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Recipes for Change validation report: Guatemalan Rice and Beans recipe

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In collaboration with

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Investing in rural people

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Recipes for Change: Guatemalan rice & beans recipe

Summary statement for selected ingredient rice

The main climate risks to rice cultivation in Guatemala are: (i) increased average and extreme temperatures, (ii) an intensification of climatic variability, and (iii) continued or enhanced incidence of extreme weather events, primarily heavy rainfall and drought.

The key adaptation measures for managing the foreseen impacts of climate change within the region upon cultivation of key grains such as rice include: (i) improved cropping practices, (ii) improved water resource management and (iii) identification of future suitable areas for basic grains cultivation.

CCAFS validates the climate threats and solutions highlighted in the IFAD statements below.

IFAD-identified climate threats to rice:

- *Increased temperatures*
- *Changes in growing seasons*
- *Increased incidence of extreme weather events*

ASAP solutions:

- *Improved farm management encourages more sustainable practices with yields maintained or even increased*
- *Better crop storage to protect against extreme weather*
- *Improved water storage to overcome changes in growing seasons*

Agriculture and food security overview

Guatemala is the largest and most populous country in Central America (INE, 2015). The population growth rate is also amongst the highest in the region, with a current doubling rate of 25 years (ibid.). The country's classification as a lower-middle income country hides a significant disparity in incomes (depending on the source, Guatemala is close to or within the top ten countries with the highest income inequality). Over half of the population are below the poverty line. Although the national income share made up of agriculture has fallen in relative terms (now at 12%) agriculture remains a vital economic activity, employing approximately one third of the economically active population and producing a comparable share of the country's total export earnings (World Bank, 2015). The major crops are maize, beans and rice for domestic consumption and coffee, sugar and bananas for export. National production of food crops covers only 60 per cent of demand, with imports mainly from the U.S. making up the difference. Consequently, seasonal food shortage is an ongoing problem for poor households (NewAg, 2015).

Guatemala has the fourth highest level of chronic malnutrition in the world (WFP, 2014). Most food insecure populations are concentrated in western and northwestern departments, where the local population is predominately indigenous and infant malnutrition and poverty are both high. Access to productive land in these areas is limited, and available land is steep and degraded. Other highly food insecure areas are located in the eastern departments, along the dry corridor, a semi-arid zone characterized by low and variable rainfall, degraded soils and low agricultural yields. Guatemala's vulnerability and exposure to natural hazards is extremely high, ranking fourth in the United Nation's 2014 World Risk Report (UNU-EHS, 2014). The impact of such hazards is regularly observed as negatively affecting food security. For example, in 2014 the prolonged dry spell which affected much of Central America resulted in the declaration of a state of emergency in Guatemala after 256,000 families lost their crop (WFP, 2014). Subsequently, 175,000 households required food assistance (ibid).

Improving food security in Guatemala will involve addressing underlying drivers, namely the extremely unequal distribution of land, exposure to natural hazards and access to affordable food. In addition to these factors, cultivation itself also bears risks of negative impacts due to exposure to several climatic hazards, most of which pose an increasing threat under ongoing climate change. The following sections focus on a single food crop in Guatemala: rice. The key climatic impacts affecting this crop will be described in greater detail, as will methods for managing and adapting to these foreseen impacts.

Climate risks to rice cultivation

A changing climate can lead to variation in the frequency, intensity, spatial extent, duration, and timing of weather and climate extremes. Table 1 below summarises the main observed and projected trends in climate parameters across the wider Central American region. Specific changes within Guatemala itself are also mediated by the country's diverse topography and the influence of regional weather features, such as the El Niño/La Niña cycle. However, few studies examine these local intricacies. And although wider trends can be indicative of the local situation, this is not necessarily the case for all parameters.

Table 1: Observed and projected changes in climatic parameters across Latin American region (Seneviratne, 2012; CDKN, 2013)

