

# Sustainable Development Opportunities at the Climate, Land, Energy and Water Nexus in Nicaragua

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## ABSTRACT

There is a significant interconnection between land, energy and water issues in the Nicaraguan context, especially given that the national importance of agriculture, the future implications of water scarcity, and the potential of local energy resources.

The goal of our work is to synthesize the state of Climate, Land, Energy and Water issues (CLEW) in Nicaragua, in order to then identify barriers and opportunities for sustainable solutions and highlight the potential for Integrated Resource Planning in the region.

We explore three case studies: breadfruit-based flour production as a community scale solution to poverty on the Atlantic Coast; rain water harvesting potential in the Pacific Mountain Corridor as a means to reduce risk and increase incomes of small farmers in the region; and bioenergy production in the form of biogas and liquid biofuels from agricultural wastes at the national scale.

## BACKGROUND ON NICARAGUA

Nicaragua has a very challenging history of dictators, trade embargos and foreign military intervention, and beginning in the late 1970's, experienced more than a decade and a half of civil war. The Managua earthquake of 1972, Hurricane Joan of 1988, severe drought across the country in 1989 and Hurricane Mitch of 1998 are just some of the major natural disasters that have also plagued and hindered Nicaraguan development. A major change in the governance model stemmed from a 1990 election which shifted the nation toward a free-market economic policy. Another election in 2006 saw a preservation of the free-market economic policies, but with a more social approach combined with some curtailing of civil liberties. We explore sustainable development solutions within this political economy context.

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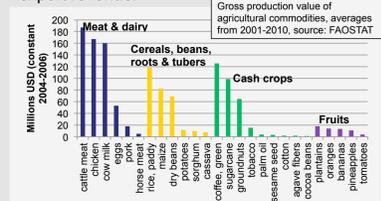
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## NICARAGUA: A country of potential

### Land Resources:

Agriculture forms the backbone of the Nicaraguan economy, employing 30% of the workforce, and with timber production, contributing a third of annual GDP and 75% of export revenue.



Since 1980 permanently cropped land has doubled, presenting its own challenge through deforestation and soil degradation. Most agriculture is rain fed, also making the sector vulnerable to climate change.

### Water Resources:



Regional Contrast between Water Availability and Population

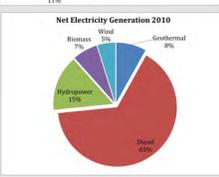
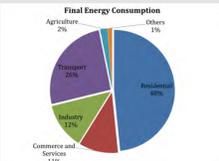
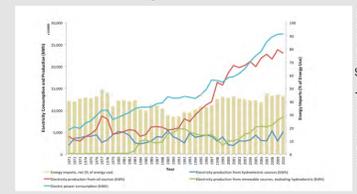
Nicaragua is one of the most water rich countries in the world. Most rainfall is received in the Caribbean Lowlands.

However surface water suffers from overexploitation and contamination. Lake Managua, 1000km<sup>2</sup>, is now one of the most polluted lakes in the world. It receives all the discharges from the capital including domestic and industrial wastewater.

Only 25% of rural population have access to piped water and 33% have access to acceptable sanitation facilities.

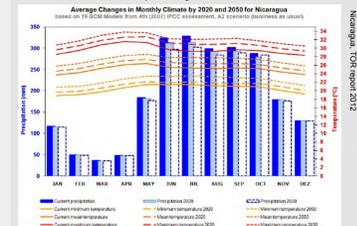
### Energy Resources:

Nicaragua has the second lowest per capita energy consumption in Latin America and the Caribbean. 55% of Nicaragua's export revenue goes towards oil expenditures. Firewood is a major source of energy with rural electricity access at 30%.



