Comprehensive project implementation report for DRR in agriculture

TCP/BZE/3202

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Introduction

This comprehensive project implementation report for DRR in agriculture, provides an overview of the implementation process and outcomes of the TCP/BZE/3202 project, titled "Improved national and local capacities for hurricane related disaster preparedness, mitigation and response in the agricultural sector in Belize". This project was implemented from October 2008 until August 2011.

The objectives of this project are:

- To support small farmers in selected villages through the identification and demonstration of appropriate DRM technologies and practices (including exploring options for adoption of financial risk mitigation tools) and build capacity for replication;
- To build the institutional and technical capacities within the MAF at national and district levels to more effectively manage all phases of the disaster cycle;
- To build the technical and institutional capacities to undertake improved damage and needs assessments in the agriculture sector (with a specific focus on the identification of the needs to protect food security and livelihoods of most vulnerable rural populations).

This report consists of several sections, including:

- Project background, rational, expected outcome and outputs and project beneficiaries;
- Selection of villages and communities vulnerable to known hazards;
- Good DRM practices implementation plan;
- Selection and testing of DRM practices for demonstrations;
- Results and lessons learned of DRM practices in the villages of Santa Martha, Concepcion Calla Creek

1. Background

1.1 General context

Natural disasters are recognized in Belize as one of the major challenges for agriculture development and food and livelihood security of small farmers. The country is affected by hurricanes, tropical storms, flooding and drought on a regular basis. In August 2007, Hurricane Dean, a category five hurricane, hit the north of Belize affecting 14 000 people and causing an economic damage of USD 14 million mostly due to direct wind damage and flooding. The northern Districts of Corozal and Orange Walk were the most severely affected. National Government, donors and international organizations have been providing support for immediate relief and early recovery, including through distribution of inputs to the most affected farmers. In 2010 Belize was again hit by a hurricane (Richard).

Limited and/or absence of technical options for risk reduction at the field level, increases farmers vulnerability to hurricanes. In fact, most cultural practices employed did not withstand the intensity of the disaster. Furthermore, the institutional framework for Disaster Risk Management (DRM) in Belize is presently inadequate in fostering prevention, preparedness and recovery in the agriculture sector. The National Emergency Management Organization (NEMO) is the national focal point for the implementation of the Hyogo framework for action. However, there is currently no direct involvement of the agriculture sector in the national activities for disaster risk mitigation and preparedness and agriculture sector and small farmers' priorities are not yet addressed in the NEMO DRM framework. In addition the review of available damage and needs assessment information revealed that post disaster response by the Ministry of Agriculture and Fisheries (MAF) is constrained due a number of challenges including use of different parameters in determining damage, and little or no formal training in damage and needs assessment among key agricultural officials.

Belize is an ethnically diverse nation on the east coast of Central America with a population of 291 800[*] and land area of 8 867 square miles. The country is divided into six administrative districts (Corozal and Orange Walk in the north, Belize and Cayo in the central zone, and the Stann Creek and Toledo districts in the south) which vary in their population density, ethnicity and patterns of culture. Overall 48 percent of the population resides in towns while 52 percent lives in rural areas[†].

Belize is considered a middle income country with a Human Development Index (HDI) ranking of 95[‡]. Albeit this, approximately one third of the population lives at or below the poverty line, while 10.8 percent of the population is designated as indigent[§]. Agriculture continues to form the foundation of the productive sector and the rural

[*] Central Statistical Office, Government of Belize. Mid-Year Estimate 2005.
[†] Government of Belize, 2002. Medium Term Economic Strategy 2003-2005.
[‡] Human Development Index, 2005. Accessed on October 19, 2007 at http://www.undp.org/.
[§] National Human Development Advisory Committee and Ministry of National Development, Investment and Culture Belize, 2007. National Poverty Elimination Strategy (NPES) 2007-2011.

economy of Belize. At least 12.1 percent of gross domestic product (GDP) is directly dependent on agriculture, fisheries and forestry[*]. Recent natural disasters within the last seven years have undermined the agriculture industry and the capacities of small farmers to achieve livelihood security.

1.2 Sectoral context

Belize's national development strategy aims at achieving sustainable development, equitable distribution of resources, and comprehensive socio-economic strategies to achieve broad-based economic growth. Poverty reduction is central to the development agenda and is a major priority of the Government of Belize. In fact, in an effort to meet the MDGs of reducing extreme poverty by one-half in 2015, the Government of Belize has developed a National Poverty Elimination Strategy 2007-2011 (NPES) which fully supports and complements national development policies[†].

Natural disasters are recognized in Belize as one of the major challenges for agriculture development and food and livelihood security of small farmers. The agriculture sector is envisioned by the Government of Belize as the vehicle for providing the economic base to support economic growth and development including poverty reduction. The National Food and Agriculture Policy (2002-2020) highlights that the major challenges for the agriculture sector in Belize are: i) the globalization process (North American Free Trade Area, World Trade Organization) which has impacted tremendously on the banana industry and may potentially affect on the citrus and sugar industries in coming years; ii) the downward trend fluctuation in prices received for export commodities; iii) natural disasters (Hurricane Keith, Tropical Storm Chantal and Hurricane Iris have caused more than USD 200 million in damages to the sector)[‡].

1.3 Project justification

In August 2007 Hurricane Dean, a category five hurricane, hit the north of Belize affecting 14 000 people and causing an economic damage of USD 14 million mostly due to direct wind damage and flooding.

FAO assistance under the Technical Cooperation Programme Facility (TCPF) was requested by the Government to review available and relevant information on reported damages in the agriculture sector and determine possible follow-up assistance. The mission produced a report which provides an overview of disaster losses data, impacts on rural livelihoods, current coping strategies and needs to enhance resilience to hurricane

[*] Central Statistical Officer, Government of Belize, 2006. National Accounts 2006.
[†] National Human Development Advisory Committee and Ministry of National Development, Investment and Culture Belize, 2007. NPES 2007-2011.
[‡] Ministry of Agriculture and Fisheries, 2003. The National Food and Agriculture Policy (2002-2020).

related disasters in the agriculture sector. The major features of the report are summarized below.

The northern Districts of Corozal and Orange Walk were the most severely affected. The two districts have populations of 36 365 and 47 145 respectively with most inhabitants concentrated in rural areas (75 percent in Corozal and 66 percent in Orange Walk). According to latest available MAF data (2003), total household population in the agriculture sector involved in cropping, livestock or agriculture in the two most affected districts was more than 22,000 dependant on slightly more than 5,780 holdings mainly in the cropping sector (4,045). According to Damage Assessment and Needs Analysis Report (DANA) of the NEMO (September 2007) the total amount of families directly affected by the hurricane was 5 200 in Corozal and 1 323 in Orange Walk[*].

Economic losses in the agriculture sector within two districts have been of USD 0.8 million in Corozal District and USD 0.3 million in Orange Walk. Both districts are predominantly agricultural oriented with sugar cane and papaya being the principal crop of economic importance and vegetable production and backyard assorted fruit trees being of key importance for food security and income generation of small farmers. Most of the economic losses (55 percent) have been associated with the destruction of papaya plantations (loss of about 50 percent of plated areas) followed by sugar cane (loss of 40 percent of the planted areas). Between 50 percent to 100 percent of backyard fruit and vegetable crops (assorted vegetables, peppers, plantain, coconut, pineapple) grown by small farmers for subsistence purposes have also been lost.

The damage assessment report indicates that communities which have been most adversely affected by the hurricane (close to 100 percent loss of subsistence crops) are the villages of Consejo, Conception and Christo Rey in Corozal and Santha Martha and San Carlos in Orange Walk. In the other affected villages a number of coping strategies were identified during brief on-site visits, they include:

- papaya farmers: majority of the young and non-fruiting papaya trees were not affected; farmers having plants at this stage continued to maintain them. All farmers were trying to broker soft loans from lending institutions;
- assorted vegetable farmers: trying to access soft loans through St. Fancis Xavier Credit Union in the Corozal District. Others were looking for short-term employment or donations to reinitiate their prehurricane agricultural production;
- fruit tree farmers: those affected were looking for soft loans. Some were working to maintain their remaining fruit trees manually;
- plantain farmers: most of these farmers were solely dedicated to plantain from an agricultural stand point and all production was lost. Some, whose villages are near the coast, were dedicating time to fishing for daily meals or to attain some sort of income. Most were also looking for some financial assistance through soft loans from lending institutions;

[*] Average family size being five members.

- corn farmers: milpa (non-mechanized) farmers would hand harvest crop blown to the ground and sell on the local market.

Immediate needs identified by small farmers included seeds and seedlings, fertilizers and agrochemicals. The majority expressed preference for accessibility to soft and affordable loans to purchase such inputs rather than direct distribution.

The Government of Belize, the Belize Red Cross, Florida Caribbean Cruise Association (FCCA), OAK Foundation, the Non-governmental organization (NGO) Alliance of Belize and other local organizations have been providing immediate support for relief. Contributions from these organizations included monetary donations, health and housing supplies and human resource capital. In addition a number of donors and international organizations have provided support to the MAF for early recovery of the agriculture sector through input distribution.
Farmers' vulnerability to Hurricane Dean was increased tremendously due to the limited and/or no incorporation of technical options for risk reduction at the field level. In fact, most cultural practices employed did not withstand the intensity of the disaster. The need to demonstrate and adopt appropriate technical options for disaster prevention and mitigation to reduce small farmers increasing vulnerability to natural hazards and poverty are therefore critical.

Furthermore, the institutional framework for DRM in Belize is presently inadequate in fostering prevention, preparedness and recovery in the agriculture sector. The NEMO is the national focal point for the implementation of the Hyogo framework for action. It was established in February of 1999, as the result of Government's immediate response to the aftermath of Hurricane Mitch. NEMO's mission is to "preserve life and property throughout the country of Belize in the event of an emergency and to mitigate the impact on the country and its people". Arrangements for disaster preparedness and response plans are well advanced in the country while hazard mitigation planning is currently being developed with the support of Canada, Italy, Barbados, Jamaica and Inter-American Development Bank (IDB).

However, there is currently no direct involvement of the agriculture sector in the national activities for disaster risk mitigation and preparedness and agriculture sector and small farmers priorities are not yet addressed in the NEMO DRM framework. The technical capacity within the MAF is also inadequate and must be strengthened to facilitate disaster risk reduction and effective response and rehabilitation also taking into consideration climate change adaptation needs.

In addition, the review of available damage and needs assessment information revealed that post-disaster response by the MAF is constrained due to a number of challenges *inter alia*, inadequate maintenance of farmers baseline livelihood information, use of different parameters in determining damage and little or no formal training in damage and needs assessment among key agricultural officials. The need, therefore, is to

enhance capacities within the MAF in preparation for postdisaster response and in assessing damage and needs within the agriculture sector for immediate flash and post-flash appeals for timely aid relief are critical.

The occurrence in June 2008 of the Tropical Storm Arthur and its impact on the agricultural sector has reinforced the urgent need to proceed along the above outlined strategy and strengthen preparedness capacities. Practical field demonstrations in areas affected by the recent storm of good practices for DRM will assist farmers in recovery and a sustainable rehabilitation process.

The streamlining of the Comprehensive Disaster Management (CDM) coordination and enhancement process programme is a Caribbean Community (CARICOM) initiative funded by the Canadian International Development Agency (CIDA) to promote better harmonization for donor support for CDM driven programming in key sectors including agriculture. Within that programme context FAO has been requested to take a lead role for the agricultural sector. The expected outputs of the process are: DRM priority outcomes 2006-2011; assessment report of CDM implementation; revised CDM strategy and framework and monitoring plan for the region. The TCP offers a timely opportunity to establish operational links in the agricultural sector in Belize to actively participate in and contribute to the region wide CDM process.

The project is also positioned to maximize the complementary benefits of the Belize Rural Development Programme (BDRP)[*] and the European Union's (EU) funded Accompanying Measures for Sugar Protocol Countries project[†], which supports income generation and diversification projects in Northern Belize.

1.4 Beneficiaries and targeting

Direct beneficiaries include the MAF Extension and Policy Departments, producers organizations and vulnerable small farmers within the poorest villages of the Corozal and Orange Walk Districts and other recurrently hazard exposed districts.

Starting point for targeting beneficiaries for good practices for disaster mitigation in agriculture will be areas heavily affected by hurricane dean and within those:

- in the Corozal District plantain farmers in Chunox and Sarteneja, and vegetable farmers in Consejo, Concepcion and Christo Rey due to the following reasons:
  - the majority of papaya and sugar cane acreages affected are owned by large private corporations, does not fit within the FAO's mandate for assistance;

[*] The BRDP seeks to reduce rural poverty through assistance to poor small farmers in all districts including Corozal and Orange Walk.
[†] An investment of EUR 3 038 million/BZD 7 633 886.4.

- plantain farmers in Chunox and Sarteneja, and the vegetable growers in Concepcion, Christo Rey and Consejo are considered the most vulnerable groups of farmers due to the lack of safety nets and the extreme difficulty in acquiring soft loans for recommencing field production;

In the Orange Walk District the villages of San Carlos and Santa Martha due to the following reasons:

- the high incidence of poverty and the remoteness of these farming communities to the major economic and administrative centres in Orange Walk;
- Santa Martha is one of the three poorest villages in Orange Walk and suffered tremendous losses among the three most economically important crops;
- Similarly, San Carlos village is totally dependent on vegetable production for their economic livelihood and sustainability. All assorted vegetable production, including a recently developed external market driven hot pepper production, was lost due to Hurricane Dean in this village.

Building on the previously mentioned initial targeting strategy, other farming communities/villages, including in other districts affected by hurricane Arthur and also vulnerable to hurricane hazards, will be included as well (detailed criteria for selection will be determined at the project inception workshop).

Within the vulnerable farmers' communities, farmers will benefit at two levels. All farmers in the targeted districts/regions will benefit from demonstrations of good practices, their analysis and support for replication of successfully tested options. Those farmers who volunteer to conduct pilot demonstrations on their own fields will further benefit from direct learning and on the spot training, and the fact that the project will contribute (30-60 percent depending on technology) to the costs of the demonstrations.

The project aims at implementing about 100 demonstrations on farmers field for the benefit of about 600 families (which is equivalent to about 12 percent of all farm holdings in Corozal and Orange Walk) through demonstrations either on their own fields or participation in design, development and testing of protection structures and infrastructure such as covered protection for crops, stocking facilities, drainage clearance, etc.

1.5 Expected project impact, outcome and outputs

Impact

The project will contribute to the improved resilience of the agriculture sector to natural disasters and to the sustainable attainment of food and livelihoods security.

Outcome

Improved national and local capacities for hurricane related disaster mitigation, preparedness and response in the agricultural sector.

Outputs

Output 1: appropriate DRM technologies and practices**,** including financial risk mitigation tools, identified and promoted on pilot basis in selected villages affected by hurricanes Dean and Arthur and other areas representing vulnerable farming systems highly exposed to hurricane hazards.

Output 2: a Plan of Action (PoA) to strengthen national and local capacities for DRM in the agricultural sector, including mechanisms for linking with national DRM and climate change adaptation frameworks.

Output 3: national and local capacities for conducting livelihoods based damage and needs assessment enhanced.

2. Selection of villages, communities vulnerable to known hazards

Before the identification of villages and communities vulnerable to hazards took place, appropriate DRM technologies and practices were identified. The technical specifications describing the technologies and practices and how to implement them are described in a separate report titled **"Good DRM practices for Belizean small farmers"**, which can be found on the FAO project website. In this section, the methodology and results for the selection of the villages, as well as the methodology and rating for defining the standard practices for successful small farming systems in Belize are described.

2.1 Introduction

Events leading to the development of and the rationale for the DRM project are presented in the project document. The intended outcome is improved national and local capacities for hurricane related disaster mitigation, preparedness, and response in the agricultural sector. This has been modified somewhat to include other weather related hazards, namely drought and flood.

It was recognized that while hurricanes get the most media coverage because of their dramatic impacts on people and physical structures, drought and flood have been, and will continue to be major constraints to agriculture and pose even greater threats than hurricanes to livelihoods in this sector. Within the context of climate change, drought, floods, and hurricanes are expected more frequently and with widely fluctuating intensities in the future, and therefore no DRM project would be complete without the inclusion of all three.

The expected outputs remain unchanged, namely testing appropriate DRM technologies and practices, a national plan of action, and national and local capacity building. Selecting villages/communities vulnerable to known hazards is the first in a series of activities associated with output one, the testing of appropriate DRM technologies and practices in such areas. This report deals with the selection process.

2.2 Method

Selection of villages/communities vulnerable to hazards for testing of DRM technologies and practices was conducted in three parts and presented in a plan of work (*table 1*), namely:

- Series of inception meetings to inform, and obtain tangible support from strategic stakeholders, especially in Government, on project objectives, expected results, and potential areas of collaboration and locations for implementation.