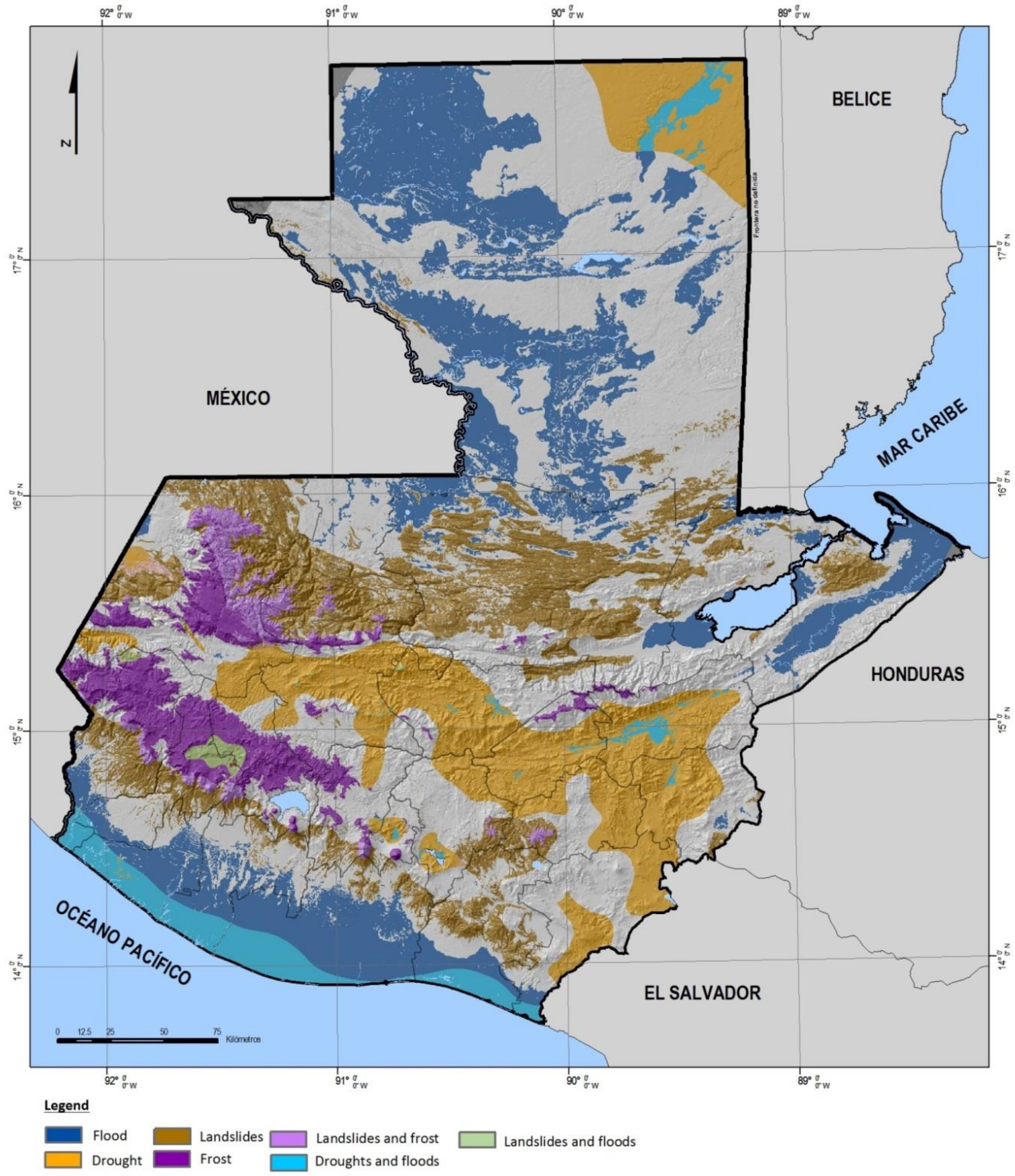
	Trends in maximum temperature (warm and cold days)	**Trends in minimum temperature (warm and cold nights)**	**Trends in heat waves/warm spells**	**Trends in heavy precipitation**	**Trends in dryness and drought**
Observed Changes since 1950 (1961-1990 baseline)	Increase in the number of warm days, decreases in the number of cold days	Increases in number of warm nights (decrease in number of cold nights	Spatially varying trends (increases in some areas, decreases in others)	Increases in many areas, decreases in few areas	Varying and inconsistent trends
Projected changes at the end of 21st century	Warm days *likely* to increase (cold days *likely* decrease)	*Likely* increase in warm nights (*likely* decrease in cold nights)	*Likely* more frequent, longer and/or more intense heat waves/warm spells in most of the region	Inconsistent trends	Increase in dryness, with less confidence in trend in extreme South of region

Low confidence
Medium confidence
High confidence

Temperature trends are among the most robust outputs of climate projection exercises and indicate an increase and the annual average temperature across the region of 2-4°C by the end of the 21st century under medium-high warming scenarios (CIAT, 2013; Magrin et al, 2013). Warming is expected to be greater in the lowlands than in the highlands, with the southern coast having the most significant changes in the temperatures (World Bank, 2011). The highest temperatures could exceed 28°C in the summer month of May, just before the onset of the rainy season (ibid.). Like many flowering species, rice is susceptible to heat stress, particularly during the reproductive and ripening stages. Higher temperatures can also impact upon soil fertility through the acceleration of organic matter decomposition processes (Altieri et al, 2008).

