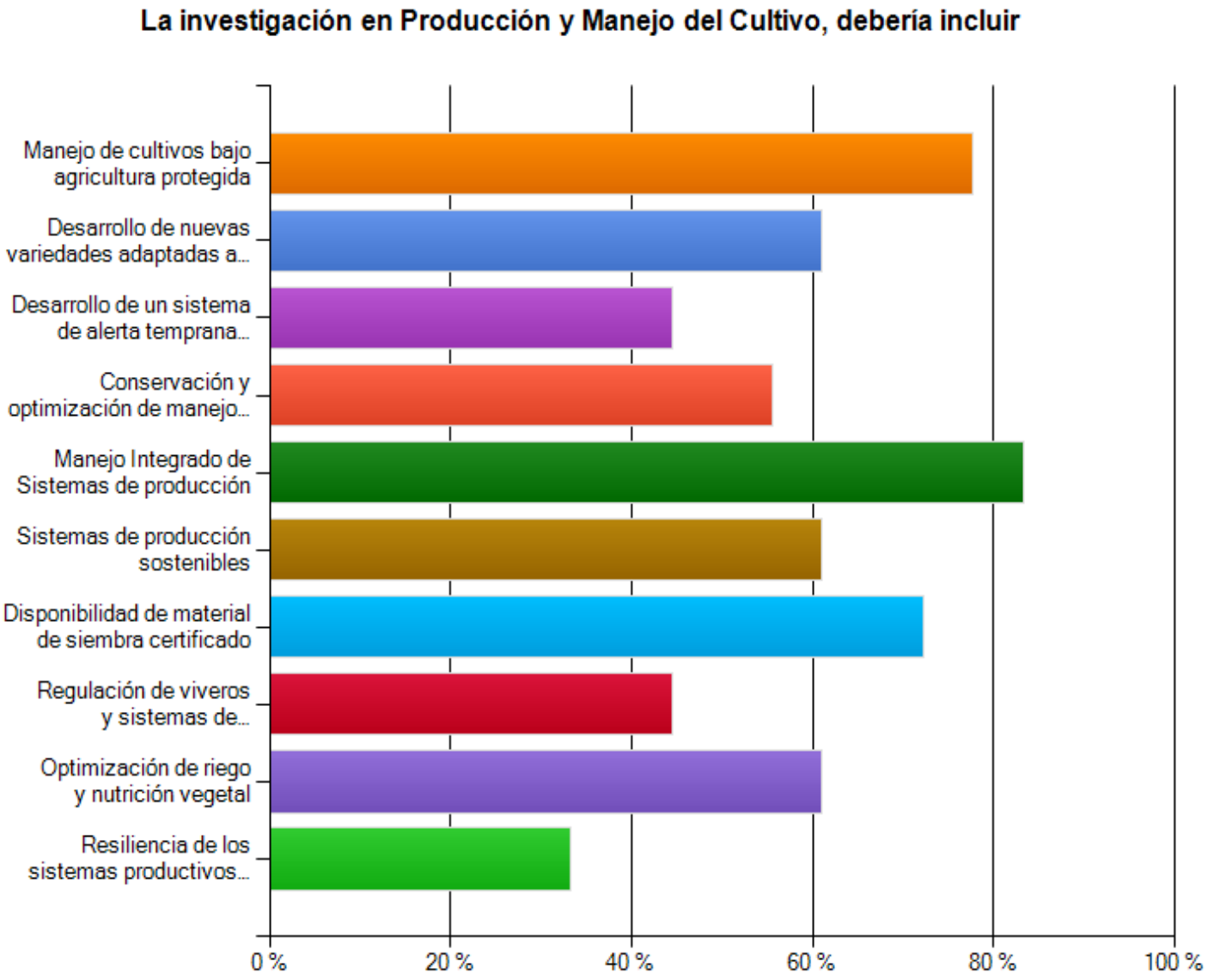
Q15 Honduras



Q16 Both Countries

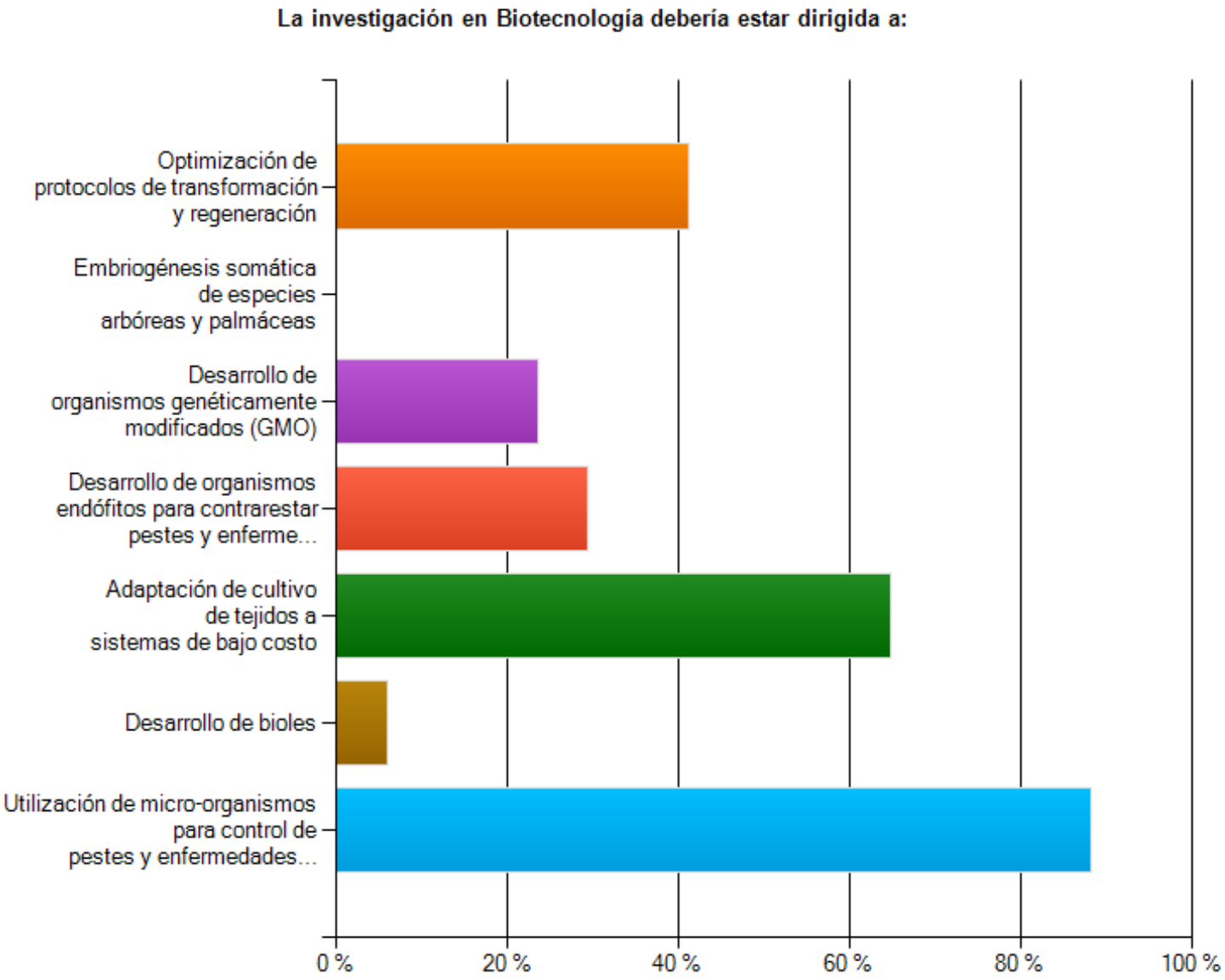


Q17 Guatemala

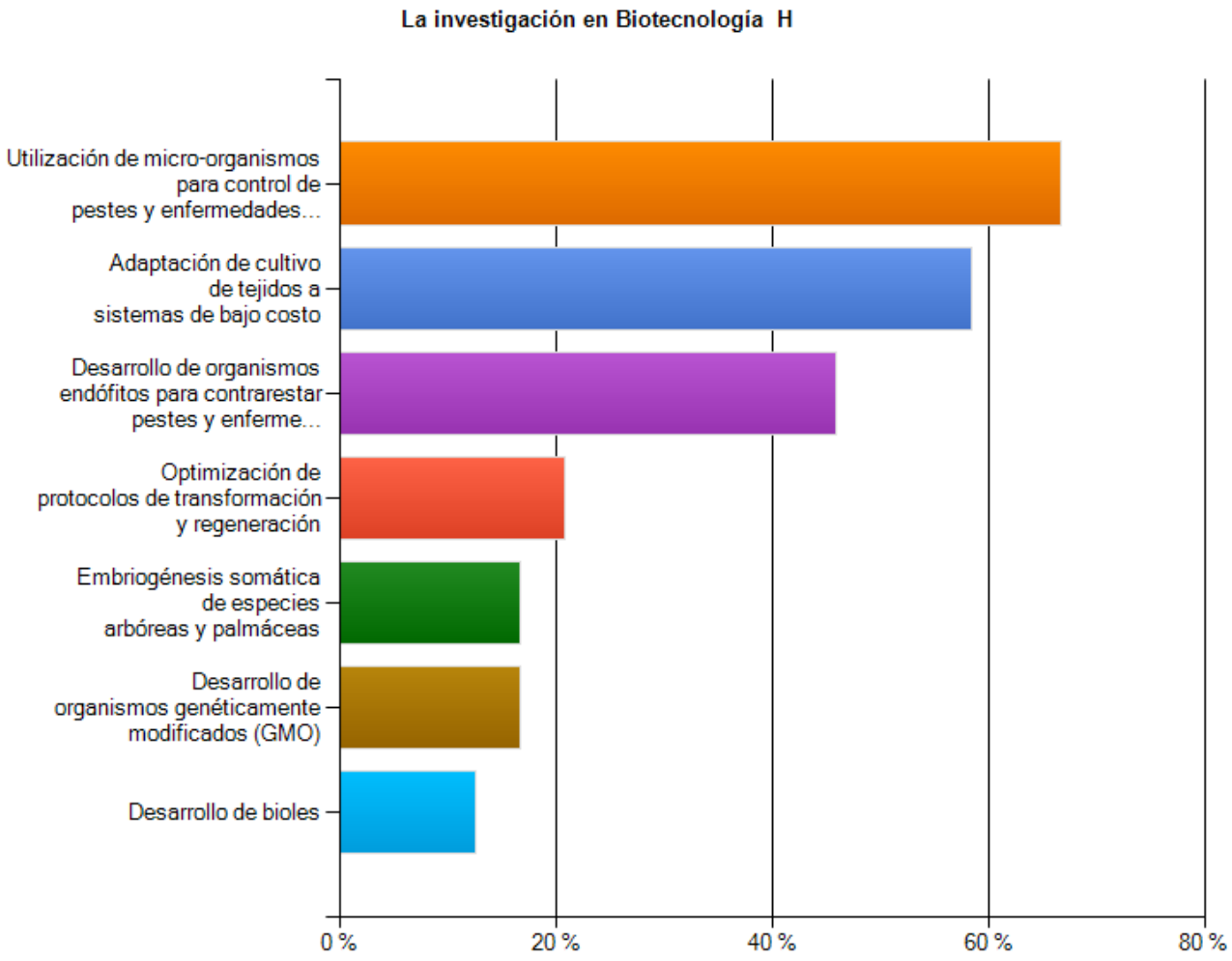


Q17 Honduras

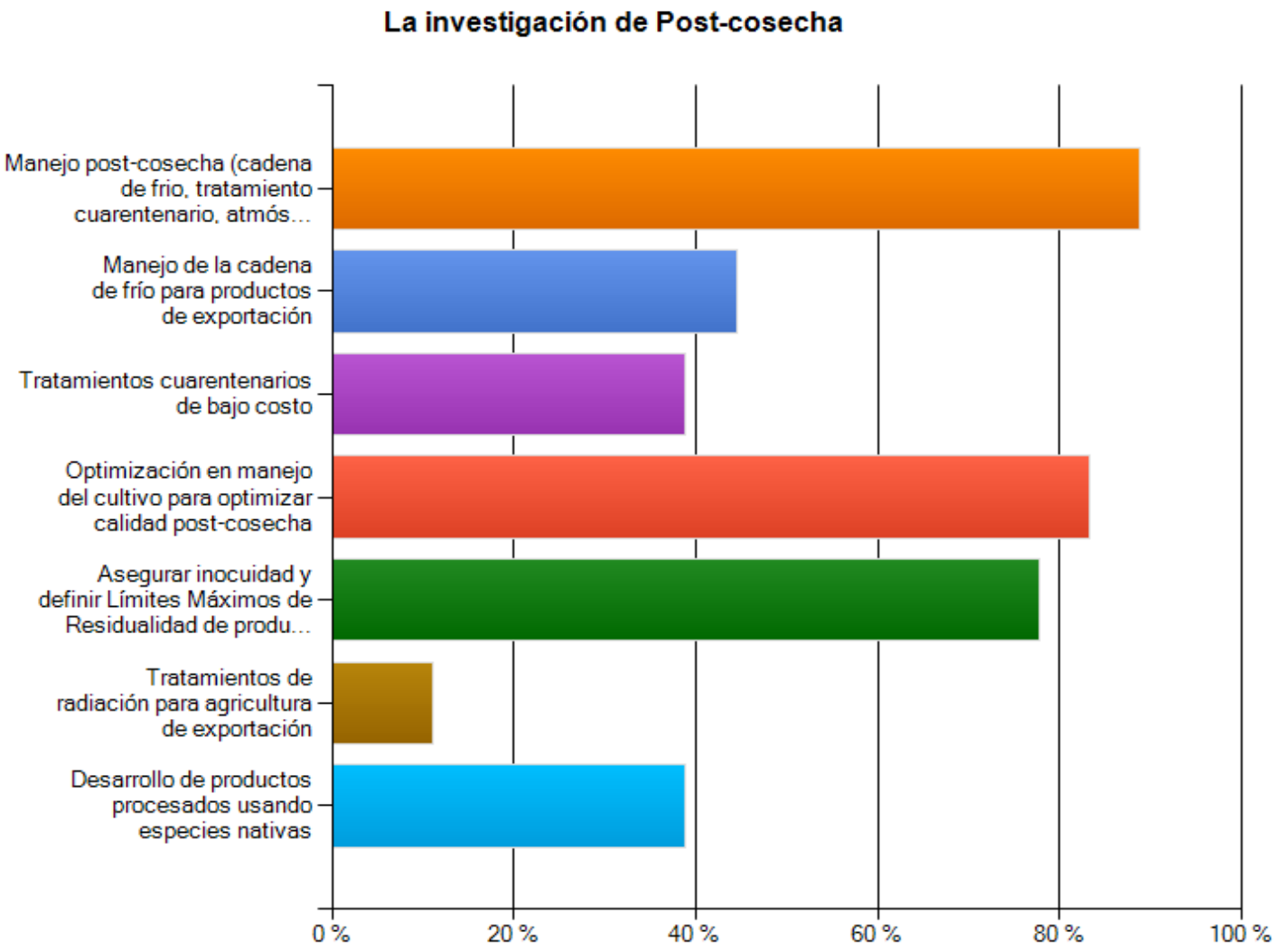
Q18 Guatemala



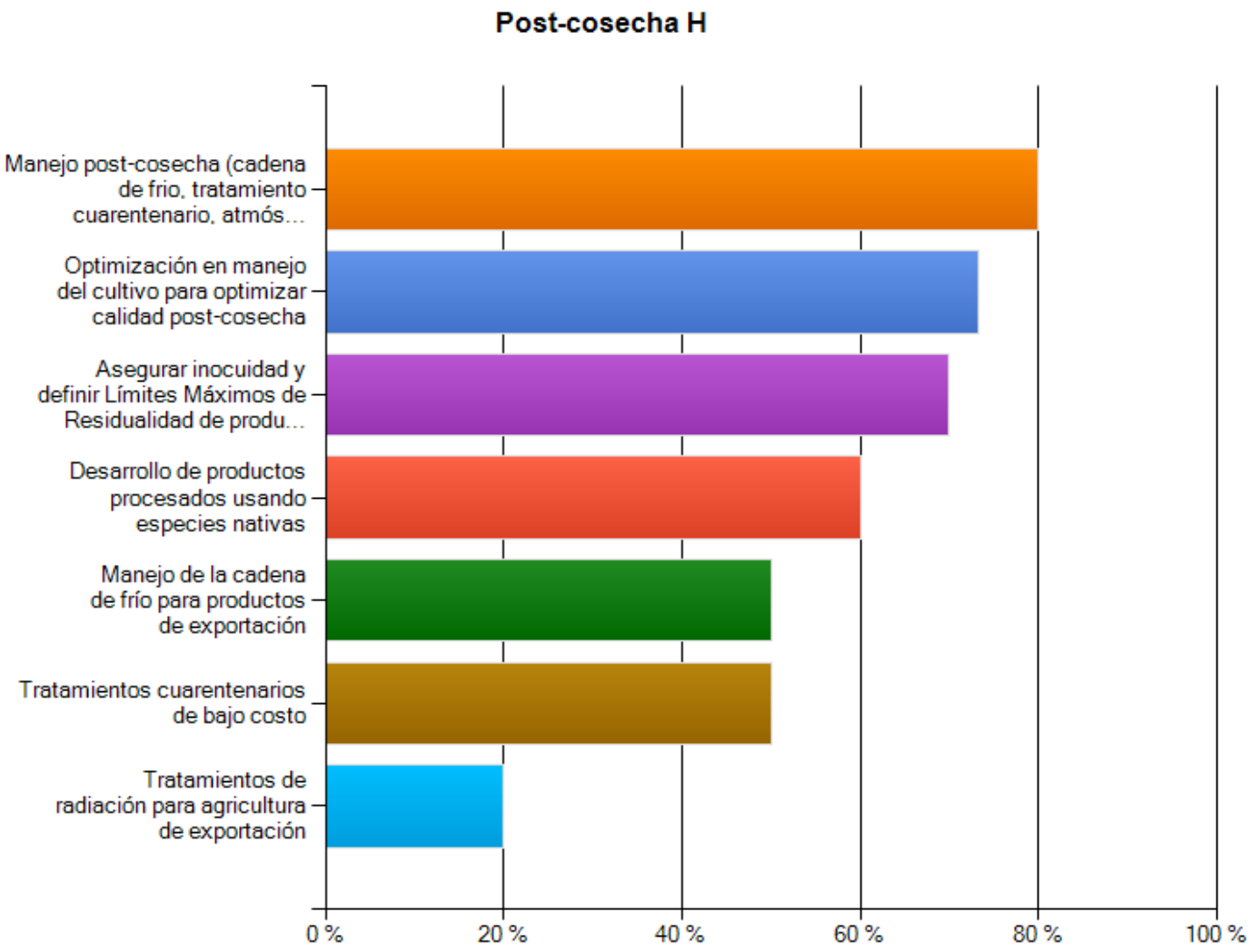
Q18 Honduras



Q19 Guatemala



Q19 Honduras



APPENDIX F: CROP-SPECIFIC RESEARCH NEEDS AS IDENTIFIED BY AGEXPORT, GUATEMALA

