Good DRM practices for Belizean small farmers and an approach at inclusion and acceptance, on a pilot basis, to promote Disaster Risk management in the agriculture sector.

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[1] FAO/MAF stands for the ' Food and Agriculture Organization /Ministry of Agriculture and Fisheries'.

Summary: A menu of good Disaster Risk Mitigation (DRM) practices is presented for Belizean small farming systems. Selected essentially from successful small farming systems, not seen in the rest of the Caribbean, which are sustainable and have demonstrated tremendous risk management capabilities as an innate and integral part of their framework. Furthermore, characteristics of such systems have been identified and form a standard for comparing pilot groups in an attempt to identify weakness and deficient areas as entry points for good DRM practices. The approach goes beyond the reduction of risks arising from disasters, and addresses farming system enhancement and coping capacities, aimed at achieving stable and sustainable livelihoods.

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1. Introduction

Disaster risk mitigation (DRM) pilot project is new to Belize. Having had similar projects in the Caribbean (Anon., 2007; SPENCE, 2008; ROBERTS, & SHEARS, 2008) in islands with a history of losses arising from hydro meteorological disasters, namely Cuba, Jamaica, Haiti and Grenada, it was felt that Belize could benefit from a similar exercise.

The expected output is to demonstrate good DRM practices at the farm level, develop a national plan of action for DRM strategies, and capacity building of institutions involved in disaster risk management at all levels. These goals are modest as indeed the project itself is small. To expect significant responses at the national and even at the district levels in the time frame of two years is in large measure, wishful thinking. However, if the project is at least successful in stimulating agriculture based communities, on their own, to prepare for or actively participate in disaster preparedness, develop or at least initiate strategies to reduce losses and enhance their coping capacities, then the project would have been successful.

The underlying assumption in developing the project is that the current approach to DRM in our farming communities is weak if indeed one does exist. The burden of disaster management falls naturally on the National Disaster Management body (NEMO[2]), which, resource deficient, is stuck with a reactive agenda devoid of special provisions for agriculture.

The desired goal is an aggressive proactive approach to risk mitigation. It is justifiable therefore in identifying good local DRM practices, building upon these by borrowing from other local experiences and around the Caribbean, to demonstrate enhanced ways and means of reducing losses due to disasters at the farming level. While this is logical thinking, and the right focus, the approach is somewhat deficient and needs to go a step further towards using good DRM examples to further develop small farming systems in pursuit of sustainable livelihoods.

Unlike most of the Caribbean and Central America, Belize has communities of small farmers which are highly successful, expanding in both size and efficiency, providing stable and sustainable livelihoods for their members without government or external support even in extreme disasters. In fact, these communities not only contribute significantly to food security, but have provided significant resources to both local and regional recovery efforts after natural disasters. It must be assumed that for these farmers to succeed when others, with similar livelihoods, both at home and in the region are failing, not only in times of disaster, but even in normal times, suggests serious problems beyond disasters.

[2] NEMO stands for National Emergency Management Organization.

To be successful, expand, and have significant coping and resilient capacities to deal with disaster situations suggests inherent incorporation of sound disaster management practices and principles. These practices, within an agriculture system, have been tested in the local environment, and have contributed significantly to growth and sustainability despite disasters. It is these practices, in the context of a successful farming system, which are relevant and should be promoted in the pilot projects. This report examines the successful small farmer systems, select relevant good DRM practices and principles for possible inclusion in pilot programs to address the further development of small farmer systems towards stable and sustainable livelihoods.

1.1 Sustainable small farming systems in the Caribbean

It is impossible to analyze such a complex topic in a short space. For this paper, it suffices merely to give a few factors, both exogenous and endogenous, which have negatively impacted the development of sustainability in Caribbean small farming systems.

With the exception of 'slash and burn' agriculture of the Amerindians in Guyana, the Caribbean has virtually lacked real sustainable small farming systems capable of surviving without significant government support and intervention. Reasons for this lack of development can be found in both the social history in relation to the colonial plantation economy (RODNEY, 1981), and a series of institutional missteps on behalf on nationalist governments from independence to present day. Foremost amongst the missteps are the promotion of cash crops in farming systems which were essentially subsistence farming systems without the requisite support mechanisms to assure success and preserve sustainability; a paradigm shift to import oriented tourism as the development thrust, neglecting agriculture in the process.

Jamaica and Guyana may have been spared serious damage to their small farming systems, the former, because of the strong agriculture institutions developed over time and the latter because tourism is still in its infancy.

Corrective measures are in the pipelines as it was recognized that small farming systems and their produce could be integral parts of successful tourism development frameworks, though the process has been complicated by escalating world food prices, shortages of inputs, and by the challenges of climate change.

1.2 Small farming systems Belize

Belize currently has approximately 10,000 farm holdings of which 75% are considered small farms based on a holding size of 25acres or less. Many small farms are mixed farms, having some livestock and crops producing both for subsistence and income generation, exhibiting a variety of farming systems constrained more by market forces than productive capacity.

Of all the farming systems, two have survived the test of time and are considered sustainable, namely the Milpa or 'slash and burn' system (HOLDER *et al*., 1999) practiced by traditional Mayas, and the Amish small farming system. They are both mixed farming systems which practice low external input agriculture (LEIA).

Unfortunately, Milpa farming is on the decline as it remains labor intensive and has not evolved sufficiently to act as an attractive livelihood to the young members of this ethnic group who migrate to urban centers in search of non-farming lifestyles. The Amish communities are rapidly expanding to accommodate young families. In addition to the traditional Upper and Lower Barton Creek communities, we have seen Springfield, and Pine Hill emerge in the past 15 years, with new communities planned at Santa Martha in Cayo and the southern bank of the Swasey in the Toledo district for 2010.

Amish agriculture is characterized by the use of animal power and natural forms of energy, and is almost completely independent from fossil fuels as a form of energy. Success is measured in a number of ways foremost amongst these are the capacity to feed themselves, contribute to national food security, create sustainable livelihoods based on farming for all community members, be independent from government financial support, social, and educational services, though they use health services. Last but not least, their capacity to purchase their own production resources.

Amish agriculture is well planned, sustainable, and expanding. They have successfully mitigated losses associated with disasters through a number of interventions and/or good practices which forms part of the agricultural system, both on an individual and community basis. The complete devastation of Pine Hill settlement in 2001 by hurricane Iris, was met with swift reconstruction and rehabilitation without assistance from government, demonstrating their tremendous resilience capacity.

