POWERING AGRIFOOD VALUE CHAINS

2015-2017 REEEEP
Water-Food-Energy in Agrifood Portfolio
**ABOUT REEEP**

**REEEP** invests in clean energy markets in developing countries to reduce CO2 emissions and build prosperity. Based on a strategic portfolio of high impact projects, REEEP works to generate energy access, improve lives and economic opportunities, build sustainable markets, and combat climate change.

**REEEP** understands market change from a practice, policy and financial perspective. We monitor, evaluate and learn from our portfolio to understand opportunities and barriers to success within markets. These insights then influence policy, increase public and private investment, and inform our portfolio strategy to build scale within and replication across markets.

**REEEP** is committed to open access to knowledge to support entrepreneurship, innovation and policy improvements to empower market shifts across the developing world.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Topic</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>WATER-ENERGY-FOOD NEXUS</td>
<td>6</td>
</tr>
<tr>
<td>IN AGRIFOOD</td>
<td></td>
</tr>
<tr>
<td>CLEAN ENERGY IN THE AGRIFOOD VALUE CHAIN</td>
<td>8-11</td>
</tr>
<tr>
<td>CLIMATE: PREDICTING THE ALTERNATE FUTURE</td>
<td>12</td>
</tr>
<tr>
<td>PROSPERITY: FROM CO-BENEFITS TO CORE-BENEFITS</td>
<td>13</td>
</tr>
<tr>
<td>POWERING AGRIFOOD VALUE CHAINS: PORTFOLIO</td>
<td>14-45</td>
</tr>
<tr>
<td>SOLAR POWERED IRRIGATION IN KENYA – PART I</td>
<td>16-19</td>
</tr>
<tr>
<td>SOLAR POWERED IRRIGATION IN KENYA – PART II</td>
<td>20-21</td>
</tr>
<tr>
<td>SOLAR POWERED MULTI-USE COLD STORAGE IN UGANDA</td>
<td>22-25</td>
</tr>
<tr>
<td>BIOGAS POWERED AGRICULTURAL PROCESSING IN CAMBODIA</td>
<td>26-29</td>
</tr>
<tr>
<td>PICO HYDRO POWERED MILLS IN NEPAL</td>
<td>30-33</td>
</tr>
<tr>
<td>SOLAR POWERED DAIRY REFRIGERATION IN BANGLADESH</td>
<td>34-37</td>
</tr>
<tr>
<td>SOLAR POWERED AGRIFOOD PROCESSING IN TANZANIA</td>
<td>38-39</td>
</tr>
<tr>
<td>RENEWABLE ENERGY FARMING SOLUTIONS IN NICARAGUA</td>
<td>40-43</td>
</tr>
<tr>
<td>EFFICIENT IRRIGATION IN NICARAGUA</td>
<td>44-45</td>
</tr>
</tbody>
</table>

An efficient low-pressure drip irrigation system (Credit: iDEal)

WATER-ENERGY-FOOD NEXUS IN AGRIFOOD

CLEAN ENERGY IN THE AGRIFOOD VALUE CHAIN

CLIMATE: PREDICTING THE ALTERNATE FUTURE

PROSPERITY: FROM CO-BENEFITS TO CORE-BENEFITS

POWERING AGRIFOOD VALUE CHAINS: PORTFOLIO

SOLAR POWERED IRRIGATION IN KENYA – PART I

SOLAR POWERED IRRIGATION IN KENYA – PART II

SOLAR POWERED MULTI-USE COLD STORAGE IN UGANDA

BIOGAS POWERED AGRICULTURAL PROCESSING IN CAMBODIA

PICO HYDRO POWERED MILLS IN NEPAL

SOLAR POWERED DAIRY REFRIGERATION IN BANGLADESH

SOLAR POWERED AGRIFOOD PROCESSING IN TANZANIA

RENEWABLE ENERGY FARMING SOLUTIONS IN NICARAGUA

EFFICIENT IRRIGATION IN NICARAGUA
WATER-ENERGY-FOOD NEXUS
IN AGRIFOOD

Water, energy and food systems are inextricably interconnected.

Water and energy are needed to produce food; water is needed for almost all forms of power generation; energy is required to treat and transport water. The relationships and trade-offs within this triangle of resources are known collectively as the water-energy-food nexus.

Understanding water-energy-food inter-linkages and managing them holistically is critical to sustainability. But while some private enterprises in the agrifood sector understand the significance of the nexus – and some have already seen competitive advantages in nexus-driven solutions for sustainable crop management, processing, distribution and retailing – most have not yet grasped this opportunity. REEEP has since 2012 put special emphasis on tackling the nexus, focusing in particular on the agrifood sector – the most prominent single subsector within the nexus. With global food production expected to increase 70% by 2050, the sector is facing unprecedented resource pressures, with more on the horizon.

AGRIFOOD SECTOR

70% > OF TOTAL FRESHWATER USE

30% > TOTAL ENERGY DEMAND

12–30% > MAN-MADE GHG EMISSIONS

70% > INCREASE IN GLOBAL FOOD

Rice husks, a waste product of processing, can be converted into power through biodigestion in Cambodia (see page 28 for more).
CLEAN ENERGY IN THE AGRIFOOD VALUE CHAIN

The REEEP Water-Energy-Food Nexus in Agrifood Pathway stems from recognition of critical need for investment in agricultural value chains in development countries. The sector is hugely important for ensuring food security for rapidly growing populations, and providing economic security for numerous people participating at various stages of agricultural value chains, from farm to table.

Food-producing agriculture (agrifood) value chains can and must undergo innovation to increase efficiency and yields, enhance variety, and meet new dietary demands of growing middle-classes worldwide. To do so sustainably they must reduce waste and pollution, better manage and conserve water resources, and ensure that local prosperity is improved.

Energy will power the sweeping developments in agriculture that will happen over the coming decades, and while the potential for improving economic and human prosperity is great, so too is the potential for exacerbating climate change – if that energy is derived from fossil fuels.