Trends in annual or monthly average precipitation specific to Guatemala are not clear from the surveyed literature. Positive trends have been noted in some areas; however, the average annual precipitation and the number of consecutive wet days do not show significant changes (World Bank, 2011). The longer term trend across Central America shows precipitation from the North American Monsoon System (NAMS) commencing later and becoming more irregular, while rainfall has been increasing and the intensity of rainfall has been increasing during the onset season (Magrin et al, 2013). Projections of trends in precipitation for the region vary between different climate models. Hence, there is little agreement over the direction of change in terms of average levels of rainfall in future years (ibid). However, an intensification of rainfall events and increase in variability is foreseen under both outcomes (CIAT, 2013). The direct impacts of warmer conditions combined with more variable rainfall are expected to impact on the productivity of major food crops, including maize, beans and rice (Lobell et al 2008; ECLAC 2010). Furthermore, a greater prevalence of flooding and drought is also expected, with negative impacts on water availability and quality, soils, forests, and agricultural production. The Institute of Agriculture, Natural Resources and Environment (IARNA) found that 73% of all villages in the country and 75% of the total population are at risk from one or more of climate sensitive natural hazards. The distribution of these areas across the country is shown in Figure 3 below.

Figure 1: Map of climate change induced hazards (URL/IARNA. 2009)



Adaptation to climate risks

In 2013, the Government of Guatemala passed the Framework Law to Regulate the Reduction of Vulnerability, Adaptation Compulsory to the effects of Climate Change and Mitigation of Greenhouse Gases (LMCC acronym in Spanish)[1]. This legislation builds on the 2009 "National Climate Change Policy" which identified broad objectives and priorities for climate change adaptation. Regarding the agricultural sector, key objectives include meeting basic food security needs and minimizing resource degradation. The National Climate Change Policy highlights how integration with adaptation action in other sectors such as forestry and water were also highlighted as necessary to effective adaptation within agriculture. This need for integration has been picked up in the more recent LMCC, with a focus on joint work across government departments. For example, the National Energy Plan for Production and Consumption, based on the use of renewable natural resources involves collaboration across three related departments. Specific options for managing the main climate hazards to rice cultivation in Guatemala include the use of improved cropping practices and resource management (including water resources).

Results reported to the FAO from a series of technology transfer programmes demonstrated that high yields without significant cost increases are possible with the use of simple technology. For example, initiatives in neighbouring Central American countries have demonstrated the potential of water harvesting as a method for increasing the use of irrigation in upland rice production. The project was initiated by the Latin American Fund for Irrigated Rice (FLAR) and trialed low-tech, low-cost water harvesting techniques, such as earth dams built in smallholder's fields. These dams allow farmers to retain rainwater for later irrigation-by-gravity use (Zorrilla et al, 2012). Rice irrigated in this fashion yielded 65% more than neighbouring non-irrigated rice crop in two trails in the southeast of Mexcio (ibid.). Although there are some modern farms which irrigate rice paddies and use modern harvesting equipment, most rice cultivation in Guatemala is rain fed, particularly in upland areas (USDA, 2009). Along with improving yields in these areas, simple water harvesting techniques can also improve rainfall infiltration and limit surface run-off, reduce erosion and flooding risks (Bradford & Hogarth, 2011).

A second significant constraint on achieving better yields is the availability of nutrients. Correct application in terms of the amount, timing and balance between mineral and organic fertilizers can help maintain and potentially enhance soil fertility. The results are seen in terms of improved nutrient efficiency, increased crop productivity and minimized nutrient losses to the environment. Another project overseen by the Latin American Fund for Irrigated Rice (FLAR) demonstrated the positive impact of improved agronomic practices such as nutrient management on rice yields. Yield increases were seen in all 14 of the Latin American nations where improved management practices had been trialed (Zorrilla et al, 2012).

Statistics on post-harvest losses are not sufficient to quantify total losses nationwide nor their impact on food security or the economy. However losses are apparent in the fruit, vegetable and staple food crop sectors. Significant losses are reported for the two main food crop staples, beans and maize. These are susceptible due to heavy rainfall, high temperatures and therefore elevated humidity year-round, and post-harvest losses in both crops can be as high as 50% at the farm level (IICA, 2013). Storage in homemade small-scale bins prove inadequate against the elements (ibid.). On-farm storage of rice appears less widely practised as harvests are typically sold directly or through farmers associations to millers who store the grain at scale. Climate sensitive hazards relating to storage include spoilage of stored grains through exposure to hot and humid conditions, as well as storms, flooding and mudslides which may put storage facilities at risk of damage.