1.3 Characteristics of sustainable and successful small farming systems, as exemplified by traditional Amish farming systems in Belize

Amish farming systems in Belize are found in agro ecological zones ranging from limestone hills with shallow soils under moderate rainfall conditions in the Barton creek area of Cayo, to high rainfall and deep, highly acidic soils of Pine Hill in the Toledo district. Nevertheless their agricultural systems are characterized by some of the following:

- Share a common **vision.**
- All **mixed farming** systems, integrated, and making efficient use of weather and natural resources.
- Production is well **planned** and addresses first and foremost the food needs of the farmer and secondly income generation.
- A **collective approach** to marketing, procurement of inputs and solving common challenges.
- Wide **skills base**, including: crop, soil, and animal management; construction; logging; hunting; food processing and preservation; all developed through experience.
- **Soil management** and the use of organic amendments form an important part of the cropping base.
- Widespread use of draught animals and **natural sources of energy**.

The highlights emphasizes key elements essential to their success. These will be used to develop a standard for assessing other groups in the pilot communities. The essential ingredients are: *a shared vision, mixed farming systems, the collective approach and planning, capacity building through practice, soil management, and conservation both in energy and the environment.*

2 Good DRM practice menu taken from successful small farming systems in Belize

Good practices are presented in groups designed to emphasize the characteristics of sustainable small farming systems. The groups are not mutually exclusive as some practices could be placed in one or more groups and there is considerable integration and overlap of practices which is desirable. The format for presentation was taken from SELVARAJU (2007).

- ***Multiple farming systems.***
  - Dairy cattle production.
  - Beef cattle production.
  - Sheep production.
  - Improved forages.
  - Dry season forages.
  - Live fence posts using legume trees.
  - Hay production and feeding.
  - Forage protein banks.
  - Agriculture by-products and wastes as livestock feeds and feeding components.
  - Local fowl/scavenging fowl production.
  - Diversified cropping systems.
  - Homestead gardening.
  - Drip irrigation systems.
  - Plastic mulching.
  - Agryl. tunnel structures.
- ***Planning and the collective approach.***
  - Planned cropping schedules/patterns.
  - Community networking, input procurement and marketing.
- ***Skills development.***
  - Food preservation and storage.
  - Life skills development through experience
- ***Soil management.***
  - Organic matter, green manure, and crop residue additions to the soil.
  - Deep bedding systems for drainage
- ***Conservation of energy and the environment.***
  - Forest conservation and harvesting.
  - Shade tree selection, preservation, and management.
  - Draught animals.
  - Hunting dogs and hunting.
  - Fire breaks and fire passes.
  - Water ponds for harvesting and storage.

- Water transportation and pumping system.
- Water storage systems, troughs, tanks cisterns.

Multiple farming systems

All successful small farmer systems in Belize are multiple farming systems or systems with species diversification. This is itself a mechanism to manage risks, and efficiency is enhanced through integration of the components. The following section presents examples of good practices, as components of multiple farming.

2.1 Dairy cattle production

Place: All Mennonite communities, especially the small farmers' communities of Upper and Lower Barton Creek, Springfield, Pine Hill.

Historical Perspective: Traditionally the Mennonites from their arrival in 1958 have introduced dairy breeds and produced their own dairy products as part of their food security and income generation goals. Government, at its Central farm station, promoted dairy cattle and dairy crosses to encourage farmers into milk production in the mid to late eighties. There was some initial growth which dissipated with the demise of the Macal cooperative and dairy plant. However, with the exception of a few medium farmers, dairy production is concentrated in the Mennonite communities and their satellite villages.

Hazards: Drought, floods, and hurricanes.

Description: Dairy cattle are raised on improved pastures with high protein supplements, after parturition, the calf is allowed the colostrums, and then moved to supplements while the cow's milk is harvested daily for processing either in individual homes or at the central milk plant at Spanish Lookout.

Suitability: Most lands with natural drainage with topography ranging from flat to rolling, provided forages are of good quality and available with a non-limiting supply of water throughout the year. Supplements are essential to maintain a high protein diet if milk yield is to be maintained at high levels.

Possible beneficiaries: Small rural farmers and even landless laborers could benefit from manual dairying. This practice is used both for subsistence and income generation.

Cost estimate: Cost of initial stock, pasture development, room in barn for milking, and containers for milk handling.

Implementation: Easy to implement in areas where there is a demand for non refrigerated cream and cheese, and/or in areas with easy access to a dairy reception centre or processing plant.

Maintenance: Maintenance of pastures, provision of high quality supplements, and replacement of low yielding animals.

Benefits: The practice assures income generation and contributes to food supply throughout the year, even during periods of disaster; important source of manure for soil management.

Institutional support: Genetic improvement, development of supplements from agro-industrial wastes, and import restrictions on dairy products to expand local marketing opportunities.

2.2 Beef cattle production

Place: Beef cattle is produced throughout rural Belize.

Historical perspective: A traditional part of Belizean agriculture, beef cattle production systems have evolved and are still evolving towards greater efficiency. Systems range from large and small farmer systems with high capital investments in pasture development, hay, and silage production, to less efficient traditional systems using native pastures, indigenous breeds with highly variable production outputs.

Hazard content: Drought, and under some conditions of high rainfall when crop production is significantly reduced.

Description: Beef cattle are raised on improved pastures established on well drained lands provided with a non limiting supply of water, salt, minerals, and protein supplements as required. Seasonal breeding is practiced where possible and excess stock and culls are sold off at the beginning of the dry season to reduce the grazing pressure. In periods of heavy rains, floods and hurricanes the animals are given access to higher grounds.

Suitability: To most well drained areas, shallow soils, rolling lands where water is available. Low lying areas and the highly leached acidic soils, “Pineridge lands”,have additional challenges and as a consequence higher production costs.

Possible beneficiaries: Cattle is often referred to as "money in the bank" on account of the ease with which it could be converted to cash. This is advantageous to all cattle and mixed farmers during periods of disaster as stock is readily converted to cash for procurement of essential inputs during recovery.

Cost Estimate: Cost of starter stock, pasture development, fence and corral. Actual figures depend on the size of the operation.

Implementation: Pasture and infrastructure should be in place before animals are procured. A dry season stocking rate of 1:2 animals: acres is recommended. Particular attention should be given to dry season forages and supplements, a health program, good herd management, and record keeping.

Maintenance: Maintenance entails supplements, salt/minerals, veterinary supplies, and proper rotation to avoid overgrazing.

Benefits: Income source during disasters, source of manure for soil management, source of draught power for tillage, land clearing/cleaning operations and haulage of bulk materials.

Institutional Support: Farmers require support in the area of genetic improvement, supplement formulation, hay, silage, and agro industrial byproducts feeding systems.

2.3 Small ruminant (sheep) production

Place: Several farms and farming systems throughout all six districts of Belize.

Historical perspective: Traditionally a minor part of small farm production systems. In the last 10 years production at all levels was initiated with the introduction of new breeds, in particular the Dorper, and Government support in light of a market demand pull by the tourist industry.

Hazard content: Drought, and periodic flood conditions.

Description: Raised on improved forages in a system of rotation which assists in the control of internal parasites, and prevention of overgrazing. A secure house on well drained or high ground, prevents hoof diseases and protects from predators, extremes of weather, and thieves. A daily supplement is provided to provide a balanced nutrition.