- Meetings with District Agricultural Coordinators (DACs), Agriculture extension staff, and National Emergency Management Organization (NEMO) coordinators, to discuss the project and select potential villages/communities for implementation of pilot studies.
- Meetings with Villagers to explain the project, its importance in preserving livelihoods and reducing risks associated with future hazards, and selecting villages based on criteria developed (*table 2*).

2.3 Results

Results of the selection process are summarized in *table 3*. From sixteen potential villages, six were selected for testing DRM technologies and practices on a pilot basis. Those selected were Patchakan and Concepcion in Corozal district, San Jose and Santa Martha in Orange Walk district, and Calla Creek and El Progresso in Cayo district. Villages/communities in the Belize district were not selected for the DRM study as social issues posed greater risks to agriculture than natural hazards in this district and addressing such issues were not within the scope of this project.

The six communities cover a wide range of farming systems which include short term crop production as with vegetable production in El Progresso, Calla Creek, Concepcion and Santa Martha, perennial crop production, as exemplified by sugarcane, in Santa Martha, San Jose, and Patchakan, and mixed farming involving both crops and livestock in Calla Creek. Drought and flood were identified as the principal hazards. The northern communities offer opportunities for synergies with the EU funded crop diversification project in sugarcane which also fits into the proposed DRM framework and naturally expands the resource base of the project.

The next series of activities scheduled are associated with study and documentation of agricultural practices in each village/community or with each farming system, especially as they relate to climate risk reduction and identify potential entry points for the project. This would be combined with the visit of Nabi Khan, an expert in DRM to assist in directing the proposed pilot projects.

Table 1: Work Plan: Selection of Villages/Communities with faming systems vulnerable to hazards (DROUGHT, FLOODS, and HURRICANES).

Objectives	Activities	Time frame	Outputs
Develop criteria for selecting villages/communities	• Visits to disaster sites • Discussions with team and extension staff. • Literature review.	Completed 05/01/09	Criteria for village suitability.
Project briefs	Inception meetings with:	06/01/09	

presented to stakeholders.	• Minister and CEO MAF • National Emergency Coordinator • Chief meteorologist and chief hydrologist. • DAOs and NEMO coordinators for Cayo, Belize, and North Belize (Orange Walk, Corozal). • Minister of Nat. Resources/Representative.	to14/01/09	
Identify potential villages/communities for project study.	• Meetings with: Agric. Extension staff and NEMO district coordinators. • Examination of damage assessment, and hydro-met. Data.	06/01/09 to 14/01/09	A list of three potential villages/communities from each of three districts: Cayo, Belize and North Belize (Orange Walk and Corozal).
Selection of villages/communities.	Each village was visited and evaluated based on criteria for suitability.	16/01/09 to 20/01/09	Two villages/comm. from each district selected.

Table 2: Criteria for selection of Villages/Communities with faming systems vulnerable to hazards (DROUGHT, FLOODS, and HURRICANES)

1. Must be rural and located within the administrative districts of Cayo, Belize, and North Belize (Orange Walk and Corozal).
2. Region or area is frequently affected by hazards.
3. Data is available to characterize the hazards and the frequency of recurrence.

4. Hazards, especially DROUGHT, FLOODS, and HURRICANE, pose significant risks to the farming systems, are major constraints to further agriculture livelihood development of residents.
5. Small agriculture based enterprises and subsistence farming comprise the main economic activity of villages/communities.
6. Village /community is structured with participation of a wide cross-section of residents in its community based organizations. Access to village resources and means of production is not restricted to special interest groups.
7. Village/community should demonstrate an awareness of hazards and potential risks to their farming systems, and must be supportive of efforts to mitigate (lessen) the impact of hazards, and development of a culture of safety and resilience.

8. Distances between selected villages/communities pose no operational constraints to project implementation, and offer opportunities for collaboration and information sharing between groups.
9. Villages/communities themselves offer opportunities for synergies between this and other projects.

Table 3: Summary of village selection process for DRM project, Belize.

Administrative district	Potential Village/Community	Selected Village/Community	Identified Hazards	Comments
Cayo	El Progresso Calla Creek Bullet Tree Falls Santa Familia	El Progresso Calla Creek	Drought/ Flood, Soil borne diseases	Project welcomed in both communities selected.
Belize	Maypen Isabella Bank Lemonal Scotland Halfmoon	None	Floods	Social issues override environmental/weather constraints and dominate state of agric. dev.
Orange Walk	Santa Martha San Carlos San Jose San Pablo	Santa Martha San Jose	Drought, Flood, Salinity.	Potential for synergies with EU project in area of crop diversification as DRM intervention.
Corozal	Concepcion Patchakan Cristo Rey San Narcisco	Concepcion Patchakan	Drought, Flood	Potential for synergies with EU funded project.

2.4 Farming systems

Four characteristics, namely common vision, teamwork, mixed farming, and natural resource management, were used to define the standard practices for successful small farming systems in Belize. The first two define the social character of the residents and the community, while the latter two addresses the technical capabilities.

Farmers from the four selected groups were qualitatively rated based on these criteria and the results summarized in *table 4*. Vision was lacking in all the groups. Santa Martha exhibited the best teamwork approach, though there is room for development in relation to structure and responsibilities. All had some form of mixed farming as a coping strategy, but integration was lacking. Natural resource management was weak to non-existent and there was tendency towards the unsustainable and heavy use of fertilizers and chemicals in crop production; primarily as a response to advice from agrochemical businesses, but also because information of the dangers to the environment and its users, along with credible alternatives were lacking.

With respect to Hydro meteorological hazards, the groups at Concepcion, Calla Creek, and El Progresso are considered highly vulnerable, while Santa Martha is considered moderately vulnerable.

Table 4: Qualitative rating of the four demonstration groups in relation to the standard practices for successful small farming.

Village	Common Vision	Team Work/Collective Approach	Mixed Farming	Natural Resources Management
Santa Martha	Weak	Moderate	Moderate	Moderate
Concepcion	Weak	Weak	Weak	Weak
Calla Creek	Weak	Weak	Moderate	Weak
El Progresso	Weak	Weak	Moderate	Weak

3. Good DRM practices implementation plan

Appropriate DRM technologies and practices for Belizean small farmers were identified and described in a separate report titled "Good DRM practices for Belizean small farmers", which can be found on the FAO project website.

The introduction of and testing of good DRM practices to reduce losses due to disasters at the farming level is the common approach taken in introductory DRM studies in the Caribbean (FAO, 2007, 2009(a); Spence, 2008; Roberts & Shears, 2008) and forms the basis of this study. However, the current approach goes a step further and uses DRM practices to support and nurture the development of farming systems in pursuit of sustainable livelihoods.

3.1 Characteristics of successful, sustainable, small farming systems in selected pilot sites

The characteristics of successful, sustainable small farming systems in Belize were discussed previously (section), and four were selected in defining a standard. The selected characteristics were:

Common vision
Team work/collective approach
Integrated mixed farming
Natural resource management, with emphasis on soil management

Successful small farming communities must share a common vision which among other things must include farming as a business generating income and capable of supporting healthy, honest, and sustainable livelihoods. The stigma of associating agriculture as an inferior income generating activity, and excessive manual labour must be dispelled.

Promoting a culture of planning and working together is as essential to risk management and recovery efforts as it is to successful farming systems. Meeting to plan the crop cycle, planting schedules, procurement of inputs, marketing, etc., are all essential prerequisites in developing the collective approach in small farming communities. The practice once implemented and even institutionalized, becomes an important tool in planning and mobilization for disasters, and coordinating recovery efforts in the aftermath of disasters.

While essential to natural resource management, mixed farming is the prime ingredient in risk mitigation and sustainability, especially in rainfed, small farming systems where weather adversely affects some species more than others.

The productive capacity and sustainable use of the natural resource base, namely soil, water, and forests, depends on prudent balance of output and input, checking degradation and pollution and the promotion of practices to restore and enhance desirable properties.

3.2 Situational analysis

Two types of situational analysis was undertaken: namely a socio-economic and biophysical analysis. The former can be found in the report **"Situational assessment report"** can be found on the FAO project website, whereas the latter analysis is described in the following section that deals with the physical environment in relation to rainfall, water deficits, flood frequency, and soil and water properties at the selected demonstration sites. For a variety of reasons, the desired data are not all available for this report as the laboratory in Florida seems to have misplaced two soil samples. The sites will be resampled and the analysis included in an update to this report. Eventually, the information will be merged with socioeconomic data to present a comprehensive analysis of the situation at each of the selected sites.

3.2.1 Santa Martha Village

Rainfall and mean daily temperatures for Tower Hill station in Orange Walk, the closest hydromet gauging station to Santa Martha village, and considered representative of conditions in that village have been used to compute water deficits using an empirical relationship developed by Holdridge (ARSCOTT et al., 1965). The method though having limitations is considered adequate for a general characterization of the water regime especially in situations where hydromet network density is low and only a few meteorological parameters are available.

The data are presented in *table 5*. The high rainfall months are June to October when risks a rising from floods, and coincidentally hurricanes, are high. The water deficit months are November through to May when supplemental watering is required for crop production, and the farmer, using irrigation, is better able to control the soil-water regime. The same period covers conditions of both short days and low temperatures (November-January), and long days and high temperatures (March-May), which permit the cultivation of a wide range of crop varieties.

Selected information on soils sampled from the three sites in Santa Martha is presented in *table 6*. The data for Santa Martha show high soil pH values at and beyond which availability of most plant nutrients, both macro and micro, decline (Follet et al, 1981). The C.E.C. values are low indicating that the soil has a low buffering capacity and therefore fertilizer must be applied regularly and in small quantities. The predominance of calcium in the soil environment and naturally on the exchange complex (>82%

saturation) suggest likely problems with potassium and magnesium uptake and availability.

The organic matter content is low, a given for most tropical soils, and management should prevent further decline through organic matter additions. This would also increase the soil buffering capacity, enhancing both storage and availability of plant nutrients. Management must supply the crops' requirements for most nutrients through a programme which supplies small quantities regularly, as the soil, without organic matter additions, is a poor source of crop nutrients. Weekly fertigation is one such programme.

Table 5: Average monthly rainfall, potential evapotranspiration, and water deficits for Tower Hill (Lat. 18°12" N; Long. 88°24"W, elev. 13M AMSL) considered representative of conditions at Santa Martha Village.

Parameters	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Average Monthly Rainfall (mm)	76.8	33.7	28.8	45.9	99.1	202.5	191.7	205.6	171.0	188.7	101.6	77.4
Average*pot. Evapotranspiration (mm)	117.5	112.0	129.0	134.9	139.2	141.1	143.4	143.9	139.2	138.4	126.7	123.5
Deficits (mm)	40.7	78.3	100.2	89.0	40.1	(61.4)	(48.3)	(61.7)	(31.8)	(50.3)	25.1	46.1

*Estimated from Holdridge empirical formula
ETp = 0.0035T – 0.112
ETp = pot. Evapotranspiration in ins/day
T = mean daily temperature °F

Table 6: Analysis of soil samples taken from Santa Martha and Concepcion in the North of Belize

Location	Organic Matter %	pH	C.E.C* meq/100g	Potassium ppm. (%BS)†	Magnesium ppm. (%BS)	Calcium ppm. (%BS)
SM I	3.4	6.5	2.5	23 (2.4)	23 (7.6)	411 (82.0)
SM II	5.8	6.6	6.2	71 (2.9)	46 (6.1)	1056 (84.5)
SM III‡	4.6	6.9	3.7	70 (4.9)	29 (6.6)	652 (88.6)

* C.E.C=Cation Exchange Capacity.
† %BS=Percent Base Saturation.
‡ SM1=Santa Martha,site1

The analysis of irrigation water samples taken from the three sites in Santa Martha village are presented in *table 7*. In general the water quality is poor with site II in particular exhibiting the poorest quality.

Table 7: Analysis of irrigation water for three sites in Santa Martha, and one in Concepcion villages, Northern Belize.

Parameters	Location				comments
	SM I[*]	SM II	SM III	CI	
pH	7.4	7.2	7.5	7.3	
Cond. Mmhos/cm	0.76 (H)[†]	2.91 (VH)[‡]	1.39 (H)	0.85 (H)	
TDS (ppm)	486.4 (H)	1862.4 (VH)	889.6 (H)	544.0 (H)	Impacts osmotic potential, and as a consequence uptake of both water and nutrients.
Hardness	275.5 (A)[§]	652.5 (EH)[**]	314.1 (MH)	362.0 (MH)	
Na^+ (ppm)	34 (M)[††]	753 (VH)	156 (H)	10 (M)	Has a dispersing effect on soil, degrading structure, and reducing infiltration, water holding capacities and redistribution.
K^+ (ppm)	4 (M)	8 (M)	2 (M)	4 (M)	
Ca^{2+} (ppm)	85 (H)	177 (VH)	87 (H)	128 (VH)	
Mg^{2+} (ppm)	15 (M)	50 (H)	23 (M)	10 (M)	
HCO_3^- (ppm)	207 (VH)	120 (M)	181 (VH)	129 (H)	
Cl^-	101 (H)	640 (VH)	187 (H)	112 (H)	

[*] SMI=Santa Martha site1
[†] (H)=High
[‡] (VH)=Very High.
[§] (A)=Average.
[**] (EH)=Extremely High
[††] (M)=Medium

The TDS values are high giving rise to high osmotic potentials which reduces the uptake of both water and nutrients. High osmotic potentials in the soil water reduce water gradients at the soil/plant root interface and a consequential reduction the mass flow of water and nutrients is reduced. Additionally, the high sodium contents tend to degrade soil structure through colloidal dispersion, reducing infiltration, water holding capacity, and water redistribution within the soil. It is therefore important to manage the buildup of these harmful salts.

Management practices on these lands should include:

- Organic matter additions to protect the integrity of soil structure, maintain good internal drainage to facilitate leaching during the rain months of June to October.
- The use of high beds to facilitate leaching.
- Deep surface drains to control the water table depth, reduce ponding, and waterlogging.
- The use of salt tolerant varieties when available.
- The application of water directly to the soil with minimum wetting of the foliage, and in quantities sufficient to leach the root room.

3.2.2 Concepcion village

Mean monthly rainfall and mean daily temperatures collected from Libertad and considered representative of conditions at Concepcion were used to compute water deficit data presented in *table 8*.

Table 8: Average monthly rainfall, potential evapotranspiration and water deficits for Libertad (Lat. 18°17" N; Long. 88°28" W, elev. 12M AMSL) considered representative of conditions at Concepcion village.

Parameters	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Average monthly rainfall (mm)	68.8	29.9	33.1	63.2	97.1	222.2	137.9	188.5	226.3	208.1	89.1	64.2
Average monthly *pot.Evapotrans (mm)	114.1	109.8	124.0	128.2	133.5	135.4	139.4	138.9	142.6	131.5	117.1	117.6
Deficits (mm)	45.3	79.9	90.9	65.0	36.4	(86.8)	1.0	(49.6)	(83.7)	(76.6)	28.0	53.4

*Estimated from Holdridge empirical formula

ETp = 0.0035T – 0.112
ETp = pot. Evapotranspiration in ins/day
T = mean daily temperature °F

The data show trends similar to those for Santa Martha permitting the cultivation, with irrigation, of a wide range of crops. The vulnerable months, when both floods and hurricanes pose potential threats, are June to October.

Soil data for the Concepcion site are presented in Table 6 and again the trends are similar to those identified for Santa Martha, and a similar management approach is recommended. Data for irrigation water taken from the site are presented in Table 3. Though the total dissolved solids are high, sodium is not as predominant as the Santa Martha sources and therefore for irrigation purposes the water is of better quality.

3.2.3 Calla Creek, (Cayo)

Mean monthly rainfall and daily temperatures for Chaa Creek, considered representative of conditions in Calla Creek were used to compute water deficits presented in *table 9*.

Table 9: Average monthly rainfall, potential evapotranspiration and water deficits for Chaa Creek (Lat.17°06" N; Long. 88°04" W, 241M AMSL) considered representative of conditions at Calla Creek, Cayo.

Parameters	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Average monthly rainfall (mm)	48.7	57.7	26.9	16.3	140.4	120.8	112.1	117.4	140.7	236.4	156.8	113.9
Average*pot. Evapotranspiration (mm)	111.6	110.2	131.5	133.5	139.2	137.8	139.9	140.4	137.8	135.9	123.9	119.1
Deficits (mm)	62.9	52.5	104.6	117.2	(1.18)	17.0	27.8	23.0	(2.9)	(100.5)	(32.9)	5.2

*Estimated from Holdridge empirical formula
ETp = 0.0035T – 0.112
ETp = pot. Evapotranspiration in ins/day
T = mean daily temperature °F

The situation in Calla Creek with respect to rainfall and deficits differ significantly from the other selected areas. October is the most vulnerable month when the likelihood of floods is high. Calla Creek shares a watershed with Peten, Guatemala, and runoff is

influenced not only by the characteristics of rainfall and the drainage basin within Belize but more important, rainfall and land management within the Guatemalan portion of the watershed.