The export industry, with the support of AGExport, identified the sanitary and phytosanitary research needs for horticultural crops in Guatemala in 2012 (Agenda de Investigación e Innovación para atender problemas fitosanitarios y diseño de dos protocolos en el marco del Programa Integral de Protección Agrícola y Ambiental PIPAA). The analysis was conducted on two vegetables (tomato and snow peas), five fruits (avocado, Persian lemon, Andean berries (mora), mango, melon and rambutan; five ornamental types (foliage, cut flowers, stem and leaf cuttings, stems, orchids and other epiphytes), as well as in some differentiated products (cacao, coffee, honey, cardamom).

The needs were identified through interviews, survey and consultation with crop experts. Below, those problems encountered on crops relevant to the LAC Assessment report are presented.

VEGETABLES:

Snow Peas (*Pisum sativum*)

- *Fussarium oxysporum*
- Thrips (*Frankliniella* sp.) and leaf miner (*Lyriomiza huidobrensis*)
- Pesticide above MRL found in shipments to the United States and Europe
- Varieties susceptible to pests and diseases
- Trade concentrated mostly on United States (70%) and Europe (20%)
- Planting density is not appropriate and reduce productivity
- Nutrition is generic and do not consider crop phenology
- Irrigation recommendations are lacking
- Crop information

Tomato (*Lycopersicum esculentum*)

- *Clavibacter michiganensis* in seeds
- Thrips in greenhouses
- Bactericera (*Paratrioza*) cockerelli (Homoptera: *Psyllidae*)
- Tuta absoluta (Lepidoptera: *Gelichidae*)
- Producer organizations are needed