Suitability: Small and large mixed farming systems employing a moderate to low external input agriculture.

Possible beneficiaries: Small and medium farms, as the stocking rate is 10 sheep/acre; rural women and youth.

Cost estimate: Starter stock, estimated at $1,500-$2,800 for six females and one ram depending on the breed, secure housing, and pasture sub-division costs, assuming improved pastures with perimeter fence already exist.

Implementation: Improved pastures with perimeter fence using sheep wire, a protein bank, and protective housing should be developed before stock is obtained. Deworm all animals and confine for 4-5 days before grazing in systematic manner. Threats of predators should be assessed and control/preventative measures factored into the planning and housing development.

Maintenance: Daily supplement to balance nutrition and a regular deworming program every 2-6 months depending on an assessment of need, foot rot monitoring and treatment during wet periods. Raised floors have a positive impact on animal health and should be used where possible.

Benefits: High fecundity and high growth rates make sheep ideal for use in rehabilitation programs after disasters. Source of ready cash for farmers after disasters to provide investments in the reconstruction efforts.

Institutional support: Farmers need larger quantities of reasonably priced improved breeds, and capacity building in intensive pasture management, molasses/urea blocks, and protein bank development and utilization.

2.4 Improved forages

Place: All Amish farming systems, and small farms throughout the country, ranging from Crique Sarco in the highlands, high rainfall southern region, to the low rainfall region of Corozal in the north of Belize. Adaptation in the northern districts has been slow as the easy availability of sugar cane as forage has reduced the need for exotic grasses.

Historical perspective: Early efforts at pasture improvements concentrated on Jaragua grass (*Hyparrhenia rufa*), African star (*Cynodon nlemfluensis*) native Guinea grass (*Panicum maximum*), Elephant grass (*Pennistum purpureum*) and a dwarf cultivar of the same. In the late seventies the *Brachiaria spps.* were introduced with *B. humidicola* in the lowlying wet areas, *B. brizanthia* and *B. decumbens* on well drained soils. More recently Mombasa (*Panicum maximum cv Mombasa*) on account of its high crude protein content has been the popular choice for pasture expansion, with other species in special situations, eg. Setaria (*Setaria spacelata*) for low lands, Andropogan (*Andropogon gerardii*) for low fertility soils.

Hazard context: Drought, high rainfall, and floods.

Description: Native forages are eliminated, and the area replanted with improved forage specie suitable to the specific environmental conditions and feeding system.

Suitability: All improved ruminant production systems in livestock and/or mixed farming systems.

Possible beneficiaries: All small farming systems involving ruminant production, tin smiths in the production of small hand planters agro input suppliers.

Cost estimate: Involves cost of land preparation, seeds/cuttings, and planting. Typical costs run from $200-400 /acre with the higher cost inclusive of two cycles of fertilizer at a rate of one 100lb.sk/acre/cycle.

Implementation: Land is prepared just before the rains start in mid-late May, with planting in early June when soil moisture availability is in the upper range of available moisture.

Maintenance: Removal of broad leaf species by chopping, and one cycle of fertilizer per year at a rate of 100lbs/acre. he composition should be based on a soil analysis, once every three years, or knowledge of the soil type.

Benefits: Higher nutritional supply throughout year, faster recovery after disasters, shorter development periods, and faster returns on livestock.

Institutional support: More training in forage selection and pasture management, use of forage protein banks to supplement during periods of declining forage quality, fiber supplements during periods of high rainfall when water content of forages is high, and supplemental feeding systems.

2.5 Dry season forages

Place: All small Amish farms and small livestock/mixed farms of the dry northern districts.

Historical perspective: Traditional part of small farming systems.

Hazard context: Drought.

Descriptive: Sugar cane (*S. officinarum*), Taiwan grass (*Arundo formosana),* Cameroon grass (*P. pururеum cv. Cameroon*) and Elephant grass (*P. purpureum*), either cultivated,

or ratooned along roadways and abandoned fields, harvested, chopped and fed to ruminants during the dry season. When supplemented with minerals, urea and molasses provide good dry season feed for ruminants.

Suitability: All areas with pronounced dry periods lasting more than two months when regular pastures are overgrazed or in short supply.

Possible beneficiaries: All small livestock and mixed farmer in areas with pronounced dry periods.

Cost estimates: Land preparation, cutting, and planting of small areas of a few tasks (25yds.x25yds) for 'cut and feed' system. Estimates could run at about 70-100 $/task.

Implementation: Land preparation, completed before the rains, with planting some two to three weeks into the rainy season when available soil moisture is in the higher range. Harvesting is reserved for the following dry season.

Maintenane: Two cycles of fertilizer application, high phosphorus followed by high nitrogen compound mixtures, during first two months at a rate of 100lbs/acre/cycle. Weeding in early stages before canopy is established.

Benefits: Allows year round, uninterrupted, animal production, source of feed during drought, less time to market weight.

Institutional support: Training in areas of supplements for 'cut and feed' system, promotion of sugarcane feeding using small choppers in areas where cane is easily available.

2.6 Live fence posts using legume trees

Place: Throughout Belize, especially on small fenced farms.

Historical perspective: Tradition method of fence construction on small homesteads in rural Belize.

Hazard content: Drought.

Description: The most commonly used source of live posts is Madre cocoa (glyricidia sepium) which is easy to establish by cuttings, free of thorns, high output of hardwood and a rich leaf litter. The planting pattern varies with the most common being some form of alternation with lumber posts. Posts ranging from two inches in diameter upwards offer the best chance of establishment when taken from flowering plants, in the dry period, a few weeks before the rains. The bark is removed from the planted end

to facilitate easy rooting. Other commonly used live fence materials include, Gumbo limbo (Bursera simaruba) and Leucaena (Leucaena glauca).

Suitability: Have been successfully established in most areas of Belize, and Glyricidia appears to thrive and produce better in the high rainfall areas of the south where soil are generally acidic, with Bursera and Leucaena more suitable to the drier areas of western and northern Belize where soils are neutral to alkaline.

Possible beneficiaries: Small farmers and households especially in dry and resource deficient areas, bee producers, and loggers.

Cost estimates: Involves cost of cutting, transportation, and planting in the fence line. Cutting is estimated at 50-75$/100posts with planting in the same price range depending on post sizes.

Implementation: Involves cutting posts eight feet long, transporting to fence site and planting, one and a half to two feet deep.

Maintenance: Low, and involves replacing wire imbedded in the growing posts.

Benefits: Shade; dry season, high protein fodder for ruminants; bee fodder; source of fuel wood and timber; nitrogen additions to the soil; and allergy crop.

Institutional support: Promote greater use of live fence posts through education on potential benefits to farming systems, the farmer, and the environment.

2.7 Hay production and feeding

Place: Amish small farms and many others surrounding or in close proximity to large Mennonite farming areas. Large Mennonite livestock farms in Spanish lookout, Blue creek, and Shipyard.