GHG emissions associated with Guatemalan rice production

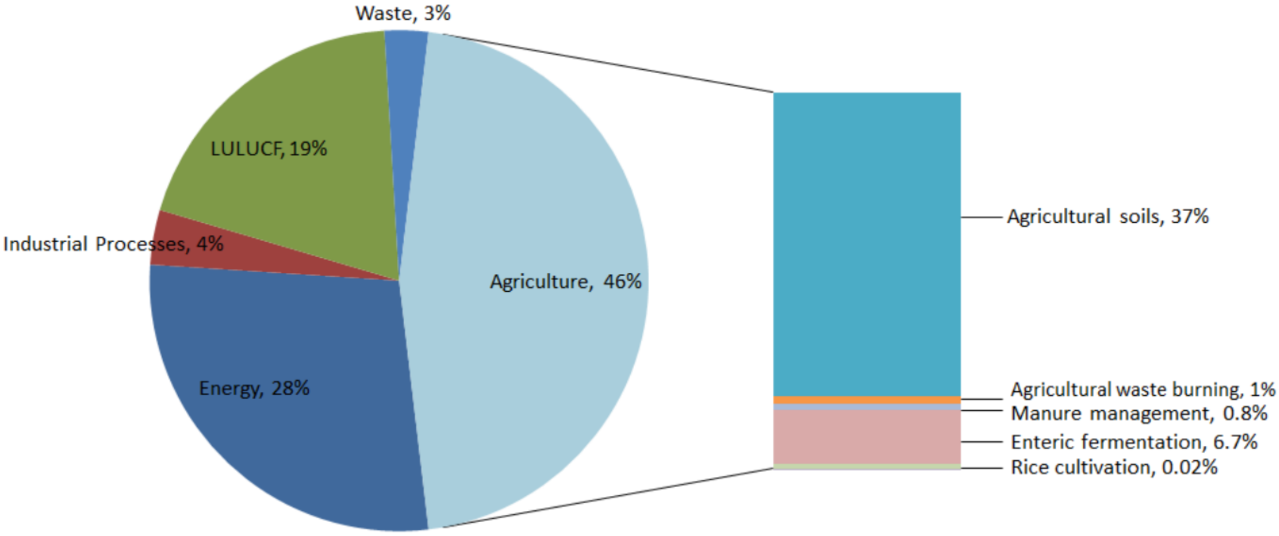
As shown in Figure 2 below, emissions attributed to the agricultural sector are a significant proportion of total emissions in Guatemala. Agricultural soils account for 37% of total emissions in Guatemala as well as the vast majority of the emissions of the agricultural sector itself. Expansion of agricultural land by conversion of forestland has been a

[1] Ley Marco para Regular la Reducción de la Vulnerabilidad, la Adaptación Obligatoria ante los efectos del Cambio Climático y la Mitigación de Gases de Efecto Invernadero (LMCC)

significant driver of emissions across the Latin American region. This is also the case within Guatemala, where a lack of land use planning particularly in the rural and upland areas has led to a significant forest clearing. Cultivation of these areas often leads to a degradation of soils, causing further release of emissions and decreased soil fertility. Limiting unsustainable clearing of forest areas would largely be a process of regulation through national and municipal legislation. However, such an initiative is entirely dependent upon effective enforcement processes (USAID, 2013).

Regarding mitigation practices targeting rice cultivation, much focus to date has been on the major growing regions such as East and South East Asia. Mitigation measures that have proved effective in those areas include alternate wetting and drying (Richards and Sander, 2014), the removal of rice straw, drying off-paddies, crop rotation, and the addition of potassium (Searchinger, 2013). However, local applicability of such mitigation measures is not guaranteed, particularly when considering potential tradeoffs with other constraints, such as the availability of labor and resources for additional infrastructure.

Figure 2: GHG emissions in Guatemala by source (CO_2eq) (USAID, 2013)



References:

Altieri MA, Parviz K. 2008. Enduring Farms: Climate Change, Smallholders and Traditional Farming Communities. Penang: Third World Network.

Bradford AA, Hogarth R. 2011. Agriculture Sector Working Paper. Appendix B. Smith School of Enterprise and the Environment. Available at: http://www.smithschool.ox.ac.uk/research/library/Rwanda_Agriculture-SWPfinal_proofed3.pdf (accessed 5 November 2014)

CDKN. 2013. Lessons from the IPCC SREX report for Latin America and the Caribbean. (Online.) Available at: http://www.cdkn.org/srex. Accessed 19 March 2015.