CLEAN ENERGY IN THE AGRIFOOD VALUE CHAIN: EXAMPLES

- Solar, wind-powered water pumping
- Biofuel-powered machinery
- Solar desalination, heating/cooling
- Efficient machinery/maintenance
- Low-pressure, efficient irrigation
- Biomass residue energy generation

- Solar, geothermal food drying for storage
- Solar cooling and refrigeration
- Minimized/efficient packaging
- Food loss reductions
- Efficient drying
- Improved insulation for cool storage

- Solar, wind, hydro milling, pressing, cooking, drying, etc.
- Renewable electricity and heating application
- Modern biomass for cooking
- Efficient processing for cooking
- Smart integration into existing fossil fuel-based power systems

- Biofuel for transportation and distribution
- Solar cooling and refrigeration (retail)
- Truck design and operation
- Improved efficient infrastructure
- Efficient market information through modern ICTs
- Capacity building for farmers, traders, etc. to improve understanding of value.
The new agricultural revolution must be clean – powered by renewable energy and energy efficient systems. Specific renewable energy and efficiency solutions aimed at developing country agrifood value chains, particularly at the SME level, face myriad challenges of the sort that have also faced renewables and efficiency in developed countries: high up-front and investment costs, comparatively long payback periods, misunderstood or mistrusted novel technologies, lack of standards and quality assurance track records, and non-existent or outmoded financing availability (both in terms of investment as well as consumer finance).

These challenges are often magnified by other policy related “ecosystem conditions” that are unique to specific countries and business cases, such as unreliable or unpredictable regulatory regimes, taxes and duties, fossil fuel subsidies, and stretched purchasing power of target markets.

To ignite and accelerate self-sustaining market growth for these solutions REEEP designed a multi-stage incubation programme for high potential ventures that pushes innovative business models forward while gaining critical insight into the ecosystem conditions that so highly influence success.

The potential benefits of clean nexus approaches are considerable in terms of avoided and reduced greenhouse gas emissions, and perhaps even greater in terms of prosperity and human well-being.

But how can we better understand these potentials: the capacities for benefit – or for harm – embodied in the various possible scenarios these immensely complex systems will follow?

### SCALING BUSINESS MODELS IN ENERGY FOR AGRIFOOD:

<table>
<thead>
<tr>
<th>Ecosystem Conditions and Commercial Value Chain Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LEGAL &amp; REGULATORY</strong></td>
</tr>
<tr>
<td>Tariffs, legal requirements, and other policy-related factors</td>
</tr>
<tr>
<td><strong>CORPORATE FINANCE</strong></td>
</tr>
<tr>
<td>Accessing investment and working capital to fund growth and operations</td>
</tr>
<tr>
<td><strong>SUBSIDIES</strong></td>
</tr>
<tr>
<td>Using public monies to break even or produce profits</td>
</tr>
<tr>
<td><strong>CARBON FINANCE</strong></td>
</tr>
<tr>
<td>Securing income from carbon credit</td>
</tr>
<tr>
<td><strong>FUEL</strong></td>
</tr>
<tr>
<td>Supply of cooking fuels, procurement of fuels / foodstock for mini-utilities or central utilities</td>
</tr>
<tr>
<td><strong>DESIGN / R&amp;D</strong></td>
</tr>
<tr>
<td>Development of product or service offerings for the market</td>
</tr>
<tr>
<td><strong>PRODUCTION / GENERATION</strong></td>
</tr>
<tr>
<td>Manufacturing of products or generation of electricity</td>
</tr>
<tr>
<td><strong>MARKETING</strong></td>
</tr>
<tr>
<td>Creating awareness of new offerings</td>
</tr>
<tr>
<td><strong>SALES &amp; DISTRIBUTION</strong></td>
</tr>
<tr>
<td>Finding customers and delivering the product or service</td>
</tr>
<tr>
<td><strong>BILLING / PAYMENT</strong></td>
</tr>
<tr>
<td>Collection of revenues from customers, product payment, or fee for service</td>
</tr>
<tr>
<td><strong>CONSUMER FINANCE</strong></td>
</tr>
<tr>
<td>Providing a means to reduce the up-front cost of purchase</td>
</tr>
<tr>
<td><strong>AFTER SALES</strong></td>
</tr>
<tr>
<td>Service, maintenance, and repairs</td>
</tr>
</tbody>
</table>
CLIMATE: PREDICTING THE ALTERNATE FUTURE

Many developing countries are, at the moment, comparatively low emitters of carbon dioxide and other greenhouse gases because of slow economic development. Thus the true potential for alleviating the effects of climate change in many sectors comes not from addressing current emissions, but from avoiding those emissions that will come as a consequence of development using current technologies and practices.

Estimating the emissions that will likely result from business-as-usual development scenarios is exceedingly difficult and plagued with uncertainties; despite this the exercise is a vital one, because it drives to the core of green growth and the role of innovation in helping developing countries leapfrog polluting and unsustainable technologies and practices.

In looking for high-potential sectors, REEEP is seeking those sectors in which a specific development-related trend can be predicted to result in significant increases in greenhouse gas emissions over a period of 10 to 15 years. In the case of agrifood value chains, this trend is generally related to the introduction of a carbon-intensive energy source or wasteful practice. For instance, the rapid expansion of irrigation practices in Kenya, supported by incentive policies at the national level, is resulting in an accelerating trend toward diesel irrigation pumps to meet demand. Without an alternative, the transition to diesel-powered irrigation will lead to a significant amount of CO2 and particulate matter pollution being emitted into the atmosphere in the coming decade.

REEEP creates 15-year baseline scenarios (to 2030) for the specific market cases in which it has preliminarily identified a potential for CO2 avoidance based on current and/or expected trends in the sector. Where available, REEEP develops Business As Usual (BAU) projections based on UNFCCC-approved methodologies with reasonable assumptions of market growth trends in existing carbon-intensive practices. REEEP then creates a reduced-emissions benchmark scenario to explore what is possible if a local or national market for a specific clean energy “fix” can be allowed to thrive.