Historical perspective: Traditional part of north American ruminant production systems, introduced into Belize by the Mennonites dairy farmers from their arrival, fifty years ago, only to be expanded and commercialized in the last 7 years. Grasses commonly used are Mombasa (P. maximum cv. Mombasa), African star (C. nlemfluensis), and beans trash.

Hazard context: Drought and flood conditions.

Description: Pastures with low weed content and free of harmful weeds is left ungrazed, fertilized, and allowed to mature. Cut just before flowering when nutrient

content is at its maximum, wilted for about a day, harvested, compacted, and tied into bundles for storage indoors, or in a shaded area.

Suitability: Large areas of pure stand, improved, high quality, forage on lands which are civilized and machine workable.

Possible beneficiaries: Ruminant farmers, and mixed farmers, especially with dairy units in areas prone to extended dry spells, with large proportions of native pastures.

Cost estimate: Additional fertilizer application of 1 sack of urea or 18:18:18 per acre, and the cutting and baling costs of 1.50-2.00$/bale by contractors. Commercially a 2.5ft.x 4.0ft bale of compressed hay sells for $4.50.

Implementation: Successful implementation depends on training the animals to eat hay, conveniently done during weaning, availability of good quality hay in close proximity to farm, availability of additional pastures for hay production, and a successful urea/molasses feeding program.

Maintenance: Protected from rain and stored in cool dry place.

Benefits: Reduces animal losses during periods of declining forage quantity and quality, as in the dry and drought conditions, and also during prolonged heavy rainfall. Important source of feed during weaning, other stress periods, and convalescence.

Institutional support: Increase availability of hay to small farmers from storage centers within the rural areas. Should be promoted along with urea/molasses blocks for feeding during dry and prolonged rainy periods.

2.8 Forage protein banks

Place: Some small farms in the north and west of Belize.

Historical perspective: Promoted by CARDI[3] for over 20 years in the Caribbean region, however, in Belize the practice was seriously promoted the Ministry of Agriculture in the past 10 years.

Hazard context: Drought.

Description: Small areas planted with shrubs/vines having foliage high in crude protein, for use as ruminant supplements or supplement formulation are known as protein banks. The forages commonly used are Madre cocoa (*G. sepium*), Leucaena *(L. glauca*),

[3] CARDI stands for Caribbean Agriculture Research and Development Institute.

Macuna *(Macuna pruriens*), and more recently Nacedero (*Trichanteria gigantea*), and Mulberry (*Morus alba*). The foliage is either, cut and fed to the animals, or they are allowed to graze rapidly en route to grazing, as over consumption of the leguminous species may result in bloating.

Suitability: All small farms where forage quality and quantity is a major constraint during periods of stress and/or as a result of overgrazing.

Possible beneficiaries: Small ruminant farms, and mixed farming systems, in areas with pronounced dry seasons and/or prolonged heavy rains. Pig farmers and range poultry from use of Mulberry and Nacedero respectively.

Cost estimate: Low cost which involves collecting cuttings, root hormone ($6.50/ounce), and planting at $50/task(25yds.x25yds).

Implementation: Treat area to be planted with herbicides, treat cuttings with hormone as directed and plant 4-6 inches in the ground. Cuttings must be well supplied with water until established. Alternatively, establish cutting in bags in a nursery, and transplant to weed free site during the rainy season, or at any time if supplemental watering is available.

Maintenance: Weeding during the early stages of development, fertilization with a low nitrogen mixture or 18:18:18 during the first three months of growth, thereafter once per year. Pruning regularly to feed the animals and encourage vegetative growth.

Benefits: Soil management as most of these forages add nitrogen and organic matter to the soil, source of additional protein for ruminants, pigs and poultry resulting in lower production costs, reduces animal losses during stress periods.

Institutional support: Stronger campaign to promote the use of protein banks in small farming systems. The campaign should make planting materials more available to the farmer along with quantitative information on benefits.

2.9 Agriculture by-products and wastes as livestock feeds and feeding components

Place: Throughout the farming community of Belize.

Historical perspective: traditional part of livestock farming. Expanded to include a large proportion of small farmers in past 20 years with the promotion of mill feed from the flour mill by ADM[4].

[4] ADM stands for Archer Daniels Midland Co.

Hazard content: Drought, excessive rains, and floods.

Description: Agro industrial wastes include: shrimp heads, chicken offal, pig and cattle offal, blood and bone meal, reject bananas, brewery waste, citrus pup and peel, and beans trash. By-products are mainly mill feed from flour and rice processing, second grade beans and corn, molasses, and broken rice. Cost and availability when needed are important considerations in their use in ration formulations.

Suitability: Supplemental feeding during normal times and especially during periods of stress arising from extremes of weather, weaning, convalescence, and recovery from illnesses, transportation and changing habitats.

Possible beneficiaries: All farming systems, especially those in close proximity to sources of by-products.

Cost estimate: Generally the cost of transporting the waste material, reject bananas, citrus peel and pulp, and brewers waste, to the farm, as the product itself is free. For example, it costs $330 for a 14 cubic yard load of citrus pulp delivered at about 60miles from the source, cheaper at shorter distances. By-products sell for about $16.50/100lb. of mill feed, and $10.00/50lb dried chicken offal.

Implementation: By-product and/or waste should be part of a balanced diet and not fed alone. For example, citrus pulp is mixed with molasses, urea, minerals, and mill feed/reject beans based on a predetermined formula to address balance, and fed to cattle.

Maintenance: Anticipating the stress period and contracting supplies of by-products ahead of time.

Benefits: Reduces cost of livestock production and increases profitability, assures adequate supply of nutrition during periods of stress, reduces overgrazing and has a role in pasture management, increased profitability of agro-industry and reduces their waste disposal costs, promotes integration in farming systems.

Institutional support: Need more research in the area of ration/diet formulation.

2.10 Local fowl (scavenging fowl) production

Place: Widespread use in small to medium farming communities throughout Belize. Restricted in large farming communities of Spanish Lookout, Blue creek, Shipyard and others where commercial poultry rearing is a major activity and/or the residents work on commercial poultry farms and in poultry processing plants.

Historical Perspective: Traditionally an integral part of small farming systems and the food security net throughout rural Belize. A successful upgrade of the genetic base in the late 1980's was carried out in the south of Belize under a project funded by IFAD[5] through the introduction of Rhode Island Red stock.

Hazard Context: Drought, excessive rains and floods, hurricanes and high winds.

Description: A system of poultry production using indigenous breeds provided with a grain supplement, maize, or paddy rice, and allowed to scavenge for the balance of their nutritional needs. Housing of various sorts and quality protect them from predators and thieves. A variety of management system have evolved ranging from totally free-range with a grain supplement, to fully housed/penned, and provided daily with balanced commercial feeds and combinations thereof.