Deficits are experienced from December to August with May showing small surplus water. The majority of villagers inhabit the vulnerable alluvial flats along the Mopan River, and while conditions are ideal for irrigated crop production for most of the year, and a surface source of good quality water in the river is readily available throughout the dry season, the expected, commensurate agricultural output is lacking.

Soil data are currently not available for this site.

3.3 Selection and review of DRM practices for demonstrations

A first round of good DRM practices, taken from the options menu previously presented, were selected jointly with each village group based on **the principles of supporting the development of farming systems in pursuit of enhanced climate resilience and sustainable livelihoods**. The selected DRM activities were consolidated into this work plan which was presented to and cleared by a national technical validation group, established under the project to evaluate the practices in their suitability for the pilot villages in Belize; thereafter it was also reviewed and cleared by the national project steering committee, and then shared with FAO for final review and technical clearance.

The format for presentation was taken from FAO (2009 (b)) with modifications which included sections on capacity building requirements and a description of the practice. A comprehensive program of capacity building is considered crucial to the success of this phase of the project.

A second round of good practice selection is planned for later in 2009, after the first round of demonstrations will have started and further demands maybe identified.

The selected good practice options are village/site specific and presented in detail in the following chapters for each village separately.

The approach presented involves synergies with other organizations, namely UB, OIRSA, and RUTA, to develop the institutional capacity at UB for the sustainable supply of dual purpose poultry breeds to rural small farmers, at subsidized costs, in an effort to enhance local fowl production. This would be supported by the development of a compulsory course in Disaster Risk Management at this institution with the assistance of IADB. Together, the package is considered a solid foundation for an effective, inexpensive, and sustainable way to show case in selected villages good DRM practice and use them for wider dissemination after successful demonstrations, while

disseminating the message of better preparedness and mitigation in disaster management throughout rural Belize if not the whole country.

Implementation of Demonstrations

Approach

Weaknesses/deficiencies in the farming systems were identified for each pilot group, and appropriate DRM practices were introduced. The primary goal is to support the development of the selected farmers to effectively live with, and manage risks associated with likely hazards.
Since this report focuses on the technical interventions also the proposed capacity building intervention are technical in nature and directly linked to the proposed activities. It is important to stress here, that the technical training packages will be supplemented by process oriented aspects of capacity building including group formation and management, DRM planning, risk contingency planning etc. (not included in this report)

3.3.1 Santa Martha Group

The DRM practices jointly selected and to be introduced by the project are:

- Dairy cattle production.
- Irrigation development at each site.
- Local fowl production enhancement.

Dairy cattle management is compatible with small mixed farming systems, and provides: additional income during the dry season, source of organic matter for soil management, enhanced returns from sugarcane crop, and last but not least, additional source of protein as fresh milk, cream, and cheese, for the community.

Supplemental watering or irrigation is essential to extending the cropping pattern into the months of November to May when crop water deficits are experienced in this area (Table 5). This period of water deficits is characterized by low to moderate rainfall and reduced risks of crop losses arising from floods and hurricanes. The traditional rainy season of June to December still requires supplemental watering on account of the distribution pattern of rainfall with significant periods of deficit within months showing on average water surpluses. Combined with enhanced drainage systems, the small farmer is provided with soil water management tools effective in reducing risks associated with soil water extremes.

Local fowl production enhancement is not only a good DRM practice, but also an inexpensive way to propagate the DRM message throughout the community.

The package of DRM practices selected supports the development of a sustainable farming system which enhances the coping and resilience capacities of the group and hence reduces their vulnerability to climate risks.

Dairy cattle production

Dairy products account for some 20% of Belize's total agricultural food imports, equivalent to an average of 23.5M$ annually over the past 11 years (MAF, 2009). Promoting dairy production is consistent with the policy of GOB for small farmer development while attempting to reduce the food import bill.

The members of the group at Santa Martha are all small Milpa cane farmers, receiving low returns on their cane on account of low yields and the system of licensing of sugarcane producers which prevents them from selling directly to the factory. Yet sugarcane, one of the more efficient grasses, is an ideal forage for ruminant production systems. A small dairy production unit would not only give better returns on the cane crop, but would enhance incomes throughout the year, provide organic matter for soil management, and make additional sources of protein available in the community, while contributing to a reduction in the national food import bill. Since cattle are mobile and can be easily moved to safer places (higher grounds) when hurricane and/or flood warnings are issued (A hurricane warning is in place and reaches each village; a flood warning system is just being establishment where needed by NEMO).

The objectives of the demonstration are to promote small farmer dairy production in the Santa Martha area, which would better utilize the sugarcane crop, enhance incomes throughout the year, create additional income generation during periods when crop production is severely constrained, provide an important source of soil additive/ ameliorant, namely, organic matter and as a result of the above, reduce the overall farming system's vulnerability to natural hazard impacts.

The group would be supplied with 6 Dairy heifers, approximately 12 to 20 months of age, after constructing a feeding shed and holding area. The animals would be confined to this area for feeding, herein called the "Plot". The diet would be sugarcane based diet following the recommendation from studies conducted at the sugarcane feed centre, Trinidad. (SFC, 1983) This would be supplemented with controlled grazing on the roadside, and on small pastures plots to be developed by each member.

A dairy bull would be borrowed/rented from GOB when the heifers are of breeding weight/age for a sufficient period to have all animals served. At parturition, the calves would be allowed an intake of colostrum for two days before placing on an artificial milk replacer diet to be followed by a dry diet, or half the cow's production of milk followed

by a dry diet, or a combination of the two. The other half would be used for processing. In addition:

- The demonstration plot must be accessible to visitors by vehicle, and must be in close proximity to a water source.
- The farmers must each have at least one acre of Milpa sugarcane, within close proximity to the plot, or with means of transporting cane to the plot.
- Additional land to develop three small pastures, each of one acre is desirable.
- Experience with cattle handling is desirable.
- Farmers must agree to bear any costs outside the budget line.

Implementation Schedule

The implementation schedule is presented in Fig.1. It is envisaged that implementation would start in September and the entire process would be completed by December. A supply of organic matter would be available from November.

Technical details/production technology

Animals: Dairy breeds used in Belize are the Brown Swiss, Jersey and Holstein Freisen. Obtainng heifers may be a difficult task, but arrangements could be made with one of the Amish communities for a supply of six animals of 12to 20 months in age.

Nutrition: The aim is to used cultivated forages and mineral supplements, as opposed to processed feeds. The bulk of the nutrition would be based on chopped Sugarcane (*S. officinarum)*, mixed with high protein forages such as Mulberry (*M. alba*), Nacadero (*T. gigantea*), and Mombassa (*P. maximum cv.Mombassa*), and supplemented with a general purpose range mineral, trace mineral blocks, urea and molasses.

Animal health: It is important to ascertain that the animals were given blackleg vaccinations at weaning, but never the less they should receive a booster shot annually. Deworming should be done every 90days using Ivermectin, in rotation with an Albendazol, until maturity, thereafter every six months. Exotic breed are very susceptible to ticks infestations and as such the animals should be carefully monitored. Any infestation must be treated by spraying with Bayticol in rotation with Bovitraz on a 3week cycle until the parasites disappear. Other ectoparasites,such as beef worms, should be treated by physical removal of the larvae, and cleaning the wound with an antiseptic and fly repellant. Cuts and bruises should be similarly treated.

General instructions

Asign board has to be posted at the demonstration site. A sample of which is presented in section. All demonstration records must be kept in an assigned ledger at intervals as recommended in the monitoring plan. Exteme care should be taken that animals are not allowed to roam, as damage to other farmers crops could result with serious liabilities for the pilot group.

Capacity building requirements

Short courses dealing with:

- Cattle management with emphasis on dairy cattle.
- Cheese and cream production and non-refrigerated storage.
- Virtues of team work and systematic planning.
- Group leadership, group management and business planning for 2 years
- Risk and emergency contingency planning

Figure 1: Implementation schedule

Activities to be undertaken	Who is responsible?	Expected Output or Outcome	Monthly Chronogram											
			J	F	M	A	M	J	J	A	S	O	N	D	Etc.
Cutting posts and collection of waste lumber from sawmill.	Farmers	Lumber procured.								X					
Procurement of roofing material, barbed wire, staples, nails.	FAO/MAF	Constr. Materials procured								X					
Transporting materials to Plot.	FAO/MAF	Construction materials delivered to plot.								X					
Construction of feeding shed and holding area.	Farmers/ FAO/MAF	Shed and feeding area completed.									X				
Purchase of heifers and cane chopper, M&S.	FAO/MAF	Animals, chopper and M&S procured.										X			
Transporting animals, cane chopper, M&S to plot.	Contractor FAO/MAF	Animals, chopper, and M&S delivered to plot.										X			
Train animals and start feeding program.	Farmers	Adjustment to new environment.											X	X	
Collection and storage of manure and unutilized cane for composting.	Farmers	Stockpile of manure and cane trash.											X	X	X

Budget

Table10: Dairy cattle production, Santa Martha group.

Category	Item of Expenditure	Amount of Input	Unit Cost ($Bze)	Contributions ($Bze)	
				FAO	Farmer Group
Construction of Shed & Feeding area.	Bush Lumber (posts, beams, rafters)	Various	-	-	$1,500.00

20’ x 16’	Sawn Lumber	Various size 400Bft.	$1.82/Bft	$728.00	-
	Zinc for Shed (galvanized)	7 Sheets (16’ x 40’) 26 gauge	$110.35/sheet	$772.45	-
	Barbed wire	6	$125.00/roll	$750.00	-
	1” staples	10 lbs	$2.95/lb	$29.50	-
	Nails (3 ½ ” & 4”)	10 lbs	$3.65/lb	$36.50	-
	Transporting lumber	3 trips	$300/trip	$900.00	-
	Construction Supervision	2 days	$75/day	$150.00	-
	Construction Labor	16 man days	$30/man-day	-	$480.00
Pasture planting.	Labour	10man days/ ½ acre. X 6persons	$30.00/man-day		$1,800.00
Animal care	Labour	(3hrs/day)X180days	$30.00/man-day		$1,800.00
Animals	Heifers	6 x 700 lb/each	$2.00/lb	$8,400.00	-
Equipment	Cane Chopper	1	$650/each	$650.00	-
	Small Motor	1	$1200/each	-	$1,200.00
M&S	Salt Blocks	3	$23.00/each	$69.00	-
	Range Minerals	2 sks	$69.00/sk.	$138.00	-
	Molasses	2 x 55gal. drums	$28.50/drum	$57.00	-
	Urea	30 lbs	$6.50/10lb	$ 19.50	-
	Dewormers	250 mls	$80.00	$80.00	-
	Syringes & Needles	10 x 10 ml	$20.00	$20.00	-
	Fly Spray (matacresa)	1 can	$18.50/can	$18.50	-
	Rope	6 lbs	$6.00/lb	$36.00	-
	(55 gal) plastic drums	3	$25.00/each	$75.00	-
Visibility FAO/GOB	Metal sign	1(4’x2.5’)	$282.00	$282.00	
	Contingencies	5%TC		$660.57	
Total				**$13,872.02**	**$6,780.00**

Irrigation development for vegetable production

Belize imports some 8-13M$ of fruits and vegetables annually which accounts for a 11yr-average of about 10% of the total food import bill (MAF, 2009). This is unacceptable for a country which has a deficit budget and GOB’s policy aims to stimulate local production of fruits and vegetables with the hope of reducing the import bill.

Shifting production to periods of water deficit, through the introduction of irrigation, not only reduces the risks associated with crop production, common in rain fed systems, but enhances the income generating capacity of small farmers and their families. The

short growing period of most vegetable crops make them ideal for small farming systems and allows the complete production shift to the less vulnerable months of the year, enhanced livelihoods, and greater resilience to disasters.

The objective is to promote the production of vegetables during the period of low risk from hydro meteorological hazards, November to May for Santa Martha, through the introduction of irrigation technology.

Three sites have been identified for vegetable production by the Santa Martha group. Moving from one to the other is necessitated by changes in the quality of irrigation water as the dry season intensifies. The project proposes to supply the group with training, a complete irrigation system for use at one site with T-tape requirements for all sites, seed, pesticides, and fertilizers for 1.5 acres of vegetables and other crops at two sites. The farmer group is expected to participate in training exercises, and would be responsible for the second irrigation system, the crop inputs at the third site and labour requirements of the entire project.

The group, in consultation with the implementation committee, may adjust the planting calendar to suit weather and market conditions provided the respective budget lines are not exceeded.

The program of vegetable production proposes 1.5 acres at each of the sites as follows:

- Nov/Dec. Site I. Onions, carrots, potatoes, and tomatoes each at ¼ acre, sweet peppers at ½ acre.
- Jan/Feb. Site II. Tomatoes and cabbage at ¼ acre each, sweet peppers and irrigated corn at ½ acre each.
- Mar. /Apr. Site III. Sweet peppers, tomatoes and irrigated corn each at ½ acre.

In addition:

- The demonstration plot must be accessible to visitors by vehicle, and must be in close proximity to a water source.
- The farmers must each have a valid pesticide applicator's license.
- Farmers must be willing to attend and participate in training sessions, and be willing to conduct tours of their demonstration plots for other farmers.
- Experience with vegetable production and marketing is desirable.
- Farmers must agree to bear any costs outside the budget line.

Implementation time

Training is expected to start in the first week of July, with field plot implementation scheduled for mid-August. Seedbed preparation is one month before the scheduled planting dates.

Figure 2: Implementation schedule

Activities to be undertaken	Who is responsible?	Expected Output or Outcome	Monthly Chronogram(2009)												
			J	F	M	A	M	J	J	A	S	O	N	D	Etc.
Budgets approved and training Starts.	FAO/MAF	Implementation commenced.							X	X					
Seedbed for site 1 prepared and planted.	Farmers	Nursery stage, site 1 completed.								X					
Site 1Prepared and irrigation installed and planted.	Farmers	Site1 planted with irrigation installed.									X	X			
Seedbed for site II prepared and planted.	Farmers	Nursery stage siteII completed												X	
			Monthly Chronogram(2010)												
			J	F	M	A	M	J	J	A	S	O	N	D	
SiteII prepared, irrigation installed, and planted.	Farmers	Site II planted with irrigation installed	X	X											
Seedbed for site III prepared and planted.	Farmers	Nursery stage, site III completed.			X										
SiteIII prepared, irrigation installed, and planted.	Farmers	Site III planted with irrigation installed				X	X								

Implementation site

Three sites in Santa Martha village identified simply as sites I, II, and III.

Capacity building requirements

Short courses dealing with:

- Soil management for sustainable vegetable production.
- Pesticides use and its impact on the environment, the user, and the consumers of produce.
- Virtues of team work and systematic planning.

General instructions

Asign board has to be posted at the demonstration site. A sample of which is presented in section. All demonstration records must be kept in an assigned ledger at intervals as recommended in the monitoring plan. Exteme care should be taken that the protocols of pesticide use are adhered to.

Technical details and production technology

Presented in programs of production activities in the appenix

On account of the poor quality of irrigation water, planting beds should be raised to facilitate internal drainage and leaching, to delay if not prevent a buildup of harmful

salts in the rooting zone. Deep drains are recommended to facilitate orderly runoff, and control the watertable depth.

Budget

Table 11: Irrigation development and vegetable production, Santa Martha Group, Site1.

Category	Item of Expenditure	Amount of inputs	Unit Costs ($Bze)	Contributions($Bze)	
				FAO	Farmer Group
Site I.	Irrigation Equipment (Pump, mains, sub-mains, valves, connectors)	Various (table.A1)	Various (table.A1)	$1,260.00	$4,495.00
	T-tape	1 ½ rolls	$780/roll	$1,170.00	-
	Tools and equipment.	Various (Table. A14)	Various (Table. A14)	$2,461.25	
	¼ acre Tomatoes (seed, pesticides, fertilizer)	Various (Table.A4)	Various (Table. A4)	$553.84	-$250.00
	½ acre Sweet Peppers (seed, pesticides, fertilizer)	Various (Table.A3)	Various (Table.A3)	$1616.63	-$500.00
	¼ acre each of carrots, onions, and potatoes(seed,fertilizers,pesticides)	Various (Tables. A5, A6, A7.)	Various (Tables. A5, A6, A7.)	$1,600.43	-$937.14
	Metal sign	1	$282.00	$282.00	
	Contingency	5%TC		$384.21	
	Sub-totals(Site1)			**$9,328.46**	**$6,182.14**

Table 12: Irrigation development and vegetable production. Santa Martha Group, Site II

Category	Item of Expenditure	Amount of inputs	Unit Costs ($Bze)	Contributions($Bze)	
				FAO	Farmer Group
Site II.	Irrigation Equipment (mains, sub-mains, valves, connectors)	Various (Table.A1)	Various (Table.A1)	$3,235.00	-
	T-tape	1 ½ rolls	$780/roll	$1,170.00	-

	½ acre Tomatoes (seed, pesticides, fertilizer)	Various (Table.A4)	Various (Table.A4)	$553.84	$250.00
	½ acre Sweet peppers (seed, pesticides, fertilizer)	Various (Table.A3)	Various (Table.A3)	$1,616.63	$500.00
	¼ acre Cabbage (seed, pesticides, fertilizer)	Various (Table.A2)	Various (Table.A2)	$291.62	$250.00
	½ acre Irrigated corn	Various (Table.A11)	Various (Table.A11)	$296.64	$388.50
	Contingency	5%TC		$421.19	
	Sub-totals(Site II)			**$7,584.92**	**$1,388.50**

Table 13: Irrigation development and vegetable production, Santa Martha Group, Site III.