REEEP continues to refine and improve the methodologies and processes behind this scenario modelling, and will be using data and knowledge gained through our enhanced monitoring and evaluation to test our benchmarks and the key indicators used to define them.

PROSPERITY: FROM CO-BENEFITS TO CORE-BENEFITS

The growth side of the green growth equation is equally important, yet even more complex and daunting than the climate aspect.

When most people talk about growth in an economic context, they mean growth in production and/or income and measured in gross domestic product (GDP). Yet there is increasing demand for a more complete—and sustainable—concept of well-being, one that would shift how we define growth from growth in production to growth in well-being, or prosperity. This definition of prosperity is a composite one, incorporating several dimensions that are critical to quality of life and well-being:

- The natural dimension, which includes the environmental and ecological components of prosperity;
- The economic dimension, which includes the income, employment, and associated components of prosperity;
- The human dimension, which includes the health, education and other benefits to human experience that make up prosperity.

Over the past decade, REEEP projects have brought about not only economic and market benefits for the areas in which they were carried out; they have resulted in an array of what are often called “co-benefits”: improved health, reduced drudgery, improved educational opportunities, employment, changes in status for women and disadvantaged groups, reduced damages to the natural environment, and others. While these benefits are often chronicled anecdotally, they are not systematically recorded through monitoring and evaluation, nor can they be systematically analysed for meaning and utilised for strategic guidance.

Yet these benefits should be seen as more than just by-products—they are core benefits to those experiencing them first hand. As a first step toward better understanding and measuring prosperity, REEEP is looking at ways to systematically record, quantify (where appropriate) and analyse changes in prosperity that occur throughout the project life cycle.

POWERING AGRIFOOD VALUE CHAINS:

CLIMATE/NATURE
- Energy output – renewable (kWh) / efficiency (kWh saved)
- GHG mitigation/avoidance (CO2)

ECONOMIC
- Employment (jobs)
- Market capitalization (of additional investment)
- Market share of clean energy (% increase)
- Debt/equity (D/E)
- Profit (% increase)
- Income (% increase among clients)

HUMAN
- Access to energy (number of individuals)

VALUE CHAIN PERFORMANCE
- Production improvement (% increase)
- Loss/waste reduction (% decrease)
- Improved product life spans (% increase)

In addition, Most Significant Change tracking helps us monitor specific expected and unexpected developments that fall outside the boundaries of this indicator suite.
POWERING AGRIFOOD VALUE CHAINS: PORTFOLIO

The following 30 pages feature profiles of the nine ventures making up REEEP’s 2015 – 2017 Powering Agrifood Value Chains Portfolio
SOLAR POWERED IRRIGATION IN KENYA – PART I

Powering Agrifood Value Chains: FUTUREPUMP

Powering Agrifood Value Chains is REEEP’s 10th funding round, and includes nine ventures with innovative clean energy-based solutions to building prosperity through agrifood value chains. In recent years, the challenge of reducing poverty in the poorest parts of Africa has often been answered by calls for increased irrigation to improve crop yields, food security and nutrition. As in many developing countries, agriculture is the lifeblood of Kenya’s economy, directly responsible for over a quarter of GDP and a fifth of formal employment (and over 70% of informal jobs in rural areas).

To improve productivity and wealth generation in the agricultural sector, irrigation will need to expand to cover the full potential of irrigable land, a trend already well underway. Currently, diesel engine irrigation pumps are powering this expansion, a reality that will – if unchecked – lead to considerable growth in CO2 and particulate matter pollution. REEEP estimates that broad expansion of a market for a renewable alternative could result in nearly 3 million tonnes CO2 of emissions avoidance per year by 2030.

THE SOLUTION, BY FUTUREPUMP

Futurepump, now receiving its second round of financing from REEEP, has developed a new model to enable smallholder farmers in Kenya to adopt sustainable irrigation solutions with a proprietary solar powered irrigation pump, combined with an end-user finance programme that allows for flexible payments at a time when the farmer is gaining the economic benefits from irrigating their lands.

With this innovative model, Futurepump is able to reach even very low income farmers with less than one acre of land – which constitute the majority of the agricultural sector in Kenya. By addressing a key barrier in up-front cost, and by targeting the market segment accounting for the majority of production (yet is most difficult to reach via conventional sales models), FuturePump’s model holds great potential for transforming the sector in the country.

KEY FACTS

AGRICULTURE

• Half of GDP (directly and indirectly)
• 65% of export earnings
• 18% of formal employment, up to 70% in rural areas

IRRIGATION POTENTIAL

• 1,341,900 hectares – only 161,000 currently irrigated
• Kenya aims to expand irrigation by 80,000 ha per year to 2030

SMALLHOLDER SECTOR

• Responsible for up to 70% of staple crop production
• 40% of irrigated land
• 0.25% of bank loans
• Establishing demonstration farms
• Solar (PV) powered irrigation systems tailored to the needs of smallholder farmers in remote rural areas
• Service is included at no charge where needed
• 3 customized asset finance approaches: Pay-as-you-go, rent-to-own, buy-as-you-use
• Partnership with last mile financing specialist to enable pay-as-you-go payments for pro-poor irrigation services

KEY INNOVATIONS: COMMERCIAL PROCESS

• Solar (PV) powered irrigation systems tailored to the needs of smallholder farmers in remote rural areas
IRRIGATION IN general – and Solar Powered Irrigation Systems (or SPIS) in particular – can provide substantial benefits to local prosperity in regions that adopt them. The most direct benefit is the increased revenue and income that come with the greater yields of irrigated cropland vis-à-vis rain-fed land. Stable water supplies allow additional growing seasons per year, massively increasing output. Drip irrigation (a central, although not unique, element of SPIS) can save around 80% of water compared to current practices, and improves crop quality thanks to more stable supply, often improving real yields by over 300%. In addition, SPIS offer significant cost savings over time on labour, fuel and fertilizer, a total value to smallholder farmers estimated at around $14,000 per acre annually.

