CIAT policy brief

Global Climate Change and Food Supply Chains: Policies for Collective Adaptation

Andreas Benedikter, Peter Läderach, Anton Eitzinger, Simon Cook, Audberto Quiroga, Antonio Pantoja, and Michele Bruni

According to climate model predictions, most parts of Latin America and the Caribbean (LAC) will see significant temperature increases and changes in precipitation by 2050. In Guatemala, Colombia, and Jamaica, for example, such shifts will pose serious challenges for food supply chains in the face of increasing demand. If crop production is allowed to fall behind, this will not only lower national income and private sector growth but also jeopardize the food security and livelihoods of thousands of smallholder farmers. Policy makers must begin now to minimize the socio-economic impacts of climate change through a coordinated effort to identify pro-active options for adaptation, which take into account the different impacts and degrees of vulnerability across locations, crops, supply chains, and cultures.

Key Messages

- Global climate change threatens food production and rural livelihoods.
- Its impacts on crops and farms will pose many challenges for private businesses involved in food supply chains, generating much uncertainty.
- Systematic assessment of climate change impacts on food supply chains is essential for targeting adaptation interventions. Factors such as impacts on crops, livelihood vulnerability, supply chain characteristics, and behaviors along with institutions may determine whether a supply chain possesses adequate organizational dynamics together with the structures and assets needed to offset impacts.
- To develop climate-resilient production systems and livelihoods requires collective adaptation aimed at strengthening structures and relationships along entire food chains. This process must involve decision makers from the public sector as well as supporting institutions, private companies, and, most important, farmer groups.
- Investments in pro-active adaptation for vulnerable farmers should focus not only on improving yields in the face of climate change but also on switching to crops that will be more suitable under new climatic conditions.
- Many supply chains will have time to adapt to predicted hazards without abandoning current supply structures. Nonetheless, the quicker they act, the more likely they are to avoid major dislocations and reduce the costs of change.

Overview

In LAC, most rural households consist of smallholder farmers, and agriculture continues to be the best way for rural people to work and trade their way out of poverty (The World Bank, 2007). Yet, according to recent predictions, climate change poses a significant challenge, threatening to reduce the suitability of conditions for many crops and to further degrade the natural resources on which food supply chains depend, especially in the tropics.

In addition to driving economic growth, food value chains catalyze rural development. By providing better market access and incomes, they benefit thousands of smallholders and help strengthen food security for millions of urban consumers.

The threat posed by global climate change is twofold. First, by jeopardizing food production and supplies, it negatively impacts consumers as well as the private sector. And second, by hindering rural and national development, it undermines food security and the already precarious livelihoods of the rural poor.

Farmers are particularly vulnerable to climate change, because it affects them directly and because, of all actors in agricultural production, they are the least prepared to adapt. But many others will feel the impacts as well – including processors, exporters, traders, wholesalers, and retailers. They will face uncertain but undeniably adverse effects on product quality and quantity as well as heightened risks to the value of their brands.

Need for collective adaptation

Even if greenhouse gas emissions were halted today, the impacts of past emissions would continue for decades. Thus, while mitigation is important for lessening the impacts of global climate change, adaptive measures are needed even more urgently to address threats that are already inevitable. Investment must be directed to initiatives that both stabilize production of climate-sensitive crops through good agricultural practices and help farmers transition to more climate-resilient crops.

Adaptation at the farm level is necessary but not sufficient to tackle the wide array of problems that will arise along food supply chains. The

technical expertise, market power, and actionable knowledge of downstream actors (such as processors, wholesalers, and retailers) will play a seminal role in facilitating the long-term co-investment needed to thwart climate change impacts on food security and rural development.

It may be feasible to scale up local, farm-level adaptation to global supply chains, assuming that other chain actors bring their capacities to the adaptation process. But this will require structural changes, in which adaptive measures are applied at critical hotspots in response to specific structures and relationships in food chains.

To bring about such changes requires a collective approach to assessing impacts and options. The results presented here underline the importance of local studies for assessing adaptation needs in specific sites and food chains and providing actionable recommendations for collective adaptation.

Systematic assessment for targeted adaptation

Because supply chains are complex, determining how global climate change will affect them is fraught with difficulty. The informal character of production and marketing systems further complicates the task, especially in developing countries, and often discourages decision makers from taking part in collective, targeted interventions.