Category	Item of Expenditure	Amount of inputs	Unit Costs ($Bze)	Contributions($Bze)	
				FAO	Farmer Group
Site III.	Irrigation Equipment (Pump, valves, mains, sub-main, connectors)	Various (Table)	Various (Table)	-	-
	T-tape	3 rolls	$780/roll	$2,340.00	-
	½ acre Tomatoes (seed, pesticides, fertilizer)	Various (Table.A4)	Various (Table.A4)	-	$1,607.68
	½ acre Sweet Pepper (seed, pesticides, fertilizer)	Various (Table.A3)	Various (Table.A3)	-	$2,116.63
	½ acre irrigated corn (seeds, pesticides, fertilizers)	Various (Table.A11)	Various (Table.A11)	-	$685.14
	Contingency	5%TC		$117.00	
	Sub-total(Site111)			**$2,457.00**	**$4,409.45**
	Grand Total (Crops). ($US)			**$19,370.38 ($9,685.19)**	**$11,980 09 ($5,990.04)**
	Grand Total(All practices) ($US)			**$33,242.40 ($16,621.20)**	**$18,760.09 ($9,380.04)**

3.3.2 Calla Creek

The DRM practices to be introduced are:

- Pasture improvement.
- Homestead gardening.
- Fruit tree and horticultural nursery.
- Local fowl production enhancement.

The practices were selected to enhance climate resilience and food security in the community, improving the income generation capacity of residents, and promote integrated farming within the community. The practices themselves encourage interaction and foster a culture of communicating, working, and planning together. The overall impact is expected to be enhanced coping and resilience capacities, and as a consequence reduced vulnerability to the principal hazards, flood, and drought.

Pasture improvement

The last ten years has seen significant improvements in the local cattle industry resulting from a demand driven, unofficial market in neighboring Guatemala and Mexico. Improved forages, genetic stock, and management have all contributed to growth and development in this sub-sector. The formalization of the Mexican market in May of this year will see significant movement of live animals to that country, leaving shortages at home. The small farmer who individually is not poised to supply the export market has a vital role in supplying the expected shortfall locally. Developing this small producer is important to the sustainability of cattle exports.

A supply of good quality forages is the foundation of cattle development. Most farmers at Calla Creek depend on local forages, which were demonstrated to be highly susceptible to waterlogging during the flood in October of 2008 when the area was inundated for 17 days killing most forages. Forage improvement is essential to ruminant development in the area. The forages which have shown tremendous resilience during the said flood, Mombassa, and African star will be promoted.

Objectives of the demonstration are to establish improved grass nurseries, 2 acres of Mombassa and ¼ acre of African star, on high ground on each of 4 ruminant producers. The former will be allowed to grow to full maturity, cut and fed to the animals daily, while the latter would be used as a source of planting material for improved pasture expansion over a period of two years. A task of sugarcane would be planted to augment the zero grazing system during the period of pasture improvement. In return the recipients would collect manure for sale to the homestead gardeners and tree crop developers.

Each member of the group would be supplied with material for fencing, 2¼ acres for the nursery, herbicides, seeds, and fertilizer for establishing 2 acres of Mombassa and 2

tasks of African Star grass. The recipient would be responsible for manual labour, which includes land clearing, constructing the fence, herbiciding, applying fertilizer, cutting star grass and establishing one task of cane, and two protein banks, to assist with forages for zero grazing during the establishment of pastures.

- The demonstration plot must be accessible to visitors by vehicle, and must be in close proximity to a water source.
- The farmers must each have a system of ruminant production which would benefit from pasture improvement, and be willing to undertake a comprehensive pasture improvement program.
- An elevated area of 3 acres must be available to develop the nursery and feeding plots.
- Farmers would have to supply vitamins, vaccines, and dewormers as required.
- Experience with cattle handling, and access to a small engine is desirable.
- Farmers would be encouraged to invest in small irrigation systems
- Farmers must agree to bear any costs outside the budget line.

Implementation schedule

The implementation schedule is presented in Fig.3. It is envisaged that implementation would start in July and be completed with the second fertilizer application in October, leaving three monthe of growth before the traditional dry season starts. Cut and feed would start in January 2010, and this would be supplemented with citrus pulp feeding. This process would be conducted with two farmers, and a repeat, with improvements where identified, would begin with the two other farmers in April of 2010.

Technical details/production technology

Animals: Should be selected and culled to adjust the stocking rates to match the available pasture and feed, especially during the replanting period. Failure to do this could result in forced access to and destruction of the nurseries.

Nutrition: The aim is to improve pastures, but also to adjust stocking rates based on available forage. During replanting, nutrition would use chopped Mombassa, augmented with sugarcane (*S. officinarum)*, and high protein forages such as Mulberry (*M. alba*), Nacadero (*T. gigantea*). Citrus pulp, molasses and urea would also be used in the dry season, and supplemented with a general purpose range mineral, trace mineral blocks year round.

Animal health: All animals would be vaccinated, dewormed castrated and culled at the beginning of the program. A program of health care would be developed for the duration of the demonstrations.

General instructions

- Asign board has to be posted at the demonstration site. A sample of which is presented in section.
- All demonstration records, including photographs, must be kept in an assigned ledger at intervals as recommended in the monitoring plan.
- Exteme care should be taken to adjust the stocking rates during pasture replanting. Failure to do so could be detrimental to the nurseries.

Capacity building requirements

Short courses dealing with:

- Cattle and pasture management with emphasis on beef cattle.
- Team building and working and planning collectively.
- Animal nutrition and dry season feeding systems.

Figure 3: Implementation schedule

Activities to be undertaken	Who is responsible?	Expected Output or Outcome	Monthly Chronogram(2009)												
			J	F	M	A	M	J	J	A	S	O	N	D	Etc.
Budgets approved and finalized. Training begins.	FAO/MAF	Implementation begins.							X	X	X				
Animals vaccinated, dewormed castrated and culled to adjust the stocking rate.	Farmer FAO/MAF	Stocking rate matches available pasture.							X						
Procurement of Posts, barbed wire, staples, nails.	FAO/MAF	Fence. Materials procured							X						
Transporting materials to Plot.	FAO/MAF	Fence materials delivered to plot.							X						
Fence erected and herbicides applied.	Farmers/ FAO/MAF	Site preparation completed.							X						
Nursery plots/cane planted and fertilized.	FAO/MAF Farmers	Planting completed.								X					
Urea applied and pulp ordered.	Farmer FAO/MAF	Fertilization completed. Pulp ordered.										X			
			Monthly Chronogram(2010)												
			J	F	M	A	M	J	J	A	S	O	N	D	
Cut and feed starts, augmented by pulp, molasses and urea	Farmers	Adjustment to new environment.	X	X	X	X	X								
Collection and storage of manure and unutilized cane for composting.	Farmers	Stockpile of manure and cane trash.	X	X	X	X	X	X	X	X	X	X	X	X	X

Budget

The budget is presented in *table 14*. The data show that FAO would invest $3,236.05 per farmer in establishing a nursery and a source of supplemental feed for use in the dry season and during pasture planting. Citrus pulp as an additional supplement is also budgeted. The farmer would contribute $2,895.00 or 89.5% of FAO's investments. There are 4 farmers in the group, and two would start this year, and the others in June of next year.

Table 14: Materials for pasture improvement demonstration, Calla Creek, Cayo district, Belize.

Item of Expenditure	Amount of Input	Unit Cost	Contributions	
			FAO	Farmer Group
Roundup/Wipeout	1 ½ liters	$17.95/liter	$35.90	-
Weedmaster (2-4-D)	1 ½ liters	$22.60/liter	$45.20	-
Knapsack spray can.	1	$102.00	$102.00	
Sugarcane chopper	1	$650.00	$650.00	
Small engine	1	$1,200.00		$1,200.00
Posts	146	$4.00/post	$584.00	-
Barb Wire	6	$125.00/roll (300m)	$750.00	-
Staples	5 lbs	$2.95/lb	$14.75	-
46:0:0	2 sks	$56.25/sk	$112.50	-
14:36:12	2 sks	$60.55/sk	$121.10	-
Seed (Mombassa)	10 lbs	$16.00/lb	$160.00	-
Molasses	1drum	$55.00	$55.00	
Plastic drum	1	$25.00	$25.00	
Urea	10lbs.	$6.50	$6.50	
Citrus Pulp	½ load	$220.00	$220.00	
Labor (fence, posts, fertilizing,herbiciding)	16 man days	$30.00/man day	-	$480.00
Labor (African star)	3 man days	$30.00/man day	-	$90.00
Labour (feeding)	2.25hrs/dayX150days (37.5man-days)	$30.00/man-day		$1,125.00
Sign board	1(3'x2.5')	$200.00	$200.00	
Contingency	5%TC		$154.10	
Total (per farmer)			**$3,236.05**	**$2,895.00**
Total (4 farmers)			**$12,944.20**	**$11,580.00**

Homestead gardening

There have been significant decreases in agriculture and agricultural activity as viable and sustainable livelihoods, in rural Belize despite national programs of sorts to promote rural farming. The trend has been a movement towards subsistence farming, supported by incomes generated through work in other sectors, quite often outsides of the community. The net result has been the intensification of the state of food insecurity and increasing dependence on the network of food suppliers, which promotes

the consumption of imported commodities. Incomes generally fall short of needs and as a consequence we witness the intensification of poverty, malnutrition, and a certain degree of social degradation. In the event of disasters, communities lacking a sound food production and storage system are more vulnerable to risks, than those sharing a vision and developing effective food security strategies, in support of "producing what you eat," as practiced among the Amish colonies.

Calla creek is a community which could benefit from interventions to promote more food production and enhanced food security, training in healthy diets and good food nutritional practices, processing and non refrigerated storage of foods during periods of excess production. One such intervention is Homestead gardening which not only addresses food security, but involves women in production.

The objectives of the demonstration are to promote the production of indigenous food varieties in small plots close to the home which would not only provide more food for family consumption but would also add diversity and enhanced nutrition to the family's diet. This would be augmented by training in food preservation and storage of both food and seeds/planting materials.

The group, of approximately 12 women, would be supplied with materials and supplies to develop and fully fence a small plot (20'X20') of land in close proximity to their homes for the production of indigenous food varieties. A likely layout is 5 beds, each 3'X16' separated by drains 10" wide and 4"-6" deep, and program of planting over a year as planting dates vary widely.

> Bed 1. Condiments: peppers (*Capsicum spp*.), cilantro (*Coriandrum sativum*), eshallot, thyme (*Thymus vulgaris*), oregano (*Origanum vulgare*).
> Bed 2. Okra (*Hibiscus esculentus*) followed by winter vegetables: carrots (*Daucus carota*), radish (*Raphanus sativus*), and onions (*Allium cepa*).
> Bed3. Leafy green vegetables: Spinach, amaranths (*Amaranthus spp*.)
> Bed 4. Potatoes (*Solanum tuberosum*).
> Bed 5. Other starchy foods. Cocoyam (*Xanthasoma sagittifolium)*, soup yams (*Diascorea spp*.).

Along the fence: sorrel, pigeon peas (*Cajanus cajan*), chaya (*Cnidoscolus chayamansa*), and vine beans, and in the drains, dasheen (*Colocasia esculenta var.esculenta*).

- The demonstration plot must be accessible to visitors by vehicle, and must be in close proximity to a water source.
- The housewives must each have a small area of deep well drained soil for planting 10 plantain suckers; dwarf Curare, a cultivar highly tolerant of sigatoka disease.
- Participants must attend all training sessions
- House wives must agree to bear any costs outside the budget line.

Implementation schedule

The implementation schedule is presented in Fig.4. It is envisaged that implementation would start in mid-July and continue into the following year, completing the entire process by August. Six house wives would start in July and the remainding six in October. All would be trained at the same time. A supply of organic matter would be available from the commencement of the project.

Technical details/production technology

Planting materials and seed storage. Indigenous varieties would be planted where possible. Seed and planting materials would be collected during the crop and stored for use after disasters, and/or the next crop cycle.

Fertilizers. Acombination of organic and inorganic fertilizers would be used.

Pest control. Based on monitoring and the utilization of principles of integrated pest management where applicable.

General instructions

A sign board has to be posted at the demonstration site. A sample of which is presented in section. All demonstration records, including photographs, must be kept in an assigned ledger/electronic files at intervals as recommended in the monitoring plan. Exteme care should be taken with the storage of fertilizers and chemicals, especially in homes with small children.

Capacity building requirements

Short courses dealing with:

- Local foods, balanced and healthy diets.
- Non refrigerated preservation of foods.
- Composts from kitchen wastes and soil management.
- Virtues of team work and systematic planning.

Fig. 4 Implementation schedule for homestead garden project, Calla Creek Cayo.

Activities to be undertaken	Who is responsible?	Expected Output or Outcome	Monthly Chronogram(2009)												
			J	F	M	A	M	J	J	A	S	O	N	D	Etc.
Budgets approved and Training starts.	FAO/MAF	Implementation phase begins.							X						
Materials and supplies procured and tools and fence materials delivered	FAO/MAF	Plot constr. Begins.								X					
Plots fenced and beds prepared.	Housewives	Plots ready for planting									X				

Seedbed prepared and planting begins.	Housewives	Planting starts.									X	X	X	X	
Weed control and fertilizer applications.	Housewives	Maintenance and crop nutrition programs in place.										X	X	X	X
			Monthly Chronogram(2010)												
			J	F	M	A	M	J	J	A	S	O	N	D	
Bed prep. For May planting.	Housewives	Beds ready for May planting			X	X									
Crops planted April/May with irrigation.	Housewives	Planting of annuals completed.				X	X								
Site visits, record keeping, and evaluation.	FAO/MAF	M&E in place.	X	X	X	X	X	X	X						
Evaluation report presented.	FAO/MAF	Responsibility and ownership transferred to housewives.							X	X					

Budget

The budget is presented in *table 15*. The data show that FAO would invest $1,031.55 per housewife, while the housewife would contribute $1,020.00 or 98.9% of the former. Budgeting was restricted to 12 housewives.

Table 15: Materials for Homestead Garden project, Calla Creek, Cayo district, Belize.

Item of Expenditure	Amount of Input	Unit Cost	Contributions	
			FAO	Farmer Group
Water can (2 gals)	1	$14.00/each	$14.00	-
Plastic drum (55 gals)	1	$25.00/each	$25.00	-
Spray can (13.5L)	1	$75.00/each	$75.00	-
Machete	1	$10.50/each	$10.50	-
Garden Hose	75ft.	$125.00	$125.00	
Weeding tool (Cuma)	1	$20.00/each	$20.00	-
Urea	10 lbs	$8.25/10 lbs	$8.25	-
14:36:12	10 lbs	$10.75/10 lbs	$10.75	-
19:19:19	25lbs.	$20.00	$20.00	
Cow manure	10bags	$5.00/bag	$50.00	
Seed (vegetables)	Various	$50.00	$50.00	-
Seed (Plantain)	10suckers.	$10.00/each	$100.00	
Malathion	1 liter	$13.25/liter	$13.25	-
Condifor	52 g	$56.25/52 g	$56.25	-
Multimaya wire	1.5 roll	$120.00/roll	$180.00	-
Posts	12	$4.00/each	$48.00	-
Labor (fence & beds)	4 man days	$30.00/man day	-	$120.00
Labour	1hr/dayX9mths.	$30.00/day		$900.00

(maintenance and care)	(30 man-days)			
Signs	1	$185.00	$185.00	
Contingency	5%TC		$40.55	
Total (per garden)			**$1,031.55**	**$1,020.00**
Total (12 Homestead gardens			**$12,379.60**	**$12,240.00**

Tree crop and horticulture nursery

Calla creek, with almost 10 months of water deficits, is considered more conducive in the absence of irrigation to the cultivation of deep rooting tree crops, than shallow rooting species, on the alluvial terrace along the Mopan River. Local experiences in this low rainfall area have all supported this assertion. The survival of a large proportion of fruit trees in the area in the aftermath of seventeen days of prolonged floods of October, 2008 lends further credence to the theory.