Economically, the benefits of increased use of SPIS translates into local opportunities beyond the agricultural boundaries, as small businesses arise to meet demand in manufacture, assembly, repair and sales of SPIS.

THE SOLUTION, BY SUNCULTURE

With the tremendous solar potential in Kenya and the maturity of PV and electric pump technology, the agricultural sector, including smallholder-level farms, is an ideal candidate for rapid growth. The limiting factors are, however, largely socioeconomic.

SunCulture is focusing on addressing several barriers to market scale. On the demand side, SunCulture is utilising several strategies to uncover and cultivate existing demand for solar powered irrigation, leveraging new media opportunities together with success stories from early adopters and the reach of a high profile local partner in East Africa’s largest microfinance-focused bank.

This partnership is a crucial element to reducing the perceived risk of the technology among a traditionally risk-averse market segment.

Further, SunCulture is developing its client base from a value chain perspective, combining the technology and financing offer with additional elements of market access and technical knowledge to help clients leverage improved productivity into improved incomes and quality of life.

**THE DATA, BY SUNCULTURE**

![Diagram](image-url)

**CURRENT TREND**

*BAU scenario: 100%*  

**NEW TREND**  

*SOLAR PUMP*

Source: REEEP Analytics

**KEY INNOVATIONS:**

**COMMERCIAL PROCESS**

- Dedicated and rapid customer response support (including agronomist support)
- Solar (PV) powered irrigation systems tailored to the needs of smallholder farmers in remote rural areas
- Customer finance from Equity Bank (largest microfinance institution in East Africa) based on Technical Survey Reports
- One-stop solution as part of installation service:  
  1. Agronomist technical advice and Technical Service Report generation based on soil and market analysis  
  2. Training for farmers in agricultural practices and access to markets  
  3. Referral partnerships with major greengrocers
SOLAR POWERED MULTI-USE COLD STORAGE
IN UGANDA

Powering Agrifood Value Chains: STATION ENERGY

Like many countries in Africa, Uganda’s economy is highly dependent upon the agricultural sector, which contributes to over 70% of its export earnings and is the main source of livelihood and employment for over 60% of the population, and in some areas of the country up to 90%. At the same time, the agricultural sector suffers from inefficiency and low productivity, and the government has identified agriculture – and especially the development of key export areas such as horticulture and fisheries – as the pillars of a strategy for increasing Ugandan economic and social development.

The fundamental challenges in Ugandan agriculture are connected to high post-harvest losses, lack of access to affordable technology, and access to medium and long-term financing. In particular food wastage from poor post-harvest storage carry a heavy toll on economies and populations in Africa, where the FAO estimates food losses could feed 300 million people. These losses represent a “double” waste of energy, in that both the energy put into production, as well as the chemical energy stored in the food itself, are wasted in post-harvest losses.

THE SOLUTION, BY STATION ENERGY

Given Uganda’s solar potential and the necessity of distributed storage facilities to minimize transport distances between field and storage, off-grid solar PV powered cold storage represents a significant opportunity to improve agricultural production and incomes, reduce waste and improve food security, and avoid the GHG emissions from fossil fuel powered alternatives. REEEP estimates that market scale up of solar powered cold storage could save more than 100,000 tonnes (equivalent) of CO2 a year by 2030.

Station Energy has developed an innovative concept for a solar-powered cold room that would provide refrigeration and freezing for fresh products of any type in isolated areas. This solution is especially adapted for agricultural cooperatives, fishermen associations, sanitary usages (conservation of vaccines) or for ensuring cold chain integrity in food processing and distribution.

Station Energy will offer use of the cold room as a service to farmers and households, rather than requiring them to put high upfront costs into ownership and maintenance. Station Energy will tap a pioneering equity crowdfunding platform to scale-up rapidly.

KEY FACTS

AGRICULTURE

- 70% of Uganda’s export earnings
- 24% of GDP
- Employs 70% of the population

POTENTIAL FOR REDUCING POST-HARVEST LOSSES

- 30 – 50% of agricultural output currently lost
- Currently available options for cold storage are diesel and kerosene based solutions with high upfront and running cost
- Favourable tax regime for solar powered cold chain exists

SMALLHOLDER SECTOR

- Most land cultivated by smallholders
- Gradual transition from subsistence to production for the market
- 30% of smallholders supplement their income with petty businesses and trade

Source: REEEP Analytics
A Station Energy solar PV powered agricultural cooling unit (Credit: Station Energy)

- Seven pilot units (cold storage containers) to demonstrate the value proposition in Uganda
- Capacity building to farmers to maximise use of agrifood production and reduce waste
- Solar powered and well insulated cold rooms tailored for fresh produce refrigeration in remote off-grid areas which do not require expensive and polluting use of batteries
- Cold space renting to cooperatives (farming, fish, dairy) to allow affordable and risk-mitigated access to food conservation and overcome capital expenditure barrier
- Innovative crowdfunded financing for scale through “Invest.In”

**AGRIFOOD VALUE CHAIN**
**SOLAR PV POWERED, INSULATED CONTAINERS**

**KEY INNOVATIONS:**
**COMMERCIAL PROCESS**

- Seven pilot units (cold storage containers) to demonstrate the value proposition in Uganda
- Capacity building to farmers to maximise use of agrifood production and reduce waste
- Cold space renting to cooperatives (farming, fish, dairy) to allow affordable and risk-mitigated access to food conservation and overcome capital expenditure barrier
- Innovative crowdfunded financing for scale through “Invest.In”
BIOGAS POWERED AGRICULTURAL PROCESSING IN CAMBODIA

In Cambodia, the agricultural sector contributes to around a third of national GDP and about half of formal employment. The staple crop is rice, of which some 9.3 million tons were harvested and processed in 2014 alone, accounting for more than 3% of the world’s exports after feeding the population of around 15 million people.