Suitability: All local agro ecological zones, especially in rural communities. Public health, sanitation, and larceny issues have largely restricted, if not eliminated this system from urban centers.

Possible beneficiaries: All rural households either as a year round protein source, and/or income generation for small farms, women, and youth.

Cost estimates: Primary costs are initial stock, and housing where used.

Implementation: Housewives, youth, and small farming systems at anytime of the year.

Maintenance: Range from the daily supply of supplemental grains and kitchen wastes to commercial balanced feeds.

Benefits: Cheap source, and quite often the main source of proteins year round, especially during disasters periods and/ during the reconstruction period after disasters, when food supply is interrupted. The litter, from housed systems, is used as a fertilizer and soil amendment in homestead gardens. Offers line of defense against small insects and pests on farms and rural households.

[5] IFAD stands for International Fund for Agricultural Development.

Institution support: Large local demand for this type of bird and support is needed to upgrade genetics, through selection for desirable traits, and breeding with superior local stock and dual purpose exotic breeds; vaccinate against diseases especially Newcastle; train farmers to reduces losses of chickens; use more farm grown forage proteins; and ensure a balanced supply of minerals especially in the high rainfall areas where calcium is in short supply.

2.11 Diversified cropping systems

Place: Most small farmers throughout Belize producing both for subsistence and income generation. Deep South, the home of the Milpa farmer, to the Amish farms in the central region, vegetable farms of the immigrants, and small cane and vegetable farmers of the North.

Historical perspective: Diversification is synonymous with risk management in all farming systems, and especially true for small farming systems from inception.

Hazard context: All agro met hazards.

Description: Diversification both in space, time, and species (mixed farming) has constituted the fundamental risk management tool of the small farmer. The Amish of upper Barton creek where soils are shallow and water for irrigation is not readily available, cultivate subsistence crops June to August, cash crops (potatoes, carrots, broccoli, cauliflower, lettuce , radish and beans for subsistence) in the winter months and perennial fruit trees year round. Mixed farming, species diversification, is practiced by all. Lower Barton creek and Springfield, with surface water available year round, deeper soils, and more flat lands, produces more animals than upper Barton creek and less crops. Pine Hill in the high rainfall south produces less vegetables, more melons and cantaloupes, pigs and cattle.

Suitability: Essential to sustainability of small farms.

Possible beneficiaries: Small farmers in vulnerable areas, mono crop farmers, consumers and markets as more local produce becomes available, the economy through import substitution, food security programs.

Cost estimates: N/A

Implementation: A strategy of diversification is essential to any small farmer development planning and is implemented from inception.

Maintenance: N/A.

Benefits: More diverse outputs, better chances of reducing risks, greater sustainability, higher returns, and greater balance in environmental management, promote more IPM[6] and reduce pest control costs.

Institutional support: Systematic promotion at the farming level is required.

2.12 Homestead gardening

Place: Found on farms, irrespective of size, throughout Belize.

Historical perspective: An established and traditional part of Mennonite farming. Practiced with different levels of sophistication from the small farmers with simple systems to automated systems on the larger farms. Exists but by no means a common feature of small farming systems of other cultures. A few could be found in residential areas of rural communities. Considered the province of women and youth, and not the farmer *per se.*

Hazard context: drought, excessive rains.

Description: Small areas of 30ftx15ft, fenced to prevent animal interference could be put into 5 beds each 3ft wide and 10ft long with drains 1ft wide. The soil is mixed with organic manure/compost from biodegradable household wastes and worked to a fine tilt through wetting and drying cycles and mechanically breaking large clods. Plant are transplanted from a nursery box in the corner of the garden and kept under shade until established. Care through watering, fertilization, propping where needed, and pest control is continued until production is realized.

Suitability: Resource deficient communities where mal nutrition is evident among children, households with underutilized yard space, areas where diets are inadequate and lack variety, households with low incomes, women and youth desirous of earning.

Possible beneficiaries: Housewives, youth, agro input suppliers, under nourished children.

Cost estimate: Initial costs of a roll of chicken wire to fence the planted area, a few simple tools, fertilizer (if used), an empty drum for water storage and a perforated can or watering can for irrigation, and seed.

Implementation: Anytime, starts with a nursery box, seed from traditional varieties, the fenced area, and beds prepared for planting.

[6] IPM stands for Integrated Pest Management.

Maintenance: Daily care of the plants, mulching, watering, propping, fertilizing, and controlling insects, and pests.

Benefits: Reduces household expenditure on food, improves the nutritional content and adds diversity to diet, promotes more local foods, adds to food security, potential small source of income for housewives and unemployed youth, preserved local germplasm.

Institutional support: Need to be promoted more in rural areas, farming and non-farming, as a means of reducing the cost of living and promoting greater food security.

2.13 Drip irrigation systems

Place: Throughout Belize, from San Jose in the deep high rainfall South, San Antonio, Valley of Peace, in the West, Cozoralito in the Belize district; Santa Martha and Concepcion in the Northern districts if Orange Walk and Corozal. Any place with successful vegetable production.

Historical perspective: Drip irrigation was introduced by USAID in the mid-eighties in BABCO[7] programs to promote winter vegetables for export to the USA. Since then, drip irrigation has become a fixture of vegetable production and papaya production systems.

Hazard context: Drought, and periods of low rainfall.

Description: A system consisting of pump, filters, valves, main and sub-mains and lines along the crop rows with emitters, or as more recently used T-tape tubing.

Suitability: Areas with water source, surface or sub-surface, relatively free of sediment or with low sediment loads, where short term crop production is feasible, and where significant periods of water stress occur even in the rainy season.

Possible beneficiaries: equipment and input suppliers, vegetable producers, papaya producers, the economy through import substitution, in the case of vegetables, and foreign currency earnings with papayas.

Cost estimates: Costs depends on the level of sophistication of the system and naturally its size. A family drip system with a 55gal drum elevated 5ft above as its source of water is in the vicinity of $300. On the other hand a system using T tape, with pump, mains, sub-mains, valves and filters, and covering 3 acres, capable of wetting 1.5 acres at any one time has an estimated total cost of $6,900 or $2,300/acre.

Implementation: After land preparation and before planting/transplanting.

[7] BABCO stands for Belize Agro Business Company.

Maintenance: Depends on the quality of materials used. Systems with high maintenance costs have low capital investment costs and *vice versa*.

Benefits: Higher yields and better quality produce, more efficient use of expensive fertilizer inputs, enables production in the dry period when problems associated with high humidity and excess water are minimal, enhances all year round production.

Institutional support: Through fiscal measures reduce the cost of irrigation equipment and materials.

2.14 Plastic mulching

Place: Upper and lower Barton creek, Springfield.

Historical perspective: Promoted as far back as the seventies when intensive cash crops were promoted.

Hazard context: Drought, and heavy rains.