DIFFERENTIATED PRODUCTS:

Cardamom

- Lack of recommendations for fertilization
- Crops are based on a mix of varieties of low productivity
- Socio-economic information of communities involved is lacking
- GAPs and GMPs are not implemented by producers and processors. High risk for bacterial contamination
- Fruit drying is conducted on energy inefficient wood ovens. Increases pressure for deforestation and costs
- Shade management require tuning for Guatemala conditions

- Growers have almost no formal education and production is based on empirical practices. Producers are not organized and selling price sometimes drop below production costs.
- Diseases are starting to put pressure on crops

FRUITS:

Avocado (*Persea americana*)- Focus on variety Hass

- Lack of knowledge on prevalent pests in avocado
- Ovary fly, mites and Thrips
- Low productivity due to ringed peduncle
- Need to know water requirements of avocado trees
- Lack of suitable rootstocks (disease, drought, soil constraints)
- Industrial use of Criollo varieties is unknown
- Nutritional requirements are not clearly established in Guateamala
- Need to create certified nurseries that provide good genetic material to growers
- No access to standardized production manual for Hass in Guatemala

Citrus x latifolia (Tahiti lime)

- Management alternatives for : White mite (*Poliphagotharsonemus latus*) y Red mite (*Tetranychus urticae*); Fumagina (*Capnodium citri) / Aleurocanthus wlogumi*; Escales (Diaspididae); Citrus Tristeza Virus (CTV) and its vector *Toxoptera citricidus*
- Methods to improve fruit quality for exporting to Europe. Fruits are yellow-green and should be dark green
- Flowering control to cover months of high demand
- Training and Education (technical assistance and manuals)
- Certified nurseries
- Tactics to prepare for HLB

Mora (*Rubus glaucus*)

- Thrips main quarantine pest (90%)
- Use of non-permitted insecticides and fungicides (MRL)
- *Peronospora* sp and *Botrytis* sp affect fruits

Mango (*Mangifera indica*)

- Lack of GAP and HACC in farms and packing sheds
- Fruit fly free areas required with support of Moscamed
- Low mango productivity in Guatemala
- High variability in management practices and productivity.
- Effective mango flowering manipulation strategies
- Access to other varieties demanded by export markets

Melon (*Cuculis melo*)

- Soil sterilization based on Methyl Bromide will phase out in 2015. Need replacement alternatives.

- Rootstocks tolerant to fungi: *Monosporascus cannonballus*.
- Inoquity and GAPs to be implemented across the industry

Rambutan (*Nephelium lappaceum*)

- Tree canopy management to maximize yield
- Appropriate grafting technologies for rambutan
- Tree nutrition is not known
- Flowering control to extend production season and avoid competition
- Alternatives to deal with stem canker disease (*Dolabra nepheliae*)
- Varieties, chemical and biological methods to deal with Fungal diseases (*Phytophthora, Colletotrhicum, Oidium, Periconia, Capnodium*)
- Harvest and postharvest management alternatives to secure fruit quality
- Appropriate packing sheds and packaging
- Production manuals

ORNAMENTALS

Cut flowers

- Pruning techniques and protocols
- Pests and diseases (mites and thrips)

Foliage

- Weed control strategies
- Rooting is slow and costly
- Sporulation control in leather leaf to increase product quality
- Pests and diseases (mites and thrips)

Stem and leaf cuttings

- Technologies to induce multiple shooting
- Pests and diseases

Stems and canes

- Technologies to induce multiple shooting
- Pests and diseases

Orchids, epiphytes and others:

- Mass propagation technologies
- Weed control
- Pests and diseases

APPENDIX G: KEY RESEARCH AND EDUCATION PROGRAMS IN THE REGION

INSTITUTION	COUNTRY	RESEARCH	EDUCATION
Escuela Agrícola Panamericana, Zamorano	Honduras	x	x
Centro Agronómico Tropical de Investigación y Enseñanza, CATIE	Costa Rica	x	x
Escuela Agrícola Tropical del Trópico Húmedo, EARTH	Costa Rica	x	x
Universidad del Valle de Guatemala, UVG	Guatemala	x	x
Fundación Hondureña de Investigación Agrícola, FHIA	Honduras	x	