The rural areas home to the rice producing sector and 85% of the population also suffer from energy poverty, with most of the rural population not having access to electricity. With Cambodia’s energy production capacity still recovering from war, there is great potential in utilising distributed off-grid electrification models to bring affordable electricity to rural households.

The Royal Government of Cambodia (RGC) has made it a priority to bring modern energy access to rural areas (at least 70% electrification by 2030), and a major potential lies in a primary waste component of the rice producing sector: the rice husk.

THE SOLUTION, BY NEXUS C4D

Rice husks are the indigestible coatings of rice grains, produced and discarded by Cambodian rice millers at the rate of more than 1 million tons per year. They are also potential sources of energy through bio-gasification processes.

At current conversion rates, Cambodia’s rice milling waste could generate between 60-100MW of electricity per year. REEEP estimates that compared to diesel alternatives, a rice husk gasification market could displace some 80,000 tonnes CO2e per year by 2030.

The project is addressing a major barrier to market expansion: access to finance for the SME-level operators of rice mills. REEEP and NexusC4D, with deep experience in the renewable energy SME sector, will set up a revolving fund to provide affordable loans to rice mills to switch from diesel electricity generation to rice husk gasification. The programme will also help operators develop a bankable offer for ongoing investments from local banks.

KEY FACTS

AGRICULTURE

• 37% of GDP (2012)
• >50% employed in the agricultural sector
• Cambodia holds 3% of worldwide rice export (1.2 million tonnes)
• integral factor for strengthening Cambodia’s economy and food security
• Cambodia participates in the World Bank’s “Pilot Program for Climate Resistance for the rice sector”

IMPACT POTENTIAL

• Electrification rate of 33% (2011).
• National plans to reach an electrification rate of 70%

RICE SECTOR

• 9.3 million tons paddy rice was produced (2014) for a total population of 15 million people
A rice processing facility in Cambodia (Credit: Nexus C4D)

**KEY INNOVATIONS: COMMERCIAL PROCESS**

- Providing a 12-month maintenance contract to the recipient of the technology within which mechanics will pay a monthly visit to the rice mill to maintain the installation and provide further trainings for the rice miller’s employees on maintenance, etc. Spare parts are included in the contract
- Revolving fund helps mill owners to avoid high interest loans at unfavourable conditions from local banks
- Offering a loan product that covers 80% of investment costs, with a payback period of approx. 3 years and an interest rate of 8%
PICO HYDRO
POWERED MILLS
IN NEPAL

Powering Agrifood Value Chains:
CLEAN ENERGY DEVELOPMENT BANK AND SNV

Nepal is among the poorest and least developed countries in the world, with about one quarter of the population currently living below the poverty line. Agriculture is the predominant sector of the economy, employing over 70% of the population and accounting for around 38% of GDP. At the same time, Nepal is highly vulnerable to food insecurity, due in large part to market access inadequacies for Nepalese farmers, who are mostly subsistence farmers. Productivity levels remain low as a result of limited access to new farming technologies, inputs, and extension services.

Nepal is also energy-poor, having no known fossil fuel reserves of any type and hindered by extremely difficult terrain upon which to build energy infrastructure. Electrification in Nepal was around 50% in 2010, with around two-thirds of Nepali citizens using locally-sourced firewood for cooking needs.

THE SOLUTION, BY THE CLEAN ENERGY DEVELOPMENT BANK AND SNV

For centuries Nepal’s farmers have utilised the country’s vast hydropower potential via Traditional Water Mills (TWMs), primarily to grind maize and wheat. This is a prime area for innovation and investment, and indeed solutions to upgrade them already exist.

Whereas a typical TWM produces up to 0.5kW and manages 10–20kg of grain per hour, an improved version (known as an Improved Water Mill or IWM) can produce between 1–5kW and process more than 50kg per hour, and new versions allow other uses such as paddy hulling, oil expelling, saw milling and electricity generation.

The potential benefits of large-scale market take-up of these new IWMs as a replacement for TWMs and displacement of encroaching diesel generators are significant. Compared to diesel, REEEP estimates that Nepal could avoid up to 60,000 tCO2 annually, and drastically improve livelihoods of local farmers.

Standing in the way is a combination of high upfront investment costs, lack of financing opportunities and under-developed business models for add-on services.

The Clean Energy Development Bank and SNV have developed an innovative offer that incorporates a new IWM, capacity building and targeted financing to allow the formation of community-owned village electrification committees and agrifood processing enterprises to manage the IWMs. A major aspect of the venture is the simultaneous provision of credit to potential owner/operators, marketing and capacity-building on how to economically utilise the IWMs benefits for smallholder and subsistence farmers, the development of pay-per-use consumer financing model for processing services and an electricity tariff structure for the village.

KEY FACTS

AGRICULTURE

- Employs over 70% of the population
- 38% of GDP
- Highly vulnerable to food insecurity

POTENTIAL FOR HYDRO POWER

- 50% electrification rate
- Economic hydro power potential 42,000 MW
- Traditional Water Mills (ghattas) used for maize and wheat processing for centuries
- Improved water mills offer better power output and increased processing capacity, as well as much needed access to electricity for rural people.

FOOD PROCESSING MICRO-ENTERPRISE SECTOR

- Low productivity due to limited access to new technologies, inputs and extension services
- Targeted communities are remote mountainous villages with little prospect for grid connectivity
AGRIFOOD VALUE CHAIN
HYDRO (PICO)

KEY INNOVATIONS:
COMMERCIAL PROCESS

• GRINDING
• MILLING
• EXPPELLING (OIL)
• PRESSING

• GRINDING
• MILLING
• EXPPELLING (OIL)
• PRESSING

• Targeted marketing and capacity building for village electrification committees, Farmer owner/operators, local banks

• Pay-per-use product for agricultural processing sales

• Consumer financing product targeted to farmer cooperatives/village electrification committees

POWERING AGRIFOOD VALUE CHAINS
SOLAR POWERED DAIRY REFRIGERATION IN BANGLADESH

Powering Agrifood Value Chains: ENERPLUS

Bangladesh’s economy is predominantly agricultural, generating around 63% of total employment, with over 70% of the population living in rural areas. In 2010, the agricultural sector accounted for 20.1% of GDP. According to the FAO, the country’s mixed farming system has led to close interdependencies between crop production and animal husbandry, with livestock having pronounced status as providers of food, nutrition, savings, draught power, manure, transport and other social and cultural functions.