Description: Beds are prepared with a fine tilt, fertilized with half of the crop requirement, using compounds high in phosphates, before the beds are covered with plastic mulch with the sides covered with soil. Holes are made in the mulch at the recommended spacing for transplanting the young seedlings. Water is applies manually and the plant nurtured to maturity. The mulch is used for two crops.

Suitability: Large scale farming, however used to limited extent by small farmers.

Possible beneficiaries: Intensive vegetable producers, watermelon and cantaloupe producers.

Cost estimates: Includes land preparation and bedding, drip irrigation, laying and removal of mulch along with normal costs of planting, fertigation, weeding and pest control.

Implementation: Prepare early in the dry season and plant early with irrigation.

Maintenance: Not significant.

Benefits: Earlier crop, increased yields, less soil compaction, less fertilizer leaching, lower irrigation costs as a result of less evaporation from the soil, less herbicide costs. The net result is a lower production costs and higher yields.

Institutional support: Duty exemption on plastic materials and other inputs as fiscal measures to reduce material costs.

2.15 Agryl tunnel structures

Place: Upper Barton Creek, San Antonio village, and La Grasa.

Historical perspective: Introduces into small farming systems in the last 5 years by Central American technicians and sales personnel.

Hazard context: Drought, excess rainfall, and insects.

Description: A tunnel structure of agryl net, 14ft wide and 150ft long is constructed, fully sealed with a door, under which vegetables are produced in the dry with a small irrigation system. The family drip system using a 55gal drum mounted 5ft above ground is appropriate for this structure. The frame is made from bush sticks and 1inch schedule 40 pvc pipe. Sweet peppers, for example, are planted 2ftx2ft, with a population of 525 plants per structure. In the rainy season, the top of the structure is covered with plastic and drains are dug on the outside.

Suitability: Areas with significant insect problems, drought or excessive rainfall, and lacking significant parcels of plat land for cultivation.

Possible beneficiaries: Small farmers, landless youth, and women.

Cost estimates: Agryl structures, as described, cost approximately $900, larger structures are more expensive. The cost of plastic and drains must be added if used in the rainy season. Small gravity fed irrigation systems run about $300. Systems with pumps run about $500 for materials and about $900 for the pump.

Implementation: N/A

Maintenance: Agryl net needs replacement after each crop.

Benefits: Significant reduction in use of insecticides and herbicides, high water use efficiency, allows production during extremes of weather, rain, or drought, reducing production costs producing more wholesome products.

Institutional support: Reduce the cost of materials through tax exemptions, more farmers training, and more evaluation of the system in relation to yields and reduced operating expenses.

Planning and the collective approach

2.16 Planned crop schedules and cycles

Place: Small traditional Amish communities of Barton creek, Springfield, and Pine Hill.

Historical perspective: Meeting and planning is a traditional part of their lifestyle and the shared vision approach in their communities.

Hazard context: Drought and high rainfall months.

Description: The cropping schedule and cycles are planned based on markets, an understanding of the weather patterns and vulnerable months, a capacity to handle produce. As an example, Upper Barton creek has recognized April, May(drought), September, and October(too wet)as vulnerable months, and the cropping cycle is planned to produce subsistence crops (rice and corn) in June to August, and cash crops (carrots, potatoes, broccoli, radish, cauliflower lettuce etc.) from November to March. Beans, a subsistence crop, is also planted in the winter months, and other activities are scheduled for the other months, such as tillage, pasture management and development, repairs and maintenance of equipment and communal structures, etc. Within the cycle, specific scheduled with respect to type of crop, acreage, planting and harvesting dates based on capacity to handle and markets are made at community meetings.

Suitability: All farming or producer communities.

Possible beneficiaries: all small producers, wholesalers, agro input suppliers, food processors.

Cost estimates: Priceless.

Implementation: At times convenient to members of the communities.

Maintenance: N/A

Benefits: Enhanced production efficiency, reducing risks, ensuring food security, better marketing, and stability of supply lines.

Institutional support: Production planning in relation to market demand, at the village or community levels need to be actively encouraged by agriculture extension service, rural development, and social workers.

2.17 Community networking, input procurement, and marketing

Place: Small Amish communities of Barton creek, Springfield, and Pine Hill.

Historical perspective: Working together on common challenges is an integral part of their lifestyles.

Hazard context: All hazards.

Description: The communities are well structures with an elected chairman, (in lower Barton creek there are two chairmen), with responsibility of: networking with official government bodies and other communities, bulk buying of inputs, organizing meetings and management responsibility for community projects and planning, marketing of produce, conflict resolution, dealing and negotiating land and community expansion issues. Inputs are distributed through the community shop in which each has a share. While the chairman delegates jobs within the community, production remains an individual responsibility. Every member is given an opportunity to lead and this develops both management and leadership capacities within the communities

Suitability: All rural small communities with a common vision.

Possible beneficiaries: Remote rural communities, small farming communities with a common vision, national disaster managers, neighboring residents and villagers.

Cost estimates: Priceless.

Implementation: As part of the community development plan.

Maintenance: N/A

Benefits: Enhances efficiency in procurement of goods, production, marketing, solving common challenges. Disseminates information and ensures better coordinated responses to every aspect of the disaster cycle.

Institutional support: Needs more tangible support from government.

Skills development.

2.18 Food preservation and storage

Place: All small and medium Amish communities especially the small farming communities of Upper and lower Barton creek, Springfield, and Pine Hill.

Historical perspective: Traditional part of Amish culture and dates back to their arrival in Belize.

Hazard context: All disasters, drought, floods, and hurricanes.

Description: Non refrigerated storage of food which includes, fresh and preserved fruit, meat, meat products, vegetables, jams, jellies, and cooked products. The process involves heating the product in glass jars in water baths, sealing with lids having air tight gaskets, which upon cooling form vacuum tight seals. Foods processed and stored by this method have shelf lives of some 2-3years. Other forms of food storage are also practiced including drying, curing with salts, cooking, and smoking.

Suitability: All rural households especially in communities and on farms without electricity, vulnerable to interruptions in the food supply chain.

Possible beneficiaries: Rural communities vulnerable to disasters and loss of power, communities and farm without reliable supplies of electrical power, all farming communities, communities with significant interruptions in availability and production of food.

Cost estimates: Storage jars, replaceable lids and gaskets are easily available at Spanish Lookout in Cayo. One liter jars with lids sell for $65 per case of 24 units.

Implementation: N/A

Maintenance: Need to replace gaskets and lids occasionally.

Benefits: Enhances coping capacities, economic use of excess produce, reduces household food expenditure, enhances food security for vulnerable communities, families and farms, promotes consumption of local produce.

Institutional support: This technology needs to be extended to all rural communities, especially those in vulnerable areas within the context of disaster management, food security, and reducing carbon footprints.

2.19 Life skills development through experience

Place: All Amish communities, small and medium, and include Upper and lower Barton creek, Springfield, Pine Hill, Shipyard, and Little Belize. Large modern Mennonite communities as well, though these do not form part of this report.