To reduce that complexity, it is important to focus only on information that is relevant to adaptation. As shown in Figure 1, the key factors for food supply chains include crop impacts, the vulnerability of livelihoods, supply chain characteristics, and behaviors along with institutions. The most important factors are temperature rise and precipitation variation, which are crucial for determining the suitability of crops to an environment. Crop impacts, in turn, affect producers' livelihood assets (such as income, soil, housing, roads, and education) and their capacity to offset climate change impacts.

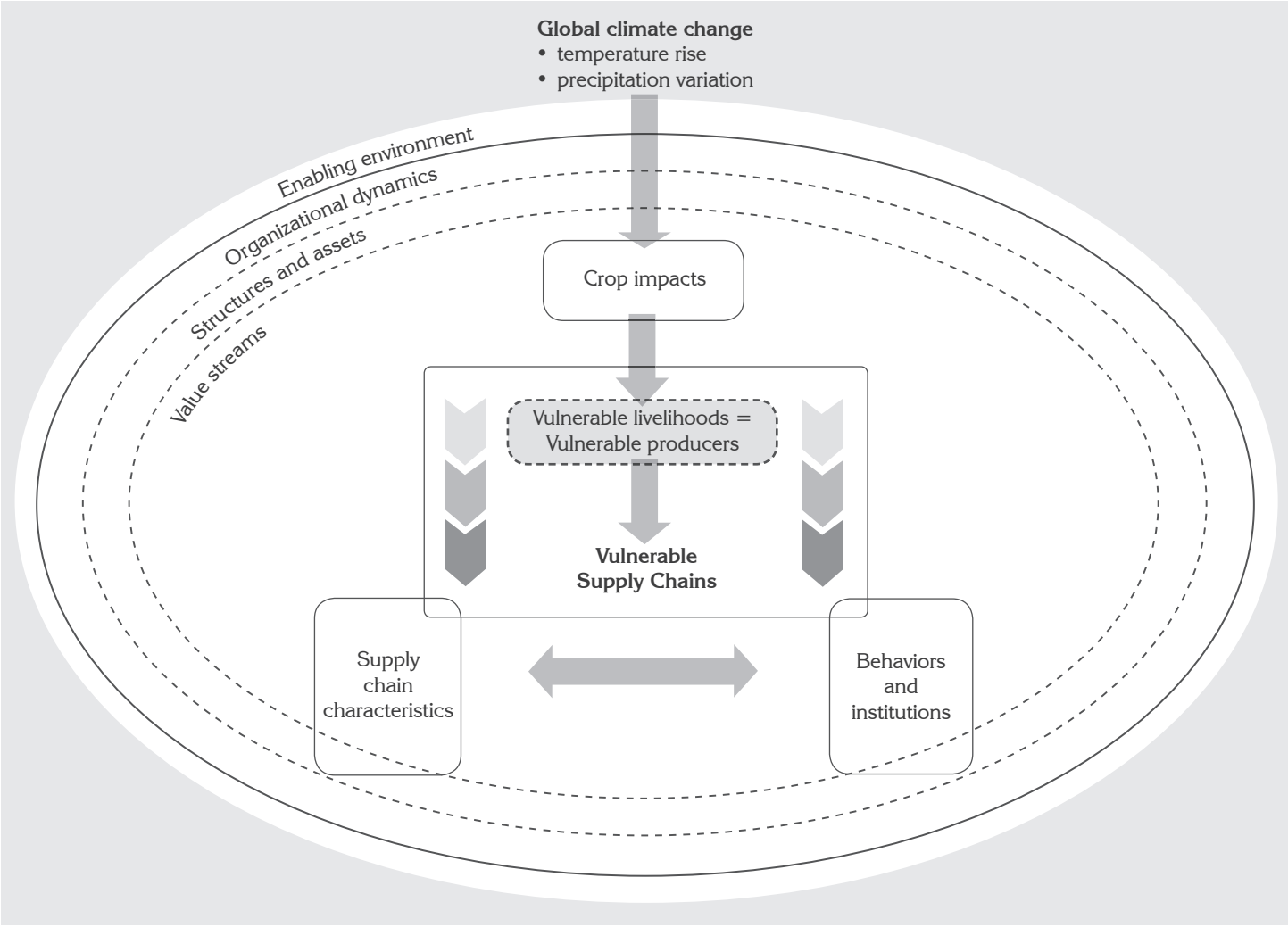

Figure 1. Assessing the implications of global climate change for food supply chains.