Bangladesh’s citizens also suffer disproportionately from malnutrition. Half of Bangladeshi children under five are chronically malnourished, leading to lifelong growth complications, and 30% of the population is below the minimum level of dietary energy consumption. Dairy products are important to providing caloric and essential vitamin intakes for both children and adults, and while bovine livestock is common, inefficiencies and waste lead to significant unmet demand, currently filled with expensive imported dairy in mostly condensed form.

Transitioning Bangladesh’s mostly subsistence-level dairy production to market-oriented units requires improvements in knowledge and technology, and access to energy.

Milk Collection Centres, which act as hubs for smallholder dairy farmers and provide access to cooling units, essential for ensuring quality over the time necessary to transport products to market, have played a large role in this transition.

THE SOLUTION, BY ENERPLUS

Enerplus is working with the dairy firm PRAN Dairy, a pioneer of the “dairy hub” concept, to retrofit existing diesel-powered cooling units with solar PV units, and build new collection centres incorporating renewable energy.

The market for dairy cooling could be avoiding close to 12,000 tonnes of CO2 annually by 2030 by shifting from diesel gensets to solar PV and other (e.g. biogas) renewable sources. At the same time, cooling provides a critical service to smallholder farmers and directly impacts dairy supply – and thus food security and related health and well-being outcomes in the country.

By offering access electricity via mini-grids to surrounding villages, the collection centres also bring modern energy access to low-access areas.

KEY FACTS

AGRICULTURE
- Employs 63% of total workforce
- Generates 20% of GDP
- Higher farm productivity and stimulating SMEs a central strategy for increasing food security

POTENTIAL FOR INCREASED DAIRY COLLECTION
- Milk production doubled during last decade
- Daily consumption of dairy products in Bangladesh remains very low (WHO)
- Dairy market dominated (80%) by unprocessed raw milk
- Dairy processing industry relying on imported milk powder

DAIRY SECTOR
- Mainly small scale operations integrated with crops and other farm activities
- Major source of nutrition and income
- Smallholders play a key role in both formal and informal markets
AGRIFOOD VALUE CHAIN
SOLAR PV/ SOLAR THERMAL ABSORPTION CHILLERS, ICE STORAGE

KEY INNOVATIONS:
COMMERCIAL PROCESS

• RE for powering milk collection centers

• Provision of electricity as an extension service to dairy farmers and increasing milk collection in return

• Sales of electricity to milk collection centers during a 5-6h receiving/cooling process as well as to dairy farmers supplying the dairy processor collecting the milk (via mini-grid)

• Deduction of farmer’s mini-grid connection fees and electricity costs from their monthly payments for milk sold to milk processor

FUEL

COMMERCIAL PROCESS

AFTER SALES

MARKETING

SALES / DISTRIBUTION

BILLING / PAYMENT

CONSUMER FINANCING

PRODUCTION / GENERATION

DESIGN / R&D
SOLAR POWERED AGRIFOOD PROCESSING IN TANZANIA

Powering Agrifood Value Chains: REDAVIA

Agriculture is the backbone of Tanzania’s economy, contributing around a quarter of GDP and employing three quarters of the labour force in this country of 44 million people. Tanzania’s staple crop is maize, in which it is largely self-sufficient; however, increasing droughts and harvest losses are endangering this, further stressing the 34% of the population below the income poverty line.

Tanzania’s rapid GDP growth of some 6–7% annually over the past decade has come in large part from the agricultural sector, including fibers (e.g. cotton), coffee, tea, sugar, fruits, nuts (particularly cashews) and oils. Much of this growth has come from advancements in farming and harvesting; for Tanzania to maintain its economic growth and generate prosperity it must concentrate on the potential in post-harvest value-added, which has received less attention from government programmes.

Adequate post-harvest processing to maintain added value within local agrifood value chains will require both energy and financing. Tanzania, which is one of Sustainable Energy for All’s 14 African priority countries, is currently struggling to expand modern energy access, which is still not available to some two-thirds of the population. At the same time, only 9% of Tanzania’s population has access to formal financial services, and only 4% has ever received a loan from a bank – a situation that has stilted investment in the agriculture sector.

THE SOLUTION, BY REDAVIA

Redavia is a pioneer in multipurpose solar-diesel hybrid farms, standalone high-output solar PV systems that can be employed in a variety of end uses in frontier markets, and paid for via an innovative Pay As You Go model.

Redavia will replicate this product, which has already found success in sectors with similar energy demand (for instance, the mining sector), and does not require up-front investment, in the agricultural sector. Redavia’s innovative business model will replace unreliable fossil fuel-based power from the electricity grid, resulting in 20–50% reductions in energy costs for agricultural processors, while expanding access to nearby communities via mini-grids.

Redavia will be focusing initially on coffee, tea, oilseeds and cashews processing firms, which suffer from frequent power outages and high costs of back-up-generator power.

This project is currently under consideration.
RENEWABLE ENERGY FARMING SOLUTIONS IN NICARAGUA

Powering Agrifood Value Chains: TECNOSOL

Nicaragua is Central America’s poorest country, with about half the population of 5.68 million living on less than USD 1 per day, most of these in rural areas. According to the Central Bank of Nicaragua, the agricultural sector represents 20% of GDP and more than 60% of annual exports, while providing 30% of formal employment. As in many developing countries, the sector is dominated by small farmers, with three-quarters of farmers owning less than 3.5 hectares.