CIAT. 2013. Tortillas on the Roaster (ToR): Central America's maize-bean systems and the changing climate. CIAT Policy Brief, No. 6.

ECLAC. 2010. The Economics of Climate Change in Central America: Summary 2010. (LC/MEX/L.978). United Nations, ECLAC. pp.146.

IICA. 2013. Post-harvest Losses in Latin America and the Caribbean: Challenges and Opportunities for Collaboration Prepared by the Inter-American Institute for Cooperation on Agriculture (IICA) for the US Department of State. (Online). Available at: http://www.iica.int/Esp/Programas/SeguridadAlimentaria/Documentos%20Seguridad%20Alimentaria/Report%20on%20Post-Harvest%20Losses%20in%20Latin%20America%20and%20the%20Caribbean%209-20-2013.pdf Accessed 25 March 2015.

INE. 2015. Instituto Nacional de Estadística –Indicadoresa (Online). Available at: http://www.ine.gob.gt/index.php/estadisticas/tema-indicadores. Accessed 14.3.2015

Lobell DB, Burke MB, Tebaldi C, Mastrandrea MD, Falcon WP, Naylor RL. 2008. Prioritizing climate change adaptation needs for food security in 2030. Science 319(5863):607-610.

NewAg. 2015. Guatemala: Country Profile. (Online). Available at: http://www.new-ag.info/en/country/profile.php?a=842 Accessed 13.03.2015

Magrin GO, Marengo JA, Boulanger JP, Buckeridge MS, Castellanos E, Poveda G, Scarano FR, Vicuña S. 2014. Central and South America. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros VR, Field CB, Dokken DJ, Mastrandrea MD, Mach KJ, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR, White LL, (Eds.)]. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press. pp. 1499-1566.

Richards M, Sander O. 2014. Alternate wetting and drying in irrigated rice: Implementation guidance for policymakers and investors. CCAFS and IRRI. CSA Practice Brief. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).
https://cgspace.cgiar.org/bitstream/handle/10568/35402/info-note_CCAFS_AWD_final_A4.pdf

Seneviratne SI, Nicholls N, Easterling D, Goodess CM, Kanae S, Kossin J, Luo Y, Marengo J, McInnes K, Rahimi M, Reichstein M, Sorteberg A, Vera C, Zhang X. 2012: Changes in climate extremes and their impacts on the natural physical environment. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field CB, Barros V, Stocker TF, Qin D, Dokken DJ, Ebi KL, Mastrandrea MD, Mach KJ, Plattner GK, Allen SK, Tignor M, Midgley PM, (Eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press. pp. 109-230.

Searchinger TD. 2013. Synergies and Tradeoffs for Small Farmers and Climate Mitigation. Oxfam America Research Backgrounder series.

URL/IARNA. 2009. Perfil Ambiental de Guatemala 2008-2009: las señales ambientales críticas y su relación con el desarrollo. *Guatemala: URL, IARNA. Serie Perfil Ambiental*, (11).

UNU-EHS. 2014. World Risk Report 2014. Bonn, Germany: United Nations University – Institute for Environment and Human Security (UNU-EHS).

USDA. 2009. Rice Situation and Outlook (Online). Available at:
http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Rice%20Situation%20and%20Outlook_Guatemala_Guatemala_4-22-2009.pdf Accessed 25 march 2015.

USAID. 2013. Institutional Assessment and Sector Analysis For The Low Emissions Development Strategy In Guatemala Forest Carbon, Markets And Communities (FCMC) Program. U.S. Agency for International Development. Washington.

WFP. 2014. WFP Guatemala: Brief (Online). Available at:
http://documents.wfp.org/stellent/groups/public/documents/ep/wfp272220.pdf. Accessed 19 March 20145

World Bank. 2011. Climate Risk and Adaptation Country Profile. (Online). Available at:
http://sdwebx.worldbank.org/climateportalb/doc/GFDRRCountryProfiles/wb_gfdrr_climate_change_country_profile_for_GTM.pdf . Accessed: 19 March 2015.

Zorrilla G, Martínez C, Berrío L, Corredor E, Carmona L, Pulver E. 2012. Improving rice production systems in Latin America and the Caribbean. In: Hershey CH (ed.). Eco-Efficiency: From vision to reality. Cali, Colombia: Centro Internacional de Agricultura Tropical (CIAT).