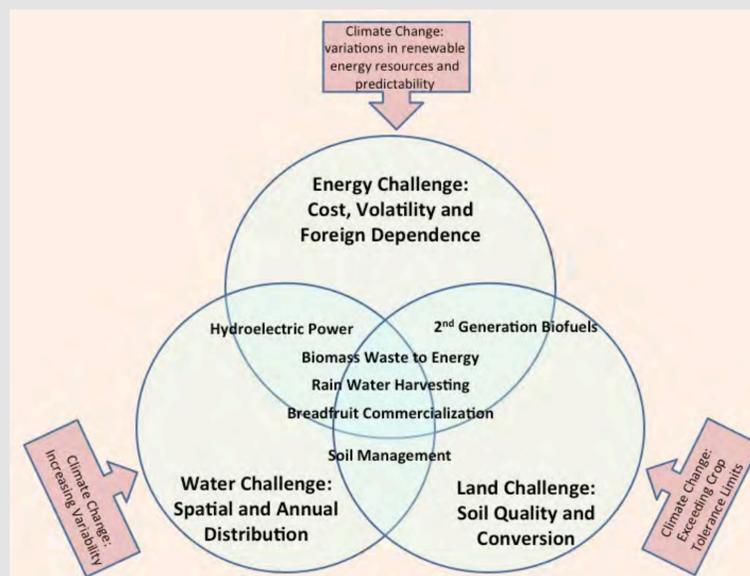
### Climate Change Impacts:

It is predicted that average annual temperature will increase by 1.8°C by 2050. Total rainfall received is not predicted to change much but timing and intensity will, thus increasing risk of drought and flooding by as soon as 2020. Nicaragua already experiences frequent exposure to extreme weather events, primarily hurricanes. A warmer, moister climate will increase the frequency of these events.



The impact on agriculture could be critical given that Nicaragua's main crops (beans and maize) are sensitive to soil moisture deficits and temperature increases. Even the changes expected by 2020 exceed tolerance limits for certain crops. The issue of water retention is exacerbated by poor soil management and the existing level of soil quality degradation.

## THE RESOURCE NEXUS



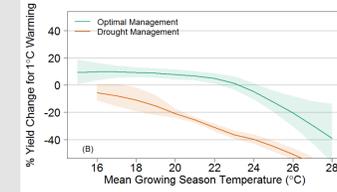
The Climate-Land-Energy-Water Nexus represents the complex and inter-related nature of development challenges for Nicaragua, but it also represents the opportunity for cross-sectoral solutions to multiple problems.

## OPPORTUNITIES FOR INTEGRATED DEVELOPMENT SOLUTIONS

### Rainwater Harvesting Systems for Agricultural Resilience:

Nicaragua has year-round rainfall on the Caribbean side of the country, but strong seasonal water scarcity in the Pacific and Central highland areas of the country. Many small maize-bean farmers experience high inter-annual variability in rainfall, while suffering from high rates of rural poverty and seasonal hunger. Either too much or too little rainfall throughout the planting season can destroy harvests or severely reduce final yields. In regions of the country prone to high inter-annual variability in precipitation, the crop loss in a given year can be 50% of the harvested area.

The ability to store and manage water is critical in reducing farmers' exposure to climate variability and drought risk. Also, sufficient soil moisture helps crops to cope with higher temperatures. Small-scale water capture and storage systems can additionally help farmers to increase their incomes by growing a 3<sup>rd</sup> crop in the dry season.



Impacts of warming temperatures on maize yields under optimal and drought management in sub-Saharan Africa; Lobell et al., 2011



Photo: Neil Palmer, CIAT

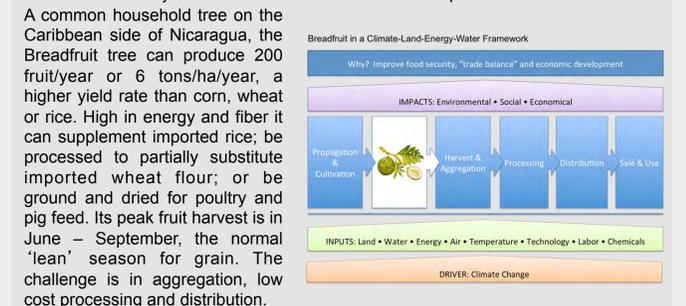
- Technical Aspects:
- Reservoir location
  - Water transport and distribution
  - System maintenance and operation
  - Economics
  - Government support

The Latin American Fund for Irrigated Rice (FLAR) and the International Center for Tropical Agriculture (CIAT) have a successful 14 micro-dam pilot project in Nicaragua.