Nicaraguan agricultural practices are highly inefficient. In the cattle livestock sector, which represents some 45% of the agricultural sector and is alone responsible for 10% of Nicaragua’s GDP, Nicaragua trails its neighbors in per-cow production, fertility and growth. Smallholder cattle farmers generally follow unproductive and environmentally deleterious short-term pasture strategies to compensate for limited grazing areas, often triggering deforestation and land degradation. Forest conversion to pasture land has accounted for some 97% of total CO2 emissions in Brazil, Chile, Nicaragua and Paraguay.

Nicaragua has no access to electricity, with only 43% electrification rates in rural areas, where the majority of the agricultural sector is located. Nicaragua is home to significant renewable potential from various sources, including solar and biomass, and while the government is pursuing aggressive renewable energy goals (94% renewable by 2017), these goals remain elusive.

THE SOLUTION, BY TECNOSOL

Tecnosol has been a pioneer for clean energy technologies in Nicaragua for over 15 years. As interest in compact clean energy solutions is increasing, Tecnosol has expanded their product offering from distributed solar PV systems to include biogasifiers, solar water pumps and solar-powered electric fencing.

As part of Powering Agrifood Value Chains, Tecnosol will be tapping latent demand for multi-purpose energy solutions that fulfill a range of needs of small farmers in off-grid areas, including manure-based biogasification, solar powered electric fencing units, solar water pumps and standalone solar PV units.

The multipurpose farming solutions will impart a breadth of benefits to farmers and rural areas. Electric fencing and the associated training significantly improves pasture management techniques and limits land degradation and deforestation. Manure biodigesters improve waste processing and generate energy for household cooking and electricity needs. Tecnosol is partnering with major micro-lender KIVA to meet demand for financing for these productivity-improving products that local banks are unable to meet.

KEY FACTS

AGRICULTURE

• 20% of GDP - cattle industry stands for 10% of GDP
• <40% of grid coverage in rural areas
• 950,000 people are employed on farms per year - 15% of total population

IMPACT POTENTIAL

• Production level 3-5L milk/cow is low compared to 14L in neighbouring countries
• Target group: 30,000 cattlemen with over 5ha in those regions

CATTLE SECTOR

• 260,000 farmers (2011) – 53,000 of which are involved in cattle farming
AGRIFOOD VALUE CHAIN
BIODIGESTER, SOLAR-POWERED ELECTRIC FENCES, SOLAR PV, SOLAR WATER PUMPS

KEY INNOVATIONS: COMMERCIAL PROCESS

- HERDING
- IRRIGATION

- Develop financial channels: Consumer finance product for first 112 systems supported by Kiva
- Create a working relationship with banks to provide loans in the future
- Develop sales channels: Distribution channels for the product cooperatives and/or slaughterhouses generate sales
- Awareness raising of technology package through cooperation with associations and cooperatives
- 28 demo plots established
- Participation in fairs and events hosted by cooperatives and productive organisations
- Production of biogas

FUEL

PRODUCTION / GENERATION

MARKETING

SALES / DISTRIBUTION

BILLING / PAYMENT

CONSUMER FINANCING

AFTER SALES

COMMERCIAL PROCESS

POWERING AGRIFOOD VALUE CHAINS
EFFICIENT IRRIGATION IN NICARAGUA

Powering Agrifood Value Chains: IDEAL TECNOLOGÍAS

Nicaragua’s agricultural sector represents 20% of annual GDP and 60% of exports.

Among the sector’s most important products are basic grains, which is responsible for around 40% of agricultural-derived GDP, and coffee, as well as various fruits and vegetables. Like the livestock sector grain, coffee, fruit and vegetable farms are significantly less productive than farms in neighboring countries, a situation that represents a significant opportunity for improving the country’s prosperity through technological and market oriented advancements.

In Nicaragua, while only around 10% of arable land is irrigated, increasing droughts and extended dry seasons are exerting additional stress on farmers throughout the country. Crop management in Nicaragua is typically inefficient, characterised by field flooding and furrow irrigation, and using disproportionate amounts of fertilizers and pesticides. The sector is ripe for innovation.

THE SOLUTION, BY IDEAL TECNOLOGÍAS

Low-pressure drip irrigation holds tremendous potential to increase efficiency, reduce water and fertilizer use, extend growing seasons and improve productivity. By precisely delivering smaller amounts of water directly to plant roots, low-pressure drip irrigation increases output and can extend effective productive seasons.

Nicaragua, barriers to this technology include a lack of financing, as well as a lack of understanding and risk aversion from both farmers and lenders. IDEal Tecnologías is addressing these with a combination of a specialised micro drip irrigation system to lower overall cost, a strategy to cultivate a retailer network of technicians who can both sell and conduct after-sales service, and a marketing plan focusing on opening doors for longer term agricultural practice transformation.

Nicaragua’s agricultural sector represents 20% of annual GDP and 60% of exports.

Among the sector’s most important products are basic grains, which is responsible for around 40% of agricultural-derived GDP, and coffee, as well as various fruits and vegetables. Like the livestock sector grain, coffee, fruit and vegetable farms are significantly less productive than farms in neighboring countries, a situation that represents a significant opportunity for improving the country’s prosperity through technological and market oriented advancements.

In Nicaragua, while only around 10% of arable land is irrigated, increasing droughts and extended dry seasons are exerting additional stress on farmers throughout the country. Crop management in Nicaragua is typically inefficient, characterised by field flooding and furrow irrigation, and using disproportionate amounts of fertilizers and pesticides. The sector is ripe for innovation.

THE SOLUTION, BY IDEAL TECNOLOGÍAS

Low-pressure drip irrigation holds tremendous potential to increase efficiency, reduce water and fertilizer use, extend growing seasons and improve productivity. By precisely delivering smaller amounts of water directly to plant roots, low-pressure drip irrigation increases output and can extend effective productive seasons.

Nicaragua, barriers to this technology include a lack of financing, as well as a lack of understanding and risk aversion from both farmers and lenders. IDEal Tecnologías is addressing these with a combination of a specialised micro drip irrigation system to lower overall cost, a strategy to cultivate a retailer network of technicians who can both sell and conduct after-sales service, and a marketing plan focusing on opening doors for longer term agricultural practice transformation.