Historical perspective: Integral part of Amish and Mennonite lifestyles based on their shared vision of life and agriculture production. Previously had an important role among other cultures, but unfortunately western style education has replaced traditional life skills development much to the detriment of their livelihoods.

Hazard context: All hazards.

Descriptions: While traditional literacy type education forms part of the development program of youth within the Amish communities, the emphasis is still on agriculture and other production skills, like carpentry, logging, lumber, fabrication, food processing, sewing, all developed through practice. This produces a well rounded individual who could actively participate in any disaster recovery effort.

Suitability: Youth development in farming communities, and vulnerable areas.

Possible beneficiaries: Women and youth in all rural farming communities, especially in vulnerable areas.

Cost estimate: Priceless.

Implementation: From an early age of learning.

Maintenance: N/A

Benefits: Develops human capital, both gender and all age groups, through expanding productive, coping and resilience capacities, reduced reliance on national social services, increases agricultural output, develops human resource for disaster reconstruction

Institutional support: Life skills development through experience should be promoted nationally and form an integral part of rural development and the national action plan for promoting DRM programs and strategies.

Soil management

2.20 Deep bedding systems for improved drainage

Place: Upper Barton creek, most soils along the southern highway from the hummingbird to deep river.

Historical perspective: Bedding is a traditional part of small farming systems, and even large plantation type cropping systems, to provide better internal drainage for row crops on heavy clay to clay loam soils in high rainfall areas or during the rainy season. Small farmers unable to form high beds generally do not plant during the vulnerable months of high rainfall.

Hazard context: Excessive rainfall leading to soil saturation and waterlogged conditions.

Description: Digging deep drains and piling the excavated soil between the drains give rise to deep beds 2-2.5 ft high which may necessitate the construction of side walls. Breaking up the soil manually to a fine tilt is next followed by the incorporation of organic matter to improve soil fertility and structure.

Suitability: Layered soils with impeded internal drainage, or heavy clay soils with fine textured or compacted sub-soil layers within12-16 inches from the surface.

Possible beneficiaries: Small intensive vegetable producers, citrus growers, plantain and banana growers, on low lying flat lands with impede internal drainage.

Cost estimates: Costly and time consuming and implemented on small areas where labor is inexpensive.

Implementation: Normally, bedding and land formation is carried out manually early in the dry season when soil moisture is still in the friable range. By mechanical means, the limiting factor is the bearing strength of the soil and implementation is delayed.

Maintenance: Side walls may have to be replaced from time to time.

Benefits: Reduces water logging during the rains and permits an extension of the cropping cycle, promotes drainage of interfacial and sub-soil areas.

Institutional support: Promote a comprehensive approach to drainage which minimizes soil erosion.

2.21 Organic soil amendments and soil management

Place: Upper and lower Barton creek, Springfield, Pine Hill and Milpa farms in the southern highlands of Belize.

Historical perspective: A traditional part of Mennonite small farming, and Milpa, systems of farming which has contributed immensely to sustainability.

Hazard context: Soil degradation and loss.

Description: Organic materials principally, animal manures, waste fodder, and crop residues are added to the soil and ploughed into the upper horizon in preparation for the next crop. Green manure is used to check soil fertility decline. In the Mennonite system, the land in fallow is seeded with a legume, the most commonly used, *Mucuna pruriens*, is cropped for a period of time, and ploughed into the soil. In the Milpa system, the cover crop improved soil fertility, controls weeds, and is burned on the land as this system does not practice tillage.

Suitability: Incorporation of organic and green manures into the soil through tillage methods is suitable for sustainable small farmer systems on flat lands. The Mila system of green manuring is practiced on both flat and sloping lands.

Possible beneficiaries: All farmers practicing mixed farming irrespective of size, and Milpa farmers, as fallow and green manuring are essential components of their cropping cycle.

Cost estimate: Minimum costs, in the case of Mila farming it involves costs associated with collection and broadcasting of seeds. In Mennonite farming, additional costs include poultry litter procurement, broadcasting and tillage.

Implementation: Forms part of routine land management practices in both systems.

Maintenance: Part of routine operations.

Benefits: Improves soil fertility and soil structure and as a consequence runoff and erosion is reduced, infiltration increased, water holding capacity increased, and the need for inorganic fertilizers is reduced. In the Milpa system, the benefits are essentially weed control and soil fertility alleviation.

Institutional support: Process or a suitable variation need to be promoted in all cropping systems, large and small, with a program to inform and educate farmers on potential benefits.

Conservation of energy and the environment

2.22 Forest conservation and harvesting

Place: Upper and lower Barton Creek, parts of Pine Hill, and Springfield.

Historical perspective: On small farmer holdings cleared manually for farming, it is traditional to conserve a piece of forest on sloping lands or on shallow and/or stony lands for non farming purposes.

Hazard context: Drought, excess rainfall.

Description: In planning the farm, a proportion of the forest is reserved for conservation. The selected piece may be located on a slope which is not suitable for cropping or clearing, shallow soils, stony soils, and may have valuable trees either for lumber, posts, soil rejuvenation, and anchorage.

Suitability: Primary or secondary forests which are being cleared for cropping.

Possible beneficiaries: Bee keepers, water users in the lower reaches of the watershed, hunters, herbalists, game animals, nesting birds.

Cost estimates: Often under brushed to reduce risk of fires and provide easy access, $35-$65/acre depending on density of undergrowth.

Implementation: In planning a small farm from forest, primary or secondary, or a forested area to be converted to farms and farmland, significant attention should be given to land evaluation from maps, to be followed by actual site evaluation along grid lines before clearing commences. This, along with the resources of the farmers determines the method of clearing. Marginal areas should be preserved.

Maintenance: Timber trees should be replanted after harvesting lumber.

Benefits: Shade and feed for animals during extended dry season and drought, source of fence posts, lumber for building, catchments for groundwater recharge, reduces surface runoff, erosion and soil loss, sanctuary for wildlife.

Institutional support: Encourage land use planning and control land clearing and forest removal through licenses requirements, mandate forest conservation in farming areas.

2.23 Shade tree selection, preservation, and management

Place: Upper and lower Barton creek, Springfield, Pine Hill.

Historical perspective: Traditionally accepted practice in land clearing, especially manual land clearing from primary forests for small farm development.

Hazard content: Drought.

Description: Before land clearing , trees are surveyed and selected. Tree and branches should not pose threat to buildings, have wide canopy, free from woodlice and rot, and should not be hollow. Hardwood timber trees are harvested for lumber, or with a number of other trees are selected and preserved for future usage. Trees belonging to the family leguminous family Fabaceae such as Leucaena are preferred, but others like Cohune nut (*Orbigyna cohune*), Bayleaf palm (*Sabal morrisiana*), Silver thatch palm (*Thrinax radiata*), Ramon tree (*Brosimum alicastrum*), Silk cotton tree (*Ceiba pentandra*), Bay cedar (*Suriana maritima*), and Gumbo limbo (*Bursera simaruba*) are all of economic value on the farm.