There is a genuine interest in rehabilitating the existing population of fruit trees in the area and planting more, especially short varieties, which are less susceptible to wind damage, to transform Calla Creek into a major producing area for a wide variety of indigenous fruits. This not only establishes an income base for the residents, but provides an important temporary sanctuary for people and fowls during periods of unexpected, night time, flash floods until rescue operations are launched.

The objectives of the demonstration are to promote indigenous fruit production in the Calla Creek area through the rehabilitation of existing trees, and the development of improved planting materials in nurseries for expanding the current fruit tree base and creating an additional income generating opportunity.

The group would be supplied with technical assistance from the University of Belize (UB) and MAF to assess the state of fruit trees in the Calla Creek area and in consultation with the interested residents, make specific recommendations for rehabilitation and further development. A small nursery consisting of 500 bagged plants is to be established by each of 8 persons and this would be used to develop propagation skills while producing plants for the fruit tree expansion and sale.
In addition:

- The small nursery plots must be accessible to visitors, and must be in close proximity to a water source.
- The farmers must each have established fruit trees on their property to qualify for participation.
- Areas/holdings where land stabilization and erosion control is needed would be given priority.

- Experience with fruit processing and preservation would be desirable.
- Participating residents must agree to bear any costs outside the budget line.

Implementation schedule

The implementation schedule is presented in Fig.5. It is envisaged that implementation would start in October with 4 participants and continue during the remainder of the project. The second 4 would start in January. Scheduling of the value added phase would depend on the availability of fruit for processing.

Technical details/production technology

To be provided by trainers.

General instructions

A sign board has to be posted at the demonstration site. A sample of which is presented in section. All demonstration records must be kept in an assigned ledger at intervals/electronic files as recommended in the monitoring plan. Exteme care should be taken that the nurseries are not accessible to animals, especially cattle as they eat the plastic. Fertilizers and chemicals should at all times be stored in a safe place, out of reach of children and animals.

Capacity building requirements

Short courses dealing with:

- Varietal selection, plant propagation of both fruit and horticultural plants, and nursery management.
- Post harvest handling of fruit, processing, preservation and marketing.
- Virtues of team work and systematic planning.

Figure. 5 Implementation schedule

Activities to be undertaken	Who is responsible?	Expected Output or Outcome	Monthly Chronogram(2009)												
			J	F	M	A	M	J	J	A	S	O	N	D	Etc.
Assessment of needs and developing plans for nurseries.	UB/MAF	Development plans completed.										X			
Training in plant propagation techniques.	UB/MAF	Implementation commenced.										X			
Materials purchased and delivered to 4 participants.	FAO/MAF	Construction phase commenced.										X			
Construction of nurseries, rooting media prepared, and seed/cuttings planted.	Participants/ FAO/MAF	Nurseries completed										X			
Plant care, propagation, and marketing.	Participants	Nursery is active and producing.										X	X	X	X
			Monthly Chronogram(2010)												

			J	F	M	A	M	J	J	A	S	O	N	D	
Plant care, propagation, and marketing.	Participants	Nursery is active and producing.	X	X	X	X	X,								
Site preparation and transplanting in the field.	Participants	Expansion phase commenced					X	X							
Care in the field.	Participant.	Crop development phase commenced.							X	X	X				
Post harvest handling of fruits from rehab trees, processing, and preservation.	UB/MAF	Value chain development commenced.			X	X	X								

Budget

The budget is presented in *table 13.* The data show an investment of $1,052.63 per person by FAO, with the participant contributing $600.00 or 57% of the former.

Table 16 Materials for fruit tree grafting project, Calla Creek, Cayo district, Belize.

Item of Expenditure	Amount of Input	Unit Cost	Contributions	
			FAO	Farmer Group
Polyethylene bags (10" x 14")	500 bags	$25.00/100 bags	$125.00	-
Budding Tape	20 rolls	$5.00/roll	$100.00	-
Ideal plastic bags	500 bags	$3.00/100 bags	$15.00	-
Sharpening Stone	1	$10.00/each	$10.00	-
Shade cloth.	30ft	$4.84/ft	$145.20	
Rootstock Seeds	$1,000	$0.10/each	$100.00	-
Rooting hormone	4ozs.	$6.95/oz	$27.80	
Polyfeed (19-19-19)	50 kg	$114.00/25 kg	$288.00	-
Cow manure	10 bags	$5.00/bag	$50.00	
Contingency	5%		$35.90	-
Labor (constr. Bagging, grafting etc.)	10 man days	$30.00/man day	-	$300.00
Labour(maintenance and care)	90hrs over 9mths.	$30.00/9hrs		$300.00
Signs	1	$105.60	$105.60	
Contingency	5%TC		$50.13	
Total (per 500 plants)			**$1,052.63**	**$600.00**
Total (for 8persons)			**$8,421.04**	**$4,800.00**

3.4.3 Concepcion Village

The DRM practices to be introduced are:

- Irrigation development for vegetable production.
- Local fowl production enhancement.

Supplemental watering or irrigation is essential to extending the cropping pattern into the months of November to May when crop water deficits are experienced in this area (Table 7). This period of water deficits is characterized by low to moderate rainfall and reduced risks of crop losses arising from floods and hurricanes. The traditional rainy season of June to December still requires supplemental watering on account of the distribution pattern of rainfall with significant periods of deficit within months which show an average water surplus, a pattern which is expected to worsen as climatic changes are experienced.

Local fowl production enhancement is not only a good DRM practice, but also an inexpensive way to propagate the DRM message.

The practices introduced were selected to assist the members of this group to develop both their coping and resilience capacities and as a consequence, reduce their vulnerability to hazards. The principal hazard is drought for 5 months, followed by floods and hurricanes during September and October. Irrigation allows the members to shift production away from the high risks months of September and October, to enhance their livelihoods while working together and developing a team spirit. Local fowl production enhances food security.

Irrigation development for vegetable production

Belize imports some 8-13M$ of fruits and vegetables annually which accounts for a 11yr-average of about 10% of the total food import bill (Anon., 2009). This is unacceptable for a country which has a deficit budget and GOB's policy aims to stimulate local production of fruits and vegetables with the hope of reducing the import bill, and at the same time pursuing a path of diversification in the sugar cane belt.

Shifting production to periods of water deficit, through the introduction of irrigation, not only reduces the risks associated with crop production, common in rainfed systems, but enhances the income generating activity of small farmers, farm workers, and their families. The short growing period of most vegetable crops make them ideal for small farming systems and allows the complete production shift to the less vulnerable months of the year, diversifies the production base, enhances livelihoods, and creates greater resilience to disasters.

The objective is to promote agricultural product diversification in the village of Concepcion, located in a sugar cane belt, an industry in decline, through the introduction of irrigation technology.

An area of some 12 acres in an abandoned Papaya field in Concepcion village has been identified for vegetable production by the Concepcion group of farmers. The site has three abandoned wells and an analysis of the water available for irrigation is presented in Table 4. The project proposes to supply the group with training, a complete irrigation

system, inclusive of T-tape for three plantings, each for 3 acres. A supply of seed, pesticide and fertilizers for the first two plantings, each of 3 acres, would be provided, and the group would be required to supply their own inputs for the third. The farmer group is expected to participate fully in all training exercises.

The program of planting is presented below. However, the group may decide to vary this schedule based on market and production conditions, but such changes must maintain a crop size of three acres at each planting, and cannot exceed the value of investments presented in the budget (Table 16).

- Sept./Dec. Onions, carrots, potatoes, tomatoes, sweet peppers, and cabbage at ½ acre each.
- Jan/Feb. Irrigated corn at 2 acres, ½ acre of melons, and ½ acre of onions.
- Mar./Apr. An acre each of Sweet peppers, and tomatoes, ½ acre each of cabbage and irrigated corn.

In addition:

- The demonstration plot must be accessible to visitors by vehicle, and must be in close proximity to a water source.
- The farmers must each have a valid pesticide applicator's licence.
- Farmers must be willing to attend and participate in training sessions, and be willing to conduct tours of their demonstration plots for other farmers. Family members are also invited to attend the training sessions.
- Experience with vegetable production and marketing is desirable.
- Farmers must agree to bear any costs outside the budget line.

Implementation time

Training is expected to start in the first week of July, with field plot implementation scheduled for mid-August. Seedbed preparation is one month before the scheduled planting dates.

Figure 6. Implementation schedule

Activities to be undertaken	Who is responsible?	Expected Output or Outcome	Monthly Chronogram(2009)												
			J	F	M	A	M	J	J	A	S	O	N	D	Etc.
Budgets approved and training Starts.	FAO/MAF	Implementation commenced.							X	X					
Seedbed for Sept/Nov. planting: prepared and planted.	Farmers	Nursery stage, first planting completed.								X					
Land for Sept/Nov. planting Prepared and irrigation installed and	Farmers	First planting site planted with irrigation									X	X	X		

planted.		installed.													
Seedbed for Jan. /Feb. planting: prepared and planted.	Farmers	Nursery stage, 2nd planting completed.												X	
			Monthly Chronogram(2010)												
			J	F	M	A	M	J	J	A	S	O	N	D	
Land for Jan. /Feb. planting: Prepared and irrigation installed and planted.	Farmers	2nd planting site planted with irrigation installed.	X	X											
Seedbed for Apr. /May. Planting: prepared and planted.	Farmers	Nursery stage, 3rd planting completed.			X										
Land forApr. /May. Planting: Prepared and irrigation installed and planted.	Farmers	3rd planting site planted with irrigation installed.				X	X								

Implementation site

Abandoned papaya field in Concepcion village

Capacity building requirements

Short courses dealing with:

- Soil management for sustainable vegetable production.
- Pesticides and the impact on the environment, the user, and the consumers of produce.
- Virtues of team work and systematic planning.

General instructions

Asign board has to be posted at the demonstration site. A sample of which is presented in section. All demonstration records must be kept in an assigned ledger at intervals as recommended in the monitoring plan. Exteme care should be taken that the protocols of pesticide use are adhered to.

Technical details and production technology

Seedbeds for peppers and tomatoes must be protected from white fly (*T. vaporariorum*) damage. Other details are presented in the programs of activities presented in the appendix.

Budgets

Budgets are presented in *tables 17,18,* and *19* and the data presented show a total FAO investment with this group of $29,963.79 with the group contributing $18,238.63 or 60.9% of the former.

Table 17: Irrigation development and vegetable production, Concepcion Village, Sept. /Dec.

Category	Item of Expenditure	Amount of inputs	Unit Costs ($Bze)	Contributions($Bze)	
				FAO	Farmer Group
Nov./Dec	Irrigation Equipment (Pump, mains, sub-mains, valves, connectors)	Various (Table.A8)	Various (Table.A8)	$7,605.00	
	T-tape	3 rolls	$780/roll	$2,340.00	-
	Land prep and development. (Organic matter appl.)	Various	Various	$2,400.00	$750.00
	Mist blowers	2	$1,485.00	$1,485.00	
	Knapsack sprayers	5	$101.75		$508.75
	½ acre Tomatoes (seed, pesticides, fertilizer)	Various (Table.A4)	Various (Table.A4)	$1,107.68	$500.00
	½ acre Sweet Peppers (seed, pesticides, fertilizer)	Various (Table.A3)	Various (Table.A3)	$1616.63	$500.00
	½ acre each of carrots, onions, and potatoes(seed,fertilizers,pesticides)	Various (Table.A5, A6, A7.)	Various (Table.A5, A6, A7.)	$3,200.86	$1,874.28
	½ acre cabbage (seed,fertilizer,pesticides)	Various (Table.A2)	Various (Table.A2)	$583.24	$500.00
	Metal sign	1	$282.00	$282.00	
	Contingency	5%TC		$1,031.02	
	Sub-totals(Nov/Dec)			**$21,651.43**	**$4,633.08**

Table 18: Irrigation development and vegetable production, Concepcion Village, Jan/Feb.

Category	Item of Expenditure	Amount of inputs	Unit Costs ($Bze)	Contributions($Bze)	
				FAO	Farmer Group
Jan./Feb.	Irrigation Equipment (Pump, mains, sub-mains, valves, connectors)	Various (table)	Various (table)		

	Mist Blower	1	$1,485.00	$1,485.00	
	Land prep and org. matter additions.	Various	Various	$600.00	$750.00
	2 acre Irrigated corn (seed, pesticides, fertilizer)	Various (Table.A11)	Various (Table.A11)	$1,186.54	$1,554.00
	½ acre Onions (seed, pesticides, fertilizer)	Various (Table.A5)	Various (Table.A5)	$1,290.37	$695.00
	½ acre melons (seed,fertilizers,pesticides)	Various (Table.A12)	Various (Table.A12)	$414.62	$241.50
	Contingency	5%TC		$248.83	
	Sub-totals (Jan. /Feb.)			**$5,225.36**	**$3,240.50**

Table 19: Irrigation development and vegetable production, Concepcion Village, Mar. /Apr.

Category	**Item of Expenditure**	**Amount of inputs**	**Unit Costs ($Bze)**	**Contributions($Bze)**	
				FAO	**Farmer Group**
Mar./Apr.	Irrigation Equipment (Pump, mains, sub-mains, valves, connectors)	Various (table)	Various (table)		
	T-tape	3 rolls	$780/roll	$2,340.00	-
	Land prep. And org. mat. additions	Various	Various	$600.00	$750.00
	1 acre sweet peppers (seed, pesticides, fertilizer)	Various (Table.A3)	Various (Table.A3)		$4,233.26
	1 acre cabbage (seed, pesticides, fertilizer)	Various (Table.A2)	Various (Table.A2)		$2,166.48
	1 acre tomatoes (seed,fertilizers,pesticides)	Various (Table.A4)	Various (Table.A4)		$3,215.36
	Contingency	5%TC		$147.00	
	Sub-totals (Mar. /Apr.)			**$3,087.00**	**$9,615.10**
	Grand Total($Bze) ($US)			**$29,963.79 ($14,982.90)**	**$18,238.63 ($9,119.32)**

4. Results and lessons learned of DRM practices in the villages of Santa Martha, Concepcion and Calla Creek

Implementation of good DRM practices for testing and possible replication in four areas of Belize started in August of 2009. For a number of reasons, the project had an uncertain start and struggled to implement the planned activities. The problems were essentially of an administrative nature and related to poor communications between the administrative units and the field units with respect to procurement of inputs that were needed for pilot demonstrations and due to the substantive time spent by the project team on procurement issues, no time was left to initiate project interventions in El Progresso, the most southern pilot village.

The project has been extended until May 2011 after the Ministry of Agriculture and Fisheries (MoAF) requested an extension of the project to also cover the dry season 2010/2011. In the following sections a detailed description of the activities per village is provided. And regarding the provided capacity building trainings and workshops, please find a detailed description in the capacity building report by University of Belize, which can be found as a separate document on the FAO website.

4.1 Santa Martha village

The following DRM practices selected for Santa Martha village included:

- Dairy cattle production;
- Vegetable production through irrigation development;
- Local fowl production enhancement.

4.1.1 Dairy cattle production

The project experienced some delays due to procurement related issues, which resulted in two members deciding to quit because they were tired of waiting for the project to start. However, there were two new members so the group size remains at six**.** A source of quality dairy cattle was identified, the animals were selected, weighed and are held at Weiler's farm ready for delivery pending a purchase order from FAO. Mr. Weiler, a Mennonite farmer himself, offered to deliver the animals to facilitate the project once the pastures were ready.

The dairy animals were delivered, but one of the main concerns of the farmers was that the pastures were not yet developed or improved, with the result that the animals were in extremely poor condition. In addition, they had not received the supplemental feeding by-products (urea, molasses, citrus pulp etc). Consequently, all the animals were in poor body condition and the non-pregnant ones could not be bred at this time. Due

to problems with procurement, they were not able to purchase and deliver the by-products, which the farmers had been promised and that procurement concerns also resulted in difficulty in getting the necessary inputs for the development of the pastures.
However, once some nutritional supplements were credited, and a drum of molasses was loaned by the agronomist the project started. The animals procured for the Santa Martha group are shown eating sugarcane leaves (*Photo: 1*). It was proposed to feed the animals with chopped sugarcane and supplements while pastures were developed, as each member cultivated sugarcane. Experiences with whole sugarcane feeding in Trinidad and Tobago conducted by Flloyd Neckles and team during the late 70's is well documented and reproduced by FAO[*]. The group required a cane chopper to effectively implement this feeding system, the procurement of which was caught in the meltdown between the administration in Jamaica and the project and never materialized during the first year.

Farmers had to graze the animals along the road ways as an alternative, while attempts were made by the extension staff and the project agronomist to introduce protein and forage banks to supplement the feeding. *Photo 2* shows the personnel cutting Cameroon grass for the establishment of a forage bank at Santa Martha. However, this could not be done in time for the dry season of 2009/2010, which started in November of 2009. As a result of failing to have a feeding system in place, the small herd was severely negatively impacted by the lack of adequate nutrition.