Though alternative crops, crop migration to higher altitudes, and adaptive capacity can partly compensate for the negative effects of climate change, they will eventually reach downstream actors in the food supply chain. It is essential, therefore, to assess the character of the supply chain as well as behaviors and institutions, since they influence both the risks and opportunities involved in managing climate change impacts and hence the chain's overall vulnerability (Figure 1).

All of those factors determine whether a supply chain has the organizational dynamics together with the structures and assets needed to offset the impacts of climate change on the enabling environment as well as the value streams linking producers via processors with consumers (Figure 1).

Climate risks and opportunities in three supply chains in LAC

The following section describes step by step how to conduct a systematic assessment for targeted climate change adaptation. It centers on three case studies that deal with contrasting food supply chains in Guatemala, Colombia, and Jamaica. In each case, the assessment led to the identification of distinct hotspots as well as response pathways that can help supply chain actors make decisions about collective adaptation.

In the departments of Sololá and Chimaltenango in Guatemala, small farmers export frozen vegetables through intermediaries to the US market. Smallholders around Bogotá, Colombia, bolster the capital's food security through direct sale and market trade. Jamaica's farmers supply fresh vegetables to the local hotel industry, which contributes importantly to national GDP.

Predicted climate change

The average result from 19 global circulation models indicates that by 2050 temperatures will increase by 1.7 °C in Jamaica, 2.2 °C in Guatemala, and 2.4 °C in Colombia. Rainfall will decline during the first months of the rainy season in both Guatemala (-25 mm) and Jamaica (-65 mm), and the effect of this change will be heightened by higher temperatures. In contrast, precipitation in Colombia will increase by 81 mm, mainly during the four driest months, although this will be partly offset by higher temperatures. Hotter climates and changing rainfall patterns will alter the ecological niches of many crops and require that farming systems adjust to seasonal shifts.

Predicted crop impacts

For most crops, the area suited for production will decline under projected future climates. In Guatemala, sweet pea and cauliflower, both important for export, will lose ground significantly, while reduced suitability for potato and fava bean, key local staples, will compromise the nutrition of local populations. In Colombia, several staple foods (plantain, maize, and cassava) will also be severely affected, putting food security at risk. But tropical fruits, which figure importantly among Colombia's exports, will be affected even more. In Jamaica, the area suited for many crops demanded by the hotel industry, such as ginger, cabbage, and high-altitude varieties of sweet potato and tomato, will plunge dramatically. Except in Jamaica, climate conditions will become more favorable only for a few local crops by 2050 (Table 1).

Vulnerable farmers and supply chains

Through its effects on the growing conditions of diverse crops, global climate change will have significant impacts on food supply chains and particularly smallholder farmers.

In Guatemala and Jamaica, farmers are especially concerned about the effects of climate-induced production decreases on their financial assets, possibly through tighter terms of credit from banks. These farmers receive little support from community organizations or participate in them only to a limited extent, indicating low levels of social capital. Inadequate family nutrition, limited

Table 1. Change in climate suitability for key crops in Guatemala, Colombia, and Jamaica by 2030 and 2050.

GUATEMALA				COLOMBIA				JAMAICA			
Crop	Current Suitability	Suitability Change 2030	Suitability Change 2050	Crop	Current Suitability	Suitability Change 2030	Suitability Change 2050	Crop	Current Suitability	Suitability Change 2030	Suitability Change 2050
Carrot	91.8	-13.4	-22.0	Cassava	88.4	-4.2	-14.9	Lettuce	91.6	-16.1	-27.5
Cauliflower	90.4	-17.6	-30.3	Plantain	87.8	-13.5	-28.6	Cabbage	91.4	-18.9	-34.9
Horse bean	90.1	-15.6	-29.2	Rice	86.6	3.5	5.9	Sweet Potato "high"	91.4	-19.2	-35.6
Snow peas	87.3	-21.2	-29.9	Guava	85.6	-13.8	-35.9	Tomato "high"	88.4	-14.1	-24.6
Broccoli	86.1	-2.4	-5.2	Papaya	82.3	-25.2	-46.8	Irish Potato	81.6	-12.8	-22.4
Beet root	85.0	-12.8	-22.5	Sugarcane	77.9	-6.2	-13.3	Ginger	80.7	-27.3	-46.7
Potato	82.2	-16.5	-29.7	Mango	77.2	-18.3	-33.9	Cucumber	73.6	12.9	19.4
Beans	75.0	2.1	1.7	Blackberry	67.4	-5.6	-12.5	Sweet Potato "low"	69.9	14.8	21.6
Tomato	61.3	11.8	18.4	Maize	67.1	-12.7	-19.3	Banana	68.8	13.0	18.4
Maize	60.8	2.4	1.0	Orange	65.6	-24.4	-35.2	Tomato "low"	67.5	16.0	23.5

knowledge of markets, and poor bookkeeping further reduce human assets in both countries. Farmers' physical capital is particularly deficient in Guatemala, as reflected in poorly maintained roads and modest housing (Figure 2). Although Colombian farmers are apparently better off in terms of financial, human, and physical capital, this is due largely to support from international nongovernment organizations (NGOs), which may or may not continue over the long term.