Nicaragua’s agricultural sector represents 20% of annual GDP and 60% of exports.

Among the sector’s most important products are basic grains, which is responsible for around 40% of agricultural-derived GDP, and coffee, as well as various fruits and vegetables. Like the livestock sector grain, coffee, fruit and vegetable farms are significantly less productive than farms in neighboring countries, a situation that represents a significant opportunity for improving the country’s prosperity through technological and market oriented advancements.

In Nicaragua, while only around 10% of arable land is irrigated, increasing droughts and extended dry seasons are exerting additional stress on farmers throughout the country. Crop management in Nicaragua is typically inefficient, characterised by field flooding and furrow irrigation, and using disproportionate amounts of fertilizers and pesticides. The sector is ripe for innovation.

THE SOLUTION, BY IDEAL TECNOLOGÍAS

Low-pressure drip irrigation holds tremendous potential to increase efficiency, reduce water and fertilizer use, extend growing seasons and improve productivity. By precisely delivering smaller amounts of water directly to plant roots, low-pressure drip irrigation increases output and can extend effective productive seasons.

Nicaragua, barriers to this technology include a lack of financing, as well as a lack of understanding and risk aversion from both farmers and lenders. IDEal Tecnologías is addressing these with a combination of a specialised micro drip irrigation system to lower overall cost, a strategy to cultivate a retailer network of technicians who can both sell and conduct after-sales service, and a marketing plan focusing on opening doors for longer term agricultural practice transformation.

Nicaragua’s agricultural sector represents 20% of annual GDP and 60% of exports.

Among the sector’s most important products are basic grains, which is responsible for around 40% of agricultural-derived GDP, and coffee, as well as various fruits and vegetables. Like the livestock sector grain, coffee, fruit and vegetable farms are significantly less productive than farms in neighboring countries, a situation that represents a significant opportunity for improving the country’s prosperity through technological and market oriented advancements.

In Nicaragua, while only around 10% of arable land is irrigated, increasing droughts and extended dry seasons are exerting additional stress on farmers throughout the country. Crop management in Nicaragua is typically inefficient, characterised by field flooding and furrow irrigation, and using disproportionate amounts of fertilizers and pesticides. The sector is ripe for innovation.

THE SOLUTION, BY IDEAL TECNOLOGÍAS

Low-pressure drip irrigation holds tremendous potential to increase efficiency, reduce water and fertilizer use, extend growing seasons and improve productivity. By precisely delivering smaller amounts of water directly to plant roots, low-pressure drip irrigation increases output and can extend effective productive seasons.

Nicaragua, barriers to this technology include a lack of financing, as well as a lack of understanding and risk aversion from both farmers and lenders. IDEal Tecnologías is addressing these with a combination of a specialised micro drip irrigation system to lower overall cost, a strategy to cultivate a retailer network of technicians who can both sell and conduct after-sales service, and a marketing plan focusing on opening doors for longer term agricultural practice transformation.

Nicaragua’s agricultural sector represents 20% of annual GDP and 60% of exports.

Among the sector’s most important products are basic grains, which is responsible for around 40% of agricultural-derived GDP, and coffee, as well as various fruits and vegetables. Like the livestock sector grain, coffee, fruit and vegetable farms are significantly less productive than farms in neighboring countries, a situation that represents a significant opportunity for improving the country’s prosperity through technological and market oriented advancements.

In Nicaragua, while only around 10% of arable land is irrigated, increasing droughts and extended dry seasons are exerting additional stress on farmers throughout the country. Crop management in Nicaragua is typically inefficient, characterised by field flooding and furrow irrigation, and using disproportionate amounts of fertilizers and pesticides. The sector is ripe for innovation.

THE SOLUTION, BY IDEAL TECNOLOGÍAS

Low-pressure drip irrigation holds tremendous potential to increase efficiency, reduce water and fertilizer use, extend growing seasons and improve productivity. By precisely delivering smaller amounts of water directly to plant roots, low-pressure drip irrigation increases output and can extend effective productive seasons.

Nicaragua, barriers to this technology include a lack of financing, as well as a lack of understanding and risk aversion from both farmers and lenders. IDEal Tecnologías is addressing these with a combination of a specialised micro drip irrigation system to lower overall cost, a strategy to cultivate a retailer network of technicians who can both sell and conduct after-sales service, and a marketing plan focusing on opening doors for longer term agricultural practice transformation.
REFERENCES


El-Hage Scialabba, N.; FAO (2010): Organic agriculture and climate change. Renewable Agriculture and Food Systems


Sutton, John and Omihi, Donath; International Growth Centre (2012): An Enterprise Map of Tanzania

Gelinas, Douglas and Reggenson, Richard; NBER (2010): AGRICULTURE, ROADS, AND ECONOMIC DEVELOPMENT IN UGANDA

IFAD (2014): Investing in rural people in Nicaragua


Azadegan, Shazi (2014): Gender mainstreaming in the Nicaraguan dual-purpose cattle value chain, CGIAR Livestock and Fish

Azadegan, Shazi (2014): Characterizing actors in the dual-purpose cattle value chain in Nicaragua: A gender perspective, CGIAR Livestock and Fish


http://www.opendevelopmentcambodia.net/briefing/the-cambodian-energy-sector/

Royal Government of Cambodia (2013): NATIONAL POLICY, STRATEGY AND ACTION PLAN ON ENERGY EFFICIENCY IN CAMBODIA

FAO (2013): Milk and Dairy Products in Human Nutrition


LEDS-GP Transportation Assessment Toolkit

PHOTO CREDITS

16: Futurepump

40: Tecnosol

22: Station Energy

44: iDEal

26: Nexus C4D

This document is printed on paper from sustainable sources.

CONTACT, REEEP

Vienna International Centre D-2170
Wagramer Str. 5
A-1400 Vienna
PHONE +43 1 26026 3425
E-MAIL info@reeep.org
www.reeep.org