### Breadfruit Flour for Economic Development and Food Security:



Nicaragua is the second poorest country in the Western Hemisphere and despite the importance of agriculture, nutrition-deficiency is a major problem, with 1 million Nicaraguans suffering from malnutrition. One solution to food security, local trade and economic development may lie in the overlooked subsistence crop: Breadfruit.



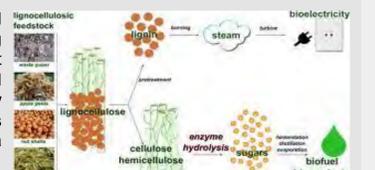
A common household tree on the Caribbean side of Nicaragua, the Breadfruit tree can produce 200 fruit/year or 6 tons/ha/year, a higher yield rate than corn, wheat or rice. High in energy and fiber it can supplement imported rice; be processed to partially substitute imported wheat flour; or be ground and dried for poultry and pig feed. Its peak fruit harvest is in June – September, the normal 'lean' season for grain. The challenge is in aggregation, low cost processing and distribution.

The Nicaragua government established a program for family farms called Nicaribe. The initiative calls for delivering over 6,000 breadfruit trees to nearly 300 families in the Southern Atlantic Autonomous Region. The trees are being cultivated by FADCANIC, a nonprofit agro-forestry and education organization in the region. FADCANIC is further investigating processing and market potential for the breadfruit harvest.

### Biofuels Opportunities:

Nicaragua's total energy demand is 14 million barrels of oil equivalent per year. Transportation is 25% of demand. Locally produced biofuels and biogas from waste biomass can help reduce the strain of satisfying this demand. Sugar cane is grown on the drier Pacific Coast. Total production is 6 million tons/year, processed at 4 main mills. In 2011, one mill began ethanol production, generating 10 million liters/year, which were mostly exported to the U.S. The Nicaraguan government formulated a policy for the development of biofuels and signed a regional agreement with goals for the blending of biofuels with fossil fuels by 2020.

However, there are many social and environmental challenges regarding land use for sugar cane. For that reason, second generation bioethanol using sugar cane bagasse or straw and other crops agricultural residues as well as forestry residues, is a highly attractive opportunity.



<http://www.cifor.org>  
<http://www.ashdenwards.org>

Nicaragua also has a history of biogas digester use, particularly in coffee plantations using agricultural residues but many of these systems fall out of operation due to lack of maintenance. Given the agricultural and cattle waste in parts of rural Nicaragua, biogas could be a working rural energy solution. Mechanisms to assess the quality of the gas produced, proper digester selection for different needs, as well as socioeconomic strategies to promote maintenance are the key challenges to overcome.

## CONCLUSIONS

- Nicaragua is now economically stable, poised for growth and actively pursuing MDGs, after many years of political instability and natural disasters.
- Agriculture is central to the Nicaraguan economy, and highly vulnerable to climate variability and change. Long-term warming will affect suitable areas for production, especially for beans and coffee, while changing rainfall patterns heighten risk of production in rain-fed systems. Proactive planning is needed.
- Nicaragua is very vulnerable to extreme weather events, principally hurricanes, but also flooding and droughts. Incidence is projected to increase in near term.
- There are large opportunities for renewable energies in Nicaragua. Local renewables could help reduce reliance on fuel imports which introduce economic volatility and vulnerability into the economy, and which contribute to global greenhouse gas accumulation.
- There are many agricultural residues such as sugar cane straw and bagasse which could potentially be used for a 2<sup>nd</sup>-generation biofuel industry in Nicaragua. Sustained availability of feedstocks, cost and access to technology are the main concerns.
- Breadfruit processing has the potential to make use of a common natural resource and promote economic development and trade on the Caribbean Coast.