[*] Experiences with whole sugarcane feeding in Trinidad and Tobago. www.fao.org/docrep/003/S8850E07.htm.

Photo: 1 Dairy cattle procured for the Santa Martha group feeding on sugarcane leaves..

Photo:2. Cutting Cameroon grass to establish a forage bank at Santa Martha.

Photo 3 shows the poor condition of one animal a few days after calving, with the mother having very little milk, as the udder size indicates, to feed the calf. Eventually the calf had to be raised on replacer milk while the mother recuperated.

Photo 3: Dairy animal with calf in the peak of the dry season without an adequate feeding system in place.

When the chopper was obtained through the project, the animals were fed with a combination of grass and chopped sugarcane. A corral/feeding shed has subsequently been built to facilitate feeding and collection of manure. Manure would be used as a soil additive in vegetable production.

Efforts continued to develop pastures and forage banks using Mombassa grass, Nacadero, and Mulberry cuttings. For the cultivation of Cameroon grass (*Pennistum pururеum cv. Cameroon*) the farmers fenced two areas for its cultivation. Planting materials in the form of cutting for the said cultivation were obtained from the government station at Yo Creek, FAO provided the transportation, and the project agronomist and the extension officer supervised the planting. Farmers conducted the actual work of selecting and cutting planting materials, loading and discharging the truck, and planting at the prepared site. The entire exercise strengthened team effort, an essential characteristic in disaster planning.

Sugarcane, which is readily available from members of the group Milpa farms, is the main forage for the project to be supplemented by forage and protein banks consisting of Cameroon grass, Nacadero (*Trichanteria gigantea*) and Mulberry (*Morus alba*). Nacadero planting, as a collaborative effort of the Ministry of Agriculture and Fisheries (MAF), FAO and the group, is scheduled for January on beds close to a source of water for transplanting to a prepared site in May. Mulberry, the more important protein forage, is less hardy and should be propagated from cutting treated with rooting hormones in nursery bags. The latter two items were not included in the original budget, an oversight during the planning phase as administrative delays were not anticipated, and are now included in a supplemental budget for approval.

The group managed to obtain seed on loan to be replaced when their supply from FAO arrives. A covered nursery was established and transplanting in the field was scheduled

for first day of the New Year. The first batch of fertilizer from FAO was delivered on 31st December, 2009 in time for the transplant.

The group transplanted as scheduled, and they do have some fertilizers released by FAO and delivered on the 31st December, 2009, but little else in term of other inputs. As we approach the dry season, January to May, it is doubtful that the crops could survive without irrigation. Requisitions for irrigation equipment submitted in November seem to have encountered difficulty at the administrative level of FAO.

The project was modified for the second year, necessitating changes to the procurement schedule. Based on experiences of year one, a well-covered shed and corral were included, along with a cane chopper, materials for planting, and fence materials for four acres of improved pasture. The grass selected was Mombasa, which could be grazed and/or cut and fed as dry or fresh forage. In addition, items essential to good husbandry practices, namely livestock minerals, de-wormers, vitamins, and molasses, were included to assist in the development of good herd management. The changes costing approximately $5,521.45USD were presented in the modified procurement schedule. This would complement sugarcane grown by each farmer, and protein banks in various stages of development.

For breeding of the eight dairy cows procured for the group by the project, it was agreed that the Ministry would be asked to lease to the group a bull for a specific period of time. The daily cost of the lease was very minimal and would be absorbed by the group. Training has been conducted in milking and milk processing at the Amish community of Upper Barton Creek to facilitate and complement milk production when it arrives. Despite all the setbacks, the farmers expressed their appreciation for the project and the support that they had received so far from both the FAO and the Ministry of Agriculture.

4.1.2 Vegetable production through irrigation development

Cultivation of vegetables namely, tomatoes, sweet peppers, and cabbage were shifted to less vulnerable periods of the year using irrigation with mixed results. A number of new challenges arose, the most significant of which, was pests and diseases. Losses range from 100 per cent to 25 per cent and the experiences have shown that the future of vegetable production for Santa Martha must utilize insect screens, and explore ways to improve soil properties that must include leaching.

The farmers have been exposed to cover structure technology during capacity building workshops and are currently undergoing training in the construction of such at UBCF. Soil parameters and water quality changes during the year and need to be carefully evaluated before a remedial program is recommended. The addition of organic matter from compost piles should be beneficial in the medium term.

With irrigation tubing, a borrowed pump, credited seed, and some insect screen borrowed from another FAO project, the farmers managed to produce a crop of sweet peppers, with tomatoes and cabbage doing poorly as adequate inputs for production were not supplied. Fertilizer and some agrochemicals were loaned to them from UB and the late procurement of half of the fertilizer requirements saw the sweet pepper crop to completion. The yield obtained was approximately 2,500 pounds sold at an average price of $2.00/pound.

Photo:4. Sweet pepper crop produced by the Santa Martha group, Jan.2010.

The cropping schedule is for the development of vegetable crops at each of two sites. Site one is reserved for carrots and onions and is suitable for planting from November to January. Any planting at site one after January is likely to encounter salinity problems in March and April.

Site two is slated for preparation in January for late planting with irrigation as water at this site is unaffected by salt as the dry season intensifies. The crops scheduled for this site are cabbages, sweet peppers, and tomatoes. However, based on the experiences of the first year it was decided that preparation would not commence until the inputs were procured. The revised procurement schedule shows an estimated cost of $5,528.12 USD, which also included tools such as a chain saw, an onion planter, a roto tiller, a spray pump, and materials for a small protected nursery. With procurement again taking a longer than anticipated time, despite the efforts of the new national coordinator, the chances of losing activities scheduled for site one increases daily as December remains the critical month for starting at this site.

Farmers, recognizing that late procurement of inputs put their earning capacity and livelihoods at risk, have proceeded to plant cabbages, sweet peppers, and tomatoes with their savings from the previous cropping cycle, hoping that inputs from FAO would be procured in time to successfully complete the crops schedules.

With the extension of the project until May 2011, a number of activities have continued both in the field and in capacity building. The new national coordinator managed to move the procurement process forward, but procurement as a constraint is anticipated to return when the coordinator leaves on the 13th December, 2010. The project provided them with small scale drip irrigation equipment as well as four calves. The pond from which irrigation water was extracted was almost dry due to the drought experienced in the country. Because of the low water level, there was a large amount of decaying organic matter in the pond and this resulted in blockages in the irrigation system. Water quality was also of some concern, because of the proximity to the sea, there was a strong possibility that over extraction would lead to salinization of the irrigation water. The crop was in poor condition, showing poor root development, nematode infestation, pests and diseases. The soil was also compacted with low organic matter content. Farmers requested the services of a back hoe to dredge the section of the pond in the vicinity of the pump intake.
Nevertheless, Mombasa has been planted at four sites each of approximately one acre in area. Plant stands were poor as germination and initial establishment was adversely affected by weather. Some replanting is necessary; fencing of the areas is in progress with the recent procurement of wire and staples. Hardwood posts are yet to be procured, but the farmers would proceed with a variety of bush sticks in the interim. Fenced pastures are important at this time as a prerequisite to introducing a rented bull.

4.1.3 Local fowl enhancement

The supply of Rhode Island Red chickens (photo 5), though promised, could not be procured at implementation as the supplier changed his mind. A second supplier was able to provide Black Sex link crosses (BSL) out of Miami as a suitable alternative dual purpose bird. BSL, a cross between Rhode Island Red roosters and Plymouth Rock hens, is known both for egg and meat production with roosters growing to 8-9lbs, and hens 6-7lbs. The chickens were reared in three small poultry houses at the field station of the University of Belize under the supervision of the national project agronomist. About 490 roosters and about 100 hens were supplied to local farmers in southern, western and northern villages, with the help of the Ministry of Agriculture and UB's outreach staff, primarily to upgrade local flocks with a strong message of disaster risk mitigation. The Ministry of Agriculture suggested that the roosters be given free to the farmers to satisfy short-term political goals, which would have had a very short lived impact on local fowl enhancement while eliminating the potential for continued institutional support for this vital activity. By selling the roosters to farmers outside of the project, UB through the project was able to invest in infrastructure for long term and sustainable support to local fowl development.

Photo 5 Rhode Island Red chickens

4.1.4 Lessons learned

With respect to disaster risk reduction, the approach of Santa Martha still remains an attractive option. Here, an attempt is made to utilize irrigation to shift cropping to the less hazardous dry season while utilizing resources efficiently through integration with livestock production. This approach not only spreads the risks from agro-met disasters, but provides the means whereby income and as a consequence livelihoods are made more stable, thereby contributing to enhance sustainability of the farming system. The weakness still remains the procurement process despite changes at the National Coordinator level, which are very short term. This certainly needs to be addressed.

Nevertheless some important lessons from Santa Martha and UB, where a supporting project in local fowl enhancement was conducted, include:

- **Risk management through diversification:** Developing an integrated system of production based on both crops and livestock, which allows for the efficient utilization of resources, enhances the coping capacity of the community/group.
- **Risk reduction:** Significant reduction in losses is possible through shifting cultivation of crops from the high risk months of September and October, when both excessively high rainfall and hurricanes are potential hazards, to the less vulnerable months of December to May, by using irrigation. Furthermore, diversification in cropping patterns and the introduction of livestock also reduces risks in terms of food security. Working together and saving together provided some degree of risk reduction: this group was generally small, but nevertheless demonstrated an important principle of risk reduction to the three participants.
- **Challenges of pests, diseases and soil management:** Irrigation did allow for shifting the cropping cycle to less vulnerable periods, but the new cropping cycles encountered new challenges of pests, diseases, and soil management. The less vulnerable periods, the dry periods, were also the times of poor water quality and the effectiveness of irrigation was diminished.

- **Implication of poor nature of soils:** The poor nature of the soils necessitated the use of more farm yard manure (FYM). The recent construction of the corral/feeding pen would certainly enhance collection for future use. The previous scattered grazing pattern did not facilitate easy collection and therefore hampered integration of the farming systems.
- **Challenges of introducing livestock in new areas:** Introducing livestock to new areas had its challenges and in this case, three animals were lost to rabies transmitted by the vampire bats.
- **Avoiding social conflicts by establishing appropriate strategies from the beginning:** It is important to establish appropriate strategies from the beginning, regarding the start of businesses so as to avoid unnecessary social conflicts, which could become bottle necks during implementation of the activities.
- **Establish agreed conditions and management decisions regarding what to do with the products of the intervention:** As some members were ambiguous about what to do with the products (e.g. off springs, milk) of the interventions. It is equally important to have a set of agreed conditions or management decisions, which would ensure efficient use of the products and by products.
- **Self-reliance and savings:** The experience has taught farmers to rely on themselves and develop support systems through savings, establishing and servicing lines of credit, and collecting and saving seed for establishing the next crop, as useful strategies for coping with natural or man-made disasters.
- **Team building**: Through the DRM project, despite its shortcomings farmers, have learned to collectively plan and to share responsibilities to achieve their work plan. This experience is invaluable in contingency planning and in developing coping strategies in the aftermath of a disaster.
- **Local control/ownership:** In many instances more local control of projects was desirable especially where changes were deemed necessary during the implementation phase.
- **Patience is essential when dealing with development projects.** Frustrations with procurement issues have demonstrated that even funding agencies have their challenges. However, the ones that are patient are still able to benefit from such projects both in terms of material support and training.

Specific lessons learned drawn from the UB's local fowl project:

- Meaningful enhancement occurs over time with the introduction of different breeds, and is not a one shot initiative. Therefore, it is important to have institutional support, preferably non-government, to make breeds available for enhancement.
- Providing cockerels/roosters to the rural households has the potential of influencing 50% of their flocks within the first generation produced within a year, and therefore has potential for a significant impact.
- Supplying hens are much less effective in enhancement initiatives.

- The importance of local fowl production in rural food production, whereby almost every household has local fowls, makes enhancement initiatives cheap, but effective tools in engaging the attention of such households.
- It involves and promotes females and youth in subsistence farming improving local food security and possibly income generation.
- Provides opportunities for integrating farming as it utilizes kitchen wastes as feed and utilizes pen wastes for manure.
- There is potential for water bird development in areas prone to excess water arising from disasters. Like the local fowl, there is demand for such duck meat from the local Asian community providing a strong market incentive for expansion and development.
- Demonstrates that government is not an appropriate institution for supporting development initiatives over an extended period, as is required for local fowl enhancement, as their goals are usually short term and more for political expediency rather than for real development.

4.2 Concepcion village

The DRM practices that were introduced are:

- Irrigation development for vegetable production.
- Local fowl production enhancement.

4.2.1 Irrigation development for vegetable production

Like Santa Martha, the project had a good start despite procurement glitches, which resulted in two farmers dropping out of the group. However, the crop plan was drastically altered as supplies were limited. The start was a result of effort, enthusiasm, and interest of the selected farmers, and private sector support. The latter was based on a good relationship between the agronomist, the extension officer Francisco Xiu and agriculture supplies and services providers in the two Northern districts of Orange Walk and Corozal, whereby a line of credit was obtained for inputs and land preparation.

The land was stony as *Photo 6* shows, which made initial land preparation and manure spreading tedious. Considerable time and effort was invested in manually removing stones from the beds to facilitate planting.

Photo: 6 Field after transplanting sweet peppers illustrating a stony texture; Concepcion village DRM project, Corozal, Belize.

A nursery was constructed at one of the member's home with discarded pallets and lumite netting borrowed from the extension services. Trays, seed, and peat moss were obtained on credit. Seedlings were transplanted on the 23rd November, 2009 and an irrigation system was constructed from discarded tubing and fitting along with materials advanced by one of the suppliers who had the lowest quote in the procurement process. Half of the fertilizer required was procured from FAO and delivered on the last day of December and agro chemicals were loaned by UBCF. With these inputs the farmers managed crops of sweet peppers, cabbage, and tomatoes, though yield from the latter was disappointing. It must be noted that data on yield were supplied by the farmer and may represent some degree of under reporting as farmers are usually conservative about their production information.

A field of Sweet peppers, also known as bell peppers, just prior to harvesting is shown in *Photo 7*. The variety used was Double Up considered suitable for this time of year in Belize. The harvested yield was 22,000 pounds sold at an average price of $1.25 per pound.

Photo 7. Sweet pepper plants and members of the group prior to harvesting; Concepcion Village DRM project, Corozal, Belize.

The cabbage field at its peak growth period is shown in *Photo 8*. The cultivar used was 'Rotunda', considered suitable for the area at that time of year when sunlight hours are reduced and mean daily temperatures are below the annual average. The farmers harvested some 24,000 pounds of cabbage and obtained an average price of $0.45 per pound.

Photo 8. Heads of cabbage (cv. Rotunda), alongside late season corn, and the farmer responsible for its cultivation; Concepcion Village DRM project, Corozal, Belize.

The tomato stand and members of the group involved in its cultivation are shown in *Photo 9*. Crop production was disappointing with harvested yield of about $8,500 pounds at an average of $0.80 per pound. The variety 'Galina' outperformed both 'Tolstoi' and 'Sultan' under the given set of conditions of reduced day length, and lower than average ambient temperatures and would be used in future crop programs.

Photo 9. Tomato stand and farmers responsible for its cultivation, Concepcion Village DRM project, Corozal, Belize.

Other crops scheduled included onions, irrigated corn, and watermelons. The former was discarded as inputs were not received. Some income was generated from irrigated corn and a small crop of watermelons with inputs from the group member and the cultivation of these crops were not recorded as specific project activities.

The project was modified for the second year, necessitating changes to the procurement schedule. Based on experiences of year one, time constraints, and problems with procurement, dry season cropping patterns were restricted to tomatoes, sweet peppers, and cabbage, with onions and carrots as winter crops. The procurement schedule was modified accordingly and $9,230 US was allocated for the purchase of seed, fertilizers, and equipment. The latter presented a major constraint in the first phase and was expanded to include an onion planter, two mist blowers, one roto tiller, and materials for the construction of a protected nursery. Protection at the seedling stage was identified as essential and an appropriate structure was promised to the group during the visit of the former FAO country representative, even though the project could not provide them with seeds. Irrigation equipment not previously supplied would hopefully be procured this time at a cost of $2,859 US. System components were borrowed and/or salvaged during phase one as the project only provided mains, sub-mains, and lateral tubing. Furthermore, onion seed for phase two planting was procured through the local FAO petty cash and were planted in a nursery from early November. Seedlings are ready for transplanting to the field. And carrots were dropped from the program, as inputs were not procured in time. Plantings in January and February, unlike onions, have not been demonstrated to give good yields.

4.2.2 Local fowl production

The supply of Rhode Island Red chickens, though promised, could not be procured at implementation as the supplier changed his mind. A second supplier was able to provide Black Sex link crosses (BSL) out of Miami as a suitable alternative dual purpose bird *(photo 10).* BSL, a cross between Rhode Island Red roosters and Plymouth Rock hens, is known both for egg and meat production with roosters growing to 8-9lbs, and hens 6-7lbs. The chickens were reared in three small poultry houses at the field station of the University of Belize under the supervision of the national project agronomist. About 490 roosters and about 100 hens were supplied to local farmers in southern, western and northern villages, with the help of the Ministry of Agriculture and UB's outreach staff, primarily to upgrade local flocks with a strong message of disaster risk mitigation.