In Guatemala, intermediate actors in food chains depend on the crop production of about 3,000 smallholder farmers and vice versa. In addition to affecting those groups, climate change will harm the international buyers of Guatemalan vegetables by creating problems of irregular supply and poor quality.

Farmers in the four departments surrounding Bogotá, Colombia – Cundinamarca, Huila, Meta, and Tolima – provide approximately 70% of the food consumed by the city's eight million inhabitants. As the major source of supply for Corabastos – South America's second largest marketplace – those farmers contribute importantly to the city's food security. Urban consumers will face higher and more-volatile food prices as a result of climate change and may be forced to import food, to the detriment of local smallholders.

Likewise, Jamaica's hotels will have to continue importing a wide range of foods from overseas, jeopardizing local farmers' livelihoods and affecting the country's balance of payments. The hotel industry currently imports 60% of the food it needs (Pennicook, 2006). Of that amount, 45% could be produced locally in the short term (Brown, 2011). But severe climate change impacts on the suitability of conditions for growing many local foodstuffs will reduce production potential in the long term.

Adaptive capacities of farmers and supply chains

In all three countries, food production systems show some capacity to adapt to the impacts of global climate change. But this capacity is decidedly modest, with only limited physical and social capital as well as low potential for using financial instruments. Of particular concern is the limited education of producers in Jamaica, which seriously restricts their adaptive capacity (Figure 2).

More established food value chains in Guatemala will be better able to adapt than emerging chains in Jamaica. This is because intermediaries and buyers in Guatemala work together with farmers in a fairly formalized manner and can therefore communicate and promote adaptation initiatives more easily. Colombian producers, who seem more receptive to change and long-term planning, are also better prepared to offset climate change impacts. In none of those countries, however, are food supply chains currently prepared for the impacts.

Emerging adaptation strategies

Faced with a wide range of threats to their livelihoods, many downstream actors in food supply chains may be tempted to opt out of the current supply structures. But there is still time to avoid this outcome, if downstream actors work together with suppliers.

Guatemala

The introduction of good practices, like low-carbon agriculture and better irrigation management, will enable Guatemalan farmers to ensure stable supplies of one of their main cash crops, broccoli, which is highly climate resilient. Gradual introduction of alternative crops, with a separate marketing channel for each, should also help by spreading the risk for both buyers and suppliers.