One pair of black sex link chickens was delivered to one member of the group, but this activity was deferred to coincide with capacity building.

Photo 10: Black Sex link crosses

4.2.3 Lessons learned

The organization of the group in relation to implementation of field activities proved to be the major constraint in demonstrating the risk reduction practices selected for Concepcion. Initially it was thought to be a step in the right direction to have individuals, who previously worked alone, to share an area of land, planting their individual plots within the project area and framework. In retrospect working on all the crops as a group would have had a more profound demonstration of risk reduction. Nevertheless, the lessons learned were similar to those of the Santa Martha project though to different and often lesser degrees (regarding the specific lessons learned from the local fowl enhancement, see section 4.14.):

- **Risk management through diversification:** The experiences of the first cycle have demonstrated that there were considerable risk reductions through crop diversification. The impact of this activity was realized more at the group level, and its significance may have missed the individuals due to the organizational structure at the field level.
- **Risk reduction:** Significant reduction in losses was realized as market conditions had a negative impact on tomatoes, and were more favorable to profit making for sweet peppers and cabbages. The benefits of planting together to avert future fluctuations of prices, high disease incidence, unfavorable weather, and simple disasters was not fully experienced by the group and needs to be reinforced in the training sessions.
- **Self-reliance and savings:** The experience has taught farmers to rely on themselves and develop support systems through savings, establishing and servicing lines of credit, and collecting and saving seed for establishing the next crop as useful strategies for coping with disasters, whether natural or man made.

- **Team building**: Unfortunately the organization of the field work did little to promote team building. Sharing of some resources was inevitable as land, access, information, and the irrigation system were shared. Responsibilities were, however, not shared and this more than anything may have constrained team building. The experience of working together to solve problems and planning for future events was in many respects lacking and as a consequence the group was not well prepared for disaster planning. The gaps would have to be addressed in the capacity building workshops.
- **Patience is essential when dealing with development projects:** Frustrations with procurement issues have demonstrated that even funding agencies have their challenges; however the patient few are still able to benefit from such projects both in terms of material support and training. Members of this group expressed more frustrations with input delivery issues than other groups.

4.3 Calla Creek village

For Calla Creek village, the three DRM good practice projects identified were pasture improvement, homestead gardening, and tree crop rehabilitation. The first two were started while a survey was conducted to collect baseline data for planning the third. Pasture improvement is the most advanced even though there were serious issues with procurement. Homestead gardening made a start in capacity building through UBCF and implementation of field practices was made with borrowed inputs which clearly was not sustainable. The survey has been completed and the tree crop project is now ready to start.

4.3.1 Pasture improvement

Participants include three small cattle farmers and one goat farmer. They all depended on native grasses as their forage sources. Floods of October 2008, which lasted for more than 17 days killed all the native grasses; demonstrating their susceptibility to prolonged waterlogged conditions. Mombasa (*P. maximum*) and African star (*C. nlemfluensis*) on the other hand, while visibly suffering from prolonged waterlogging associated with the floods, reemerged and were reestablished within two months after the excess water subsided. The first activity therefore was to promote the establishment of the latter two forages as replacements for the native grasses used for pastures. The feeding systems, especially in the dry season, were to be enhanced by feeding agro industrial wastes and byproducts, namely citrus pulp mixed with urea and molasses. However, the system of procurement would not allow for the purchase of citrus pulp, as this was a cash transaction which has a small window of availability and a high local demand. Supplemental feeding was modified to include sugarcane, Cameroon grass, and the protein rich shrubs, Nacadero (*Trichanteria gigantea*) and Mulberry (*Morus alba*). These

would be chopped, mixed with urea and molasses, and fed to the animals. Appropriate methods of storage for use during times of forage deficiency would be explored. Visits to the project sites were made by Dr. Lystra Fletcher-Paul and Dr. Cedric Lazarus, both from FAO, with the latter conducting a clinic on cattle deworming, and goat care, while the former had a first-hand view of the effect slow procurement was having on implementation, with the view of promoting possible solutions within FAO.

As was the situation in Santa Martha, the lack of good quality pastures and concerns about the delayed development of the pastures were the major concern of the farmers. The lack of adequate fencing was also a concern, but the farmers agreed to address these issues immediately with the support of the project. The group received posts, knapsack sprayers, barb wire, staples, and Mombasa seed and the members invested in land preparation, fencing, and planting. Supplemental feeding designed to reduce grazing pressures while the newly planted grass was given time for establishment, was not possible with FAO procurement policies and had to be modified to a system whereby cultivated forages were harvested, chopped and fed with molasses and some urea. Changes to the procurement plan were made in support of the changes and included, a motorized chopper and transportation for moving cuttings as new items, with urea, molasses, and fertilizers as items pending from the previous schedule which were all still needed. Cuttings would be sourced from either GOB at Central farm, UBCF, or the author's farm.

Three of the four farmers selected their areas for development, erected fence lines, and planted Mombasa seeds during the current wet season. No planting was done in August, as this month by Maya tradition is not considered a suitable time for planting. Planting of African star is scheduled for September, along with Cameroon grass, Nacadero, and Mulberry all from cuttings. One member, who is probably the neediest, had to be monitored closely as establishment was hampered by excessively high grazing pressures without a source of supplemental feed. While it was generally agreed that his animals should be moved to another site while the improved grass developed, the logistics of doing so apparently could not be accommodated in a timely manner within FAO guidelines. As a result output from the fourth farmer was less than was anticipated. Photo 11 shows an established stand of Mombassa grass showing various stages of regrowth during the cut and feed cycle.

Photo 11 An established stand of Mombassa grass showing various stages of regrowth during the cut and feed cycle, Calla Creek

One farmer, who had cattle and goats, requested technical information on the making of goat cheese for which there was a growing market in Belize.

4.3.2 Homestead gardening

Increasing food production within the family unit, would go a far way towards enhancing livelihood as an important first step in coping strategies of individual families and communities. The particular project was designed to increase the nutritional levels of households involving the female member who was generally under-employed. She was very willing and able to contribute to family income through the production of additional items for subsistence, with excess either stored for future use or sold to realize much needed additional family income. However, she needed training and initial assistance with inputs.

Backyard resources of land, household water, labour, and wastes would be contributed and combined with FAO inputs of tools, seed, and fertilizers to start production. Additionally participants would be trained in nutritious food preparations, and non-refrigerated storage with the latter as a direct intervention in disaster risk management.

The training component of the project was started at UBCF while procurement proceeded. Some inputs were borrowed to get the field implementation moving, but the slow rate of procurement brought the project to a halt. The purchase order for the posts was received, but when the order for fence materials finally arrived some months later, stock were depleted and prices changed. The group generally remained inactive during the current rainy season, but there still remains tremendous interest in the project. So due to procurement issues, major changes accounted for the inclusion of the local pullets, roosters, seedling trays, and peat moss. While the chickens would be used

as a reentry point, it is an important source of manure and in fact replaces manure as an input.

The twelve participants were each supplied with materials for fence, tools, spray can, a drum for storing water, a garden hose, fertilizers, seed and planting materials. The participants were expected to prepare and plant their garden providing their own agrochemicals where needed. Plant member of the solanaceae family, namely tomatoes and sweet pepers, though given were discouraged as these rapidly became infected with viruses transmitted by the white fly. Emphasis was given to plantains, cassava, pumpkins, running beans, cabbage, coconuts and any other crops the participants were able to obtain on their own account.

4.3.3 Tree crop enhancement

At the request of the farmers, this was included as a good DRM practice for testing and possible implementation. It was noticed that deep rooting tree crops survived the floods, on account of their root structure, better than most crops, and were more suited to this particular area than shallow rooting crops. A study was commissioned to determine the nature of assistance needed in the area of tree crop rehabilitation and design a suitable project with relevant training to enhance and further develop tree crops in the area. The study was completed and a suitable project was designed for implementation. A report on the results of the survey would be presented in the University of Belize Central Farm (UBCF) report.

4.3.4 Local fowl enhancement

The supply of Rhode Island Red chickens, though promised, could not be procured at implementation as the supplier changed his mind. A second supplier was able to provide Black Sex link crosses (BSL) out of Miami as a suitable alternative dual purpose bird. BSL, a cross between Rhode Island Red roosters and Plymouth Rock hens, is known both for egg and meat production with roosters growing to 8-9lbs, and hens 6-7lbs. The chickens were reared in three small poultry houses at the field station of the University of Belize under the supervision of the national project agronomist. About 490 roosters and about 100 hens were supplied to local farmers in southern, western and northern villages, with the help of the Ministry of Agriculture and UB's outreach staff, primarily to upgrade local flocks with a strong message of disaster risk mitigation.

A mature black sex link rooster was given to each participant in the DRM project in Calla Creek. In most cases the rooster replaced the farmer's rooster. Six local hens were also to be supplied to expand the local fowl flocks and this was yet to be implemented.

Photo 12 Participants from both Calla Creek and Santa Martha at a training session on supplemental feeding systems

Photo 13 Section of the Calla Creek participants at a workshop on contingency planning held at UBCF on 20/03/2011

4.3.5 Lessons learned

- **Improved forages under high grazing pressures:** Very difficult to establish improved forages under conditions of high grazing pressures. One either has to reduce the stocking rate to match available forages, temporarily relocate the animals, or enhance the barriers between the animals and the areas for new establishment
- **Mombassa grass an excellent forage:** Mombassa grass when established was an excellent forage for 'cut and feed' system during the drought period, with approximately 1 acre of Mombassa supporting 13 animals.
- **Mombassa provided opportunities:** After the drought the prolific growth rate of Mombassa provided additional opportunities for grazing (not recommended), for hay, and silage production in the wet periods.
- **Cameroon grass a good forage:** Cameroon grass, also known as red elephant grass, was also a good forage for 'cut and feed'.
- **Food conservation and storage:** Non refrigerated food storage was immensely popular with participants as it conveyed a real message of food conservation and storage for times of scarcity arising from disasters or production shortfalls.
- **Homestead gardens provide opportunities for women:** Homestead gardens provide opportunities for women to become more involved in food production.
- **Leadership development and teamwork:** Building teamwork without leadership and a vision is difficult if not impossible. There is certainly need to develop leadership skills and develop basic planning capacities in the community.
- **Local fowl enhancement improves food security:** By introducing dual purpose chicken breeds, which are larger and more prolific egg producers, local fowl enhancement improves food security in normal and disaster related times and is considered a good disaster risk management practice.
- **Local fowl rearing entry point for DRM discussions:** Since local fowl rearing is an integrated part of rural subsistence agricultural production, the distribution of improved breed captures attention and serves as an important entry point for DRM discussions.

5. Overall lessons learned

This document outlines the overall lessons learned from project implementation. Firstly, the general lessons learned are provided, which are then followed by specific lessons learned related to four broad categories: technical matters pertaining to resilience and specific challenges, dissemination of information, policy framework and governance and operational management.

5.1 General lessons learned

This project has provided several achievements in terms of identifying good practices for risk reduction to natural disasters. The operational challenges faced at times by the project provided an additional set of lessons useful for future replication of project outputs and for planning and design of new DRM projects. The challenges are related to stakeholder ownership, institutional support, communication and project administration:

- Agriculture is one of the most vulnerable sectors to natural disasters and the impacts of climate change. Thus DRR must be institutionalized and mainstreamed within MAF.

- Farmers and communities are interested in DRR. However, in order to become key partners in integrated sustainable development processes, including DRR, farmers need to get better organized among themselves, to enhance economies of scale, and create through farmers organizations (formal or informal) more critical mass to act on markets, and better entry points for partnering with other stakeholders in a coordinated way for planning and implementing DRR as part of integrated agricultural development.

- The institutional support from the Ministry of Agriculture for DRR, which is currently still weak, needs further strengthening. The capacities in the Ministry for DRR (as integral part of agricultural development) need to be further build up so that MAF will be in a position of a key governmental partner institution for DRR related to agriculture; a formal focal point for DRR should be established in MAF to coordinate all DRR related challenges with ongoing development work.

- Throughout project implementation and for project follow up and institutionalization of project outcomes after project funding has ceased, institutional support, particularly from the national lead agency is crucial. Strong stakeholder ownership and commitment complemented by institutional support facilitates project achievements;

- Procurement and administration related issues provided constraints for timely implementation of project led demonstrations at field level. It is desirable for the national project coordinator to be a full-time position fully embedded into the lead agencies' formal structure, and that the coordinator should be trained in project related procurement procedures; frequent replacement of NPC hampers consistency and continuity of project implementation.

- Communication lines need to be clearly defined upfront and further strengthened as they could cause significant delays in project implementation;

- Dissemination of lessons and technical information gathered should form an integral part
  of any future DRR project framework and their use in future DRM presentations should be encouraged.

- Patience is essential when dealing with development projects. Frustrations with procurement issues have demonstrated that even funding agencies encounter challenges. However, the ones that are patient are still able to benefit from such projects in terms of material support and training.

5.2 Lessons on technical matters pertaining to resilience

Risk management through diversification: Agricultural risk is better managed through an integrated system of production based on both crops and livestock, which allows for the efficient utilization of resources and enhances the coping capacity of the community/group.

Risk reduction: Shifting areas and seasons for cultivation using irrigation. Significant reduction in losses is possible through the seasonal shifting of crop cultivation from the high risk months when both excessively high rainfall and hurricanes are potential hazards, to the less vulnerable, low rainfall months by using irrigation. Furthermore, diversification in cropping patterns and the introduction of livestock reduce risks in terms of food security. In addition, as demonstrated in this project, working and saving together provided some degree of risk reduction even for small groups of farmers.

Involvement of women and youth in homestead gardens and local fowl enhancement: Bringing women and youth into the value chain development complements DRM efforts through their mere involvement in subsistence farming. Additionally, this improves local food security with possibilities for rural household income enhancement through the sale of excess produce.

Local fowl enhancement: The distribution of improved breeds of roosters to rural households has the potential of influencing 50% of their flocks within the first generation produced within a year, and can therefore be a significant and cost effective disaster risk reduction measure, which will reduce the impact of disasters. Supplying hens is a much less effective enhancement initiative.

Forage banks: The development and use of forage banks in cut and feed systems by small ruminant producers was essential to survive drought. Stored as hay, these forages provided an additional source of fibre during the period of excess moisture when green forages were low in fibre.

Shelter Modifications: Considerable mitigation is possible even without the introduction of new practices through simple modification of shelters in rural communities to house livestock, both for large and small animals.

Specific challenges.

Challenges of pests, diseases and soil management: Irrigation allowed for the shifting of the cropping cycle to less vulnerable periods, but the new cropping cycles encountered new challenges of pests, diseases, and soil management. The less vulnerable periods, the dry periods, were also those of poor water quality and diminished effectiveness of irrigation.

Challenges of introducing livestock in new areas: Introducing livestock to new areas had its challenges, such as the loss of three animals to rabies, transmitted by vampire bats.

5.3 Dissemination of information

Entry points to new communities: The importance given to local fowl production in rural food production, whereby almost every household has local fowls, makes enhancement initiatives popular and provides an effective way for engaging rural households and their respective communities in terms of disseminating information. Food conservation in the form of canning, a powerful DRR tool used by Amish communities, was also very popular among communities and provided an excellent entry point for disseminating DRM information to new communities.

Desire for Training: Training in contingency planning in relation to disaster preparedness is not only desired, but required, as expressed in a gender and culture survey by over 90% of respondents. The enthusiastic responses to DRR training in two new communities strongly supported this finding.

5.4 Policy framework and governance

Institutional Support: Though the request for DRR support in farming communities may originate with MAF, more institutional support for the execution of this type of projects should be drawn from other quasi Government institutions involved in DRM, or institutions with more hands on experience in DRM work and possessing the capacity to continue after the funding ceases.

Road map: Any planning for project implementation should not only consider implementation but should also include strategies for continuity and dissemination of results even after funding has ceased.

Governance: It will be desirable to have a full time project coordinator for the control and management of the project, who would answer to a steering committee drawn from the supporting institutions and FAO local representative. In many instances more local control of projects was desirable, especially with regards to procurement and where changes were deemed necessary during the implementation phase.

Incentives: Persons involved in implementation should be given some form of developmental incentives to enhance their input by making the said process part of a certification and training programme from an appropriate certifying body. Farmers, who are generally satisfied with the assistance they received, still require some form of certification to register their participation.

5.5 Operational management

Project familiarization and Internal Communication: Overseas administrators must be familiar with the project and its layout while the local coordinator must be familiar with the rules of procurement. Clear lines of communication must also be established between all the stakeholders and project focal points both locally and abroad for efficient and effective project implementation

Avoiding social conflict: Establishing appropriate strategies from the beginning is crucial for the use of supplies and rules regarding the use and/or disposal of products of the intervention.

Promote Team Building: As it makes implementation easier, team building should start from the beginning and be guided by an approach of shared responsibilities, which is essential for successful implementation of DRM.

Managing gender and cultural diversity: There is no aversion to living with others in temporary shelters with the exception of females from two ethnic groups, and there is considerable room for promoting activities related to culture and religion and those, which foster collective planning and working together. The specific need of females must be addressed by shelter managers.

Patience is essential when dealing with development projects: Frustrations with procurement issues have demonstrated that even funding agencies have their challenges. However, the ones that are patient are still able to benefit from such projects both in terms of material support and training.

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Appendixes Tables in support of budget data

The following appendixes include tables that support budget data. In terms of spending, the project operated on the basis of a technical cost sharing arrangement between the project and the farmers. Thus, the costs mentioned in the following tables were shared between the farmers and FAO.

Table A1: Irrigation equipment and costs for a drip system for 3 acres of vegetables

Item of Expenditure	Quantity	Unit Cost	Total Cost
3" polyethylene hose	2 rolls	$780/roll	$1,560.00
2" polyethylene hose	1 roll	$570/roll	$570.00
T-tape	3 rolls	$780/roll	$2,340.00
3" polybarb T	1	$45.00	$45.00
3" Honda water pump	1	$1,200	$1,200.00
3" Suction line	15ft	$9.00/ft	$135.00
3" disc filter	1	$350.00	$350.00
3" polybarb male	4	$45.00	$180.00
3" female adaptor	6	$5.00	$30.00
3" elbow	3	$6.00	$18.00
3" pvc tee	3	$6.00	$18.00
Reducer 3" to 1"	1	$8.00	$8.00
1" female adaptor	1	$2.00	$2.00
1" air relief valve	1	$40.00	$40.00
3" pvc pipe	1 length	$76.00	$76.00
3" pvc elbow	2	$6.00	$12.00
3" clamp	10	$2.00	$20.00
Reducer 3" to 2"	4	$9.00	$36.00
2" pvc ball valve	4	$25.00	$100.00
2" female adaptor	4	$5.00	$20.00
2" polybarb male	4	$5.00	$20.00
2" clamps	8	$1.50	$12.00
Pvc glue	½ quart	$18.00	$18.00
Pvc cleaner	½ quart	$15.00	$15.00
Teflon	5 rolls	$2.00	$10.00
Total	-	-	**$6,835.00**
Equipment less T-tape (2,340.00)			**$4,495.00**

Table A2: Seed, fertilizer, and pesticide inputs for one acre of Cabbages based on calendar of activities, MAF

	Item of Expenditure	**Quantity**	**Unit Cost**	**Total Cost**
	Seed (Green boy)	11,000	$44.75/2,500	$179.00
	Gaucho	1 Pk	$40.00/48 g	$40.00
Herbicide	Roundup	2 liters	$17.95/liter	$35.90
	Dual Gold (Lasso)*	½ liter	$76.00/liter	$76.00
	Select (Fusilade)**	½ liter	$27.00/liter	$27.00
Fungicide	Amistar (Ridomil)***	10g	$5.75/pk	$5.75
Insecticide	Dipel	1 can	$27.95/500g	$27.95
Fertilizers	14:36:12	2 sks	$60.55/110 lb sk	$121.10
	KNO_3	140 lbs	$118.25/55 lbs	$354.75
	Urea (46:0:0)	395 lbs	$56.25/100 lbs	$225.00
	Polyfeed (19:19:19)	44 ½ lbs	$114.00/55 lbs	$114.00
Total (one acre)				**$1,206.45**

Input costs for ½ acre $603.23
50% fertilizer reduction on ½ acre $399.51
*Dual Gold is used as a substitute for Lasso.
** Select is used as a substitute for Fusilade.
*** Amistar is used as a substitute for Ridomil.

Table A3: Seed, fertilizer and pesticide inputs for one more of Sweet Peppers (Bell peppers) based on calendar of activities, MAF

	Item of Expenditure	Quality	Unit Cost	Total Cost
	Seed (Lido co.)	11 Pks	$137.50/Pk of 1,000	$1,512.50
	Gaucho	1 Pk	$40.00/48g	$40.00
Insecticide	Condifor	273 g	$56.25/52g	$337.50
	Lursban (Regent)*	150 mls	$39.00/liter	$39.00
Fertilizers	14:36:12	2 bags	$60.55/110 lb bag	$121.10
	Ammon. Nitrate (NH_4NO_3)	336 lb	$60.00/110 lb bag	$180.00
	MAP (12:61:0)	52 lb	$156.75/55 lb bag	$156.75
	Polyfeed (19:19:19)	70 lb	$114.00/55 lb bag	$228.00
	Pot. Nitrate (KNO_3)	270 lb	$118.25/55 lb bag	$591.25
Total				**$3,206.25**

Input costs for ½ acre $1,603.05
50% fertilizer reduction on ½ acre $1,283.78
* Lursban is used as a substitute for Regent

Table A4: Seed, fertilizer, and pesticides inputs for one acre of Tomatoes based on calendar of activities, MAF

	Item of Expenditure	Quantity	Unit Cost	Total Cost
	Seed (Green Pride)	11,000	$80.00/1,000 Pk	$880.00
	Gaucho	1 Pk	$40.00/48 g	$40.00
Fungicide	Amistar (Ridomil)*	1 Pk	$5.75/10 g Pk	$5.75
Herbicides	Gromaxone	1 ½ liters	$16.25/liter	$32.50
	Select (Fusilade)**	1 liter	$27.00/liter	$27.00
Insecticide	Confidor	26 g	$56.25/52 g	$56.25
Fertilizers	14:36:12	2 bags	$60.55/110 lb bag	$121.10
	Ammon. Nitrate	216 lbs	$60.00/110 lb bag	$120.00
	Polyfeed (19:19:19)	40 lbs	$114.00/55 lbs	$114.00
	MAP (12:61:0)	65 lbs	$156.75/55 lbs	$313.50
	NuFol. Ca.	180 mls	$31.75/liter	$31.75
	KNO_3	132 lbs	$118.25/55 lbs	$354.75
Total (one acre)				**$2,096.60**

Input costs for ½ acre $1,048.30
50% fertilizer reduction on ½ acre $768.90
* Amister is used as a substitute for Ridomil.
** Select is used a substitute for Fusilade.

Table A5: Condensed schedule of costs for production of onions

Item	**Contributions**	
	FAO ($)	**Farmer Group ($)**
Land Preparation	-	320.00
Seed	1,095.00	-
Herbicide	243.00	-
Insecticide	87.00	-
Fungicide	243.00	-
Fertilizer	533.90	-
Labor	-	968.00
Irrigation System Fuel (30 x $8.50)	255.00	-
Subtotal	2,457.85	1,288.00
Contingency 5%	122.89	103.04
Grand Total	**2,580.74**	**1,391.04**
¼ acre	**645.19**	**347.76**

Table A6: Condensed Schedule of costs for production of carrots extracted

Item	Contributions	
	FAO ($)	**Farmer Group ($)**
Land Preparation	-	120.00
Seed	104.00	16.00
Fertilizer (3 Urea $56.25, 14:36:12 $67.55, Potassium $96.25)	579.00	-
Thinning	-	256.00
Manual Weed Control	-	768.00
Irrigation	128.00	-
Pest Control	308.00	-
Disease Control	179.00	-
Harvesting	-	256.00
Subtotal	1,298.00	1,416.00
Contingency 5%	64.90	70.80
Grand Total	**1,362.90**	**1,486.80**
¼ acre	**340.73**	**371.50**

Table A7: Condensed Schedule of costs for production of potatoes

Items	Contributions	
	FAO ($)	**Farmer Group ($)**
Land Preparation	-	130.00
Seeds (1000 lbs x 0.85/lb)	850.00	-
Bags	70.00	-
Fertilizer	991.75	-
Fungicide	180.00	-
Insecticide	163.50	-
Herbicide	71.00	-
Other	14.75	-
Labor (25/man day)	-	$700.00
Subtotal	2,341.00	830.00
Contingency 5%	117.05	41.50
Grand Total	**2,458.05**	**871.50**
¼ acre	**614.51**	**217.88**

Table A8: List of materials for the Concepcion irrigation system designed by the irrigation and drainage unit of MAF

Item of Expenditure	Amount of Input	Unit Cost	Total Cost
1 ft dripper spacing T-tape	9 rolls	$780.00/roll	$7,020.00
2" Blue Stripe	3 roll	$780.00/roll	$2,340.00
3" Blue Stripe	3 roll	$570.00/roll	$1,710.00
3" PVC Tee	3	$6.00/each	$18.00
3" to 2" PVC reducer	12	$6.00/each	$72.00
2" Ball valve	12	$25.00/each	$300.00
2" Male Poly Barb	13	$5.00/each	$65.00
2" Female PVC adaptor	12	$5.00/each	$60.00
3" Female PVC adaptor	15	$5.00/each	$75.00
3" Male Poly Barb	12	$45.00/each	$540.00
3" Tee Poly Barb	1	$45.00/each	$45.00
2" PVC Pipe	1 length	$32.00/each	$32.00
3" PVC Cross	4	$40.00/each	$160.00
2" Clamps	26	$1.50/each	$39.00
3" Clamps	20	-	$40.00
3" Elbow	3	$12.00/each	$36.00
3" to 1" Reducer	1	-	$8.00
1" Female adaptor	1	-	$2.00
1" Air Releaf valve	1	-	$35.00
3" Disc Filter	1	-	$350.00
3" PVC pipe	10 ft	-	$40.00
3" Check valve	1	-	$150.00
3" Suction Hose	30 ft	-	$240.00
60 M3/Hr. 85 ft pressure Honda Water Pump	1	-	$1,200.00
PVC Glue	1 qt	$18.00/qt	$18.00
PVC Cleaner	1 qt	$15.00/qt	$15.00
Teflon Tape	10 rolls	$1.50/roll	$15.00
Total			**$14,625**

Table A9: Cost of production for 1 acre of potatoes in Cayo

Activities	Quantity	Unit Cost	Total Cost
Land Preparation			
Plow	2 hrs.	$50.00	$50.00
Harrow	1 hr.	$40.00	$40.00
Bedding	1 hr.	$40.00	$40.00
Materials			
Seed	1,000 lbs.	$0.85	$850.00
Bags	100 bags	$0.70	$70.00
Fertilizer			
46-0-0	4 bags	$32.00	$128.00
0-46-0	4 bags	$31.40	$125.60
0-0-60	5 bags	$26.90	$134.50
Nutrileaf	2 pks	$10.50	$21.00
Bayfolan	2 liters	$10.75	$21.50
Fungicides			
Ridomil	3 pks.	$60.00	$180.00
Manzate	10 kilos	$12.50	
Insecticides			
Pegasus	1 liter	$39.50	$39.50
Confidor	1 pk.	$60.00	$60.00
Decis	1 liter	$64.00	$64.00
Herbicides			
Sencor	3 pks.	$7.00	$21.00
Fusilade	1 liter	$50.00	$50.00
Other			
Hormone	1 pk.	$6.75	$6.75
Sticker	1 liter	$8.00	$8.00
TOTAL COST OF INPUTS			**$1,909.85**

Table A10: Cost of production for one acre of onions

Activity		Description	Cost per Unit	Cost	Total
Land Preparation	Ploughing		40	60.00	
	Harrowing		40	40.00	
	Cross Plough		40	40.00	
	Bedding		40	40.00	180.00
	Seed		$180.00	540.00	
	Planting		4	200.00	740
	Fertilizer/Granular	0-46-0	38.5	115.50	
		0-0-60	32	64.00	
		46-0-0	35	70.00	
		13-0-44	75	300.00	
	Fertilizer/Foliar	20-20-20	12	24.00	
		Bayfolan	10	20.00	
	Herbicide	Fusilate	60	120.00	
		Basagran	36	72.00	
		Ronstar	54	54.00	
	Insecticide	Ambush	35	35.00	
		Malathion	15	11.25	
		Vertimec	50	25.00	
	Fungicide	Amistar	50	200.00	
		Silvacur	44	176.00	
		Bravo C.M	55	165.00	1451.75
	Onion Bags		0.6	240.00	240.00
	Spreading Fertilizer		2.5	97.50	
	Spraying Herbicide		2.5	37.50	
	Spraying Insecticide		2.5	37.50	
	Harvesting		2.5	200.00	372.5
TOTAL				**2984.25**	**2984.25**

Table A11: Production costs for 10 acres of mechanized corn

Particulars	**Unit Cost**	**Total Cost**
Bush hogging (land preparation	$35.00	$280.00
Rome plowing	$65.00	$650.00
Harrowing 2 passes	$35.00	$525.00
Seeds	$2.45	$392.00
Planting	$35.00	$175.00
Fertilizer		
Fertilizer at planting 14-36-12	$47.65	$476.60
Urea for(side area)before30 days of planting	$46.00	$460.00
Herbicide		
Atrazine(2 litre/acres)	$5.86	$117.20
Prowl(1 liter/acre	$33.00	$330.00
Insecticide -Procrone (1 liter/acre)	$22.00	$225.00
Cultivate	$35.00	$350.00
Harvesting with combine(($1.30 bags/acre	$1.30	$325.00
Total		**$4,305.80**
10 % contingency		$430.00
Grand Total		**$4,736.27**
Income from Corn Production		
Dried Corn	$0.23	**$6,750.00**

Table A12: Cost of production for 1 acre of watermelon

Activities	Quantity	Unit Cost ($)	Total Cost
Land Preparation			
Plough	1 hr.	40	40
Harrow	1 hr.	40	40
Seed			
Top Yield	4 oz.	110	110
King Charles ($85.00)			
Fertilizer			
Urea	1 bag	31	31
14:36:12	3 bags	32.5	97.5
Crop Finisher	2 pks	14	28
Fungicides			
Antracol	10 pks	17.5	175
Bravo	4 liters	33.5	134
Insecticides			
Baytroid	3 liters	33.25	99.75
Confidor	1 pk.	54	54
Weed Control			
Paraquat	4 liters	11.5	46
Grand Total			**855.25**

Table A13: Cost of production for one acre of carrots

HEAD	ACTIVITY	UNIT	COST/UNIT	TOTAL
Land Preparation	Plough	1 hr.	$40.00	$40.00
	Harrow	1 hr.	$40.00	$40.00
	Bed Preparation	1 hr.	$40.00	$40.00
				$120.00
Sowing	Seeds	8 oz.	$13.00	$104.00
	Sowing	4 hrs.	$4.00	$16.00
				$120.00
Fertilizer	Urea	3 bags	$37.00	$111.00
	Phosphorus	2 bags	$37.00	$74.00
	Potassium	3 bags	$37.00	$111.00
				$296.00
Thinning	Manual Thinning	64 hrs.	$4.00	**$256.00**
Weed Control	Manual Weed Control	192 hrs.	$4.00	**$768.00**
Irrigation	Irrigating 3 days after	32 hrs.	$4.00	**$128.00**
	sowing/3 days after			
	germination			
Pest Control	Sevin	16 lbs.	$11.50	$84.00
	Rat Bait	8 kgs.	$16.00	$128.00
	Labour	24 hrs.	$4.00	$96.00
				$308.00
Disease Control	Manzate	2 kgs.	$12.50	$25.00
	Benlate	1 kg.	$34.00	$34.00
	Labour	30 hrs.	$4.00	$120.00
				$179.00
Harvesting	Manually	64 hrs.	$4.00	**$256.00**
Grand Total				**$2,431.00**
Average yield per acre = 8,000 lbs. (none irrigated)				

Table A14: Condensed Schedule of costs for production of 1 acre of watermelons

Item	Contributions	
	FAO	**Farmer Group**
Land Preparation	-	$80.00
Seed (4 ozs)	$110.00	-
Fertilizer	$145.00	-
Fungicide	$309.00	-
Insecticides	$153.75	-
Herbicides	$72.00	-
Labor (Manual Spraying/Fertilizer application/Harvesting)	-	$150.00
Subtotal	$789.75	$230.00
Contingency 5%	$39.49	$11.50
Total	**$829.26**	**$241.50**

Table A15: Condensed Schedule of costs of production of irrigated corn per acre

Item	Contributions	
	FAO	**Farmer Group**
Land Preparation	-	$90.00
Seed (25,000 kernels)	$70.00	-
Planting (8 man days)	-	$200.00
Fertilizer	$157.25	-
Herbicides	$82.17	-
Manual Spraying	-	$50.00
Harvesting (16 man days)	-	$400.00
Irrigation Costs (30 days x 1 gal gas/day)	$255.00	-
Subtotals	$565.02	$740.00
Contingency 5%	$28.25	$37.00
Total	**$593.27**	**$777.00**
½ acre	**$296.64**	**$388.50**