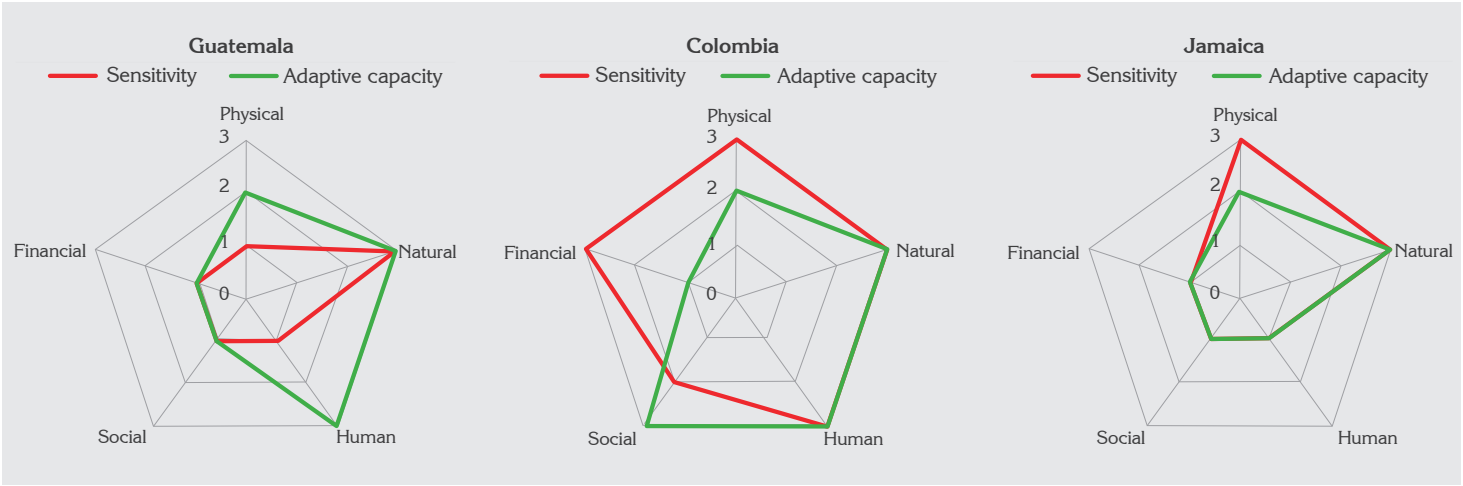

Figure 2. Sensitivity and adaptive capacity of farmers in Guatemala, Colombia, and Jamaica. 1 = high sensitivity, low adaptive capacity; 3 = low sensitivity, high adaptive capacity.

In support of those strategies, efforts will be required to raise awareness about the projected impacts of climate change along the supply chain and to train farmers to build functional adaptive capacity on the ground. Subsequently, community organizations must be formed to promote sharing of traditional and research-based knowledge without support from international NGOs. Financial support for this activity could come from micro-finance institutions or public sources.

Intermediate actors in food supply chains can help implement those strategies through sharing of capacities and knowledge with farmer organizations. Such support, by helping stabilizing crops yields and creating new opportunities for food production, would improve the supply of food to the chain, raise farmers' incomes, and build coherent and sustainable supplier-buyer alliances along the entire chain.

Colombia

Because of this country's varied geography, farmers have many alternatives for coping with climate change, including a diverse array of resilient crops and the option of moving the production of sensitive crops to higher altitudes.

In order for those strategies to succeed, however, the whole supply chain must be made aware of the threat that climate change poses to food security. Also, producers must receive training in ecologically sustainable alternatives, such as agro-forestry and low-carbon agriculture, both to mitigate climate change and diversify into more resilient crops. Those steps are important for preparing small farmers to cope, once support from NGOs ends. While some state intervention may be required, there is also much scope for establishing alternative marketing channels, such as farmers' markets and coordinated transport from geographically dispersed farms to points of sale, facilitated by equitable community organizations and active knowledge sharing.

In addition, smallholder farmers need easier access to financing, with the option of investing collectively in assets such as trucks and warehouses, which will make them more independent. The objective is to strengthen farmers' negotiating position with strong commercial actors, who currently set prices to the disadvantage of smallholders. Even though intermediaries have weak links with producers, they can still support them by trading in climate-resilient crops at stable prices, which will positively affect product quality and, therefore, traders' market position.

Jamaica

To deal effectively with climate change, Jamaica requires a comprehensive strategy for adapting crop management together with structural changes that improve farmers' livelihoods and strengthen their position in food supply chains. For the most vulnerable crops, more resilient varieties need to be selected with support from research. Seedlings of important cash crops, such as ginger, must be raised in nurseries if they prove sensitive to climate change. To ensure stable supplies of those crops for the market, irrigation can be introduced on small farms to offset stress caused by lower rainfall and higher temperatures.

In addition, community organizations must be strengthened and provided with easier access to more flexible financing, as they have a vital role to play in building climate change awareness, strengthening local capacities, promoting participation in local organizations, and implementing good agricultural practices. Stronger community organizations are critical for creating an environment that is conducive to functional education and sharing of knowledge about best practices.

Regional and national governments must assume responsibility for putting in place policies that broaden access to finance and foster stable market prices. In addition, the public sector will need to mediate between producers and the hotel industry to create sustainable interactions between suppliers and buyers. The aim should be for the tourist industry to shift the food it offers to local, climate-resilient products. Such collective adaptation measures, involving farmers, buyers, and the public sector, are essential for building alliances that bring together stakeholders in food supply chains to offset climate change impacts.

Benefits of this method

The methodology outlined here provides a useful tool for systematically reducing uncertainty and highlighting the threats and opportunities that global climate change poses for food supply chains, regardless of the crops and locations involved or the scale of the analysis. The tool is designed to help identify adaptation interventions that combine assets, structures, and organizational dynamics, such as process ownership and relationships, into a coherent strategy. It also gauges the vulnerability of production systems and offers guidance for making them more resilient under stresses caused by climate change.

Challenges and constraints

Because of the uncertainties involved, predicting climate change impacts on food supply chains requires structured analysis based on both scientific data and participatory assessments that include all key stakeholders. The method described here offers a research-based tool designed to facilitate decision making.

Supply chain structures are generally governed by individual, opportunistic actions. For that reason, policy makers may find it difficult to reconcile stakeholders' diverging interests, as they seek to foster collective adaptation.

Policy Recommendations

Global climate change is expected to have dramatic impacts on the three food supply chains described here, requiring that decision makers act now with the means available in critical hotspots. Collective adaptation should engage all stakeholders in planning and implementing interventions that contribute to the long-term resilience of the supply chain. It is important not to overemphasize agricultural mobility and farmers' adaptive capacity, as this creates the risk of excluding other actors in the public and private sectors, who play a key role in building the sustainable relationships that are critical for coping with climate change. To achieve collective adaptation and enhance supply chain resilience over the long term, all stakeholders should be included in planning interventions, such as the following:

- Public institutions should provide a research-supported platform to share knowledge about crop- and site-specific impacts as well as adaptation strategies with producers, intermediaries, and buyers.
- Public institutions, in consultation with local farm cooperatives, should improve public physical infrastructure for transportation and irrigation.
- Banks, in collaboration with governments, should offer easier, more equitable access to financial instruments, giving priority to initiatives for collective adaptation to climate change. These should include grants for start-up investments and microfinancing.
- Institutions representing farmers should promote the development and strengthening of community organizations together with capacity building aimed at enhancing farmers' role in food supply chains.
- Private companies, in cooperation with public institutions, should help make food supply chains more transparent, so that climate change impacts and the outcomes of adaptation efforts can be traced. Useful tools for that purpose include formalized trade laws and private sector business agreements as well as voluntary improvements in business partnerships across food chains.
- Private companies should draw on their market knowledge and technical capacity to help farmers adopt climate-resilient crops early on, thus stabilizing yields and enhancing product quality.
- Downstream actors (processors, wholesalers, and retailers) should focus more on long-term trading relationships and create the means to mitigate production volatility (e.g., through flexible contract terms). Spreading risks by diversifying procurement to more sites is necessary but not sufficient for collective adaptation.
- NGOs should act as mediators between supply chain stakeholders to help reconcile diverse interests, which range from stable yields and farmgate prices to calculable processing logistics to profit maximization and shareholder interests. Ensuring that all of those interests are represented at a single table will help participants make the coordination and governance of adaptation more equitable.

Further reading

Benedikter A; Läderach P; Eitzinger A; Cook S; Quiroga A; Pantoja A; Bruni M. (forthcoming). Adaptation of food supply chains to climate change: A framework. Working Paper. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia.

Brown I. 2011. Jamaica can replace 45% of imported food with local produce. In: Jamaica Observer [on line]. Kingston. Retrieved from www.jamaicaobserver.com/news/Ja-can-replace-45--of-imported-food-with-local-produce--says-Tufton (accessed 28 January 2013).

Pennicook P. 2006. The all-inclusive concept: Improving benefits to the Jamaican economy. In: Hall K; Holding R, eds. Tourism: The driver of change in the Jamaican economy. Kingston: Ian Randle Publishers. p 31–38.

The World Bank. 2007. World Development Report 2008: Agriculture for Development. The World Bank, Washington DC, USA. 365 p. Available at: http://siteresources.worldbank.org/INTWDRS/Resources/477365-1327599046334/WDR_00_book.pdf

Correct citation

Benedikter A; Läderach P; Eitzinger A; Cook S; Quiroga A; Pantoja A; Bruni M. 2012. Global climate change and food supply chains: Policies for collective adaptation. CIAT Policy Brief No. 11. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. 6 p.

For more information

Andreas Benedikter is an independent consultant for CIAT's Decision and Policy Analysis (DAPA) Research Area, focusing on climate change and food value chains. a.benedikter@gmail.com

Peter Läderach is a senior researcher in CIAT's DAPA Research Area, dealing with climate change and high-value goods. p.laderach@cgiar.org

Acknowledgements

This research was conducted under the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) with additional funding from Oxfam GB. We gratefully acknowledge the talent and efforts of María Baca, Lesbia Rizo, Christian Bunn, Beatriz Sánchez, Myles Fisher, Kevon Rhiney, Jason Gordon, Marlon Simms, Dorlan Burrell, Ismael Díaz, Saúl Mindiola, Hernán López, and Fernando Cojulun. This study would not have been possible without their valuable support.

CGIAR RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security CCAFS