Suitability: All small farms developed from primary forests.

Possible beneficiaries: Small farmers, loggers, the environmentalists, government, bee keepers.

Cost estimates: Manual labor to survey, select, and label trees d before falling. A20 acre block would take an experience logger one day, estimated at $50 with an assistant at $25.

Implementation: Manual land clearing is normally done in March and April. The process involves under brushing, falling, lopping, and burning after 3-4weeks of drying. The selected trees are circled so as to minimize any fire damage.

Maintenance: Prune of dried or dead branches before hurricanes season begins.

Benefits: Shade for livestock; fodder ruminants and horses during dry season/drought especially true of Ramon, Leucaenia, Gumba Limbo,and Madre cocoa (*Glyricidia sepium*); source of materials for thatching (Cohune leaves, Bayleaves, Silver thatch palm leaves); additional source of income from sale of thatch leaves ($1.5/bayleaf); source of organic matter and nitrogen for the soil; source of pollen and nectar for bees; nesting sites for birds.

Institutional support: Where it was not possible to select and preserve trees, government should promote the planting of trees.

2.24 Draught animals

Place: Common throughout Belize in all Amish communities, both the traditional small Amish farm of Barton Creek, Springfield, and Pine Hill, and the less traditional, Amish, medium size, farms of Shipyard, and Little Belize.

Historical perspective: A traditional part of our rural farming systems which disappeared with the introduction of the diesel engine during the era of cheap fuel. Reintroduced and institutionalized by Amish farmers in 1958, and has evolved to include light weight metal carts, water pumps, and modern cutting and grinding equipment all powered by animals.

Hazard context: Drought, heavy rains and floods.

Description: Horses and oxen are used in transportation systems, tillage, and any system requiring rotational energy such as mills, water pumps, circular blade saws etc. Four and two wheel carts, both light and heavy duty, are constructed within the colonies for transportation; gears from derelict vehicles are modified with wheels and belts to convert energy from animal moving in a horizontal circle, into rotational energy in a vertical plane.

Suitability: Suitable to most small farming systems and rural communities as a primary means of energy conservation.

Possible beneficiaries: Poor farmers in rural communities, farmers desirous of energy conservation, cart and harness makers, tin smiths, tannery and leather fabricators.

Cost estimates: Farm animals are trained for draught and the major additional costs are associated with carts and equipment. A four wheel wooden cart costs about $2,500-$3,000.

Implementation: Starts with the acceptance that draught power is not associated with backwardness, but energy conservation, cost saving, and environmental responsibility. Training of animals must precede actual use.

Maintenance: Animal and equipment care.

Benefits: Energy conservation, production cost reduction and greater profitability, source of manure for soil management, greater environmental stewardship, under high rainfall conditions and heavy clay soils animal draught is more relevant than tractor power.

Institutional support: More official support for and promotion of draught animals for small farming systems, improved availability of draught animals.

2.25 Hunting dog and hunting

Place: Common throughout rural Belize.

Historical perspective: Traditional part of rural life in Belize. Locals enjoy hunting as a sport and for subsistence food. Central American immigrants are avid hunters and in many instances have eradicated wild life in and around their immediate environs and/or farms.

Hazard context: Drought, and floods.

Description: Dogs are used to track game and chase them in the line of sight of the waiting hunter, or retrieve wounded animals. In the dry season wild animals normally go to water ponds or aguadas, favorite waiting spots for hunters and their dogs. Hunters are known to set fires to forests and pastures as the re growth attract foraging animals. Hunters await their prey in/or around the young grass patches.

Suitability: Farmers and residents of resource deficient areas.

Possible beneficiaries: Farmers and residents in close proximity to forested and protected areas; dog breeders; restaurants having game on their menus.

Cost estimates: Essentially involves cost of dogs, cartridges, and farmers' time.

Implementation: Normally on moonless nights around water holes and around sources of food.

Maintenance: Care of dogs.

Benefits: Source of food during disasters, provides protection to the farm or residence, license revenue to government.

Institutional support: Need to enforce hunting laws as they apply to protected areas, protected species, and hunting seasons, to prevent over hunting and species eradication.

2.25 Fire breaks or fire passes

Place: Responsible small farm agriculture throughout Belize.

Historical perspective: An integral part of traditional slash and burn method of land clearing practiced from the earliest recorded time to present day. Routine practice for

protection of farm and farm property from random forest fires, and/or areas cleared by the slash and burn method during the dry seasons.

Hazard context: Drought when fires pose a severe secondary hazard.

Description: A 6ft. wide pass, free of plant debris or any combustible material, is cut manually or by machine around the area to be protected to prevent the movement of fire from a burning to the protected area. A ploughed pass is also effective at preventing fire movement.

Suitability: Suitable to the protection of all freely drained lands and infrastructure during periods of low rainfall and high winds. Water deficient forests, dried savannah, and indiscriminate slash and burn pose severe fire risks to farm and farm infrastructure.

Possible beneficiaries: New farm holdings in forested areas, and on open savannah lands, during hot dry spells, would benefit tremendously from the construction of fire passes.

Cost estimate: Cutting and cleaning a 6ft. wide fire pass manually is estimated at $25 for 200yds length of pass. Thicker vegetation with shrubs and trees would cost more, while machinery would reduce costs immensely.

Implementation: Should be implemented as a routine farm operation at the beginning of the dry season, January and no later than February for most of Belize.

Maintenance: No maintenance. Needs to be cleaned each year.

Benefits: Prevents damage to neighboring property and other parts of the farm during slash and burn land clearing operations, reduces environmental degradation by containing unplanned forest fires from spreading, allows easy access around the farm perimeter.

Institutional support: The practice requires more regulation, monitoring, and stiffer penalties for persons indiscriminately burning and causing damage to property and the environment.

2.26 Water ponds for harvesting and storage

Place: Amish farms of upper and lower Barton creek, other farms in the west of Belize, and Belize river valley.

Historical perspective: Traditional part of agriculture, natural ponds found in south and low lying areas. Man-made ponds more recent, especially with the promotion of small scale fish farming.

Hazard context: Drought.

Description: A natural depression or man made dugout, when filled with water during the rains acts as an important source of water, especially in periods of low rainfall and most definitely during drought. Increasing the pond capacity, not only enhances its storage capacity, but converts it to a water harvesting structure which collects water for farm use.

Suitability: Rolling and undulating lands, presenting well defined catchments areas, collection site with elevation differentials from potential usage sites, fine textured soils relatively free from stones, all offer ideal conditions for farm pond development. Particularly suited to areas with pronounced wet (high rainfall) and dry (low rainfall) periods, and areas where ground water is not readily available.

Possible beneficiaries: Small mixed farmers, small fish farmers.

Cost estimates: Excavation and compaction costs.

Implementation: During the dry season before the rains.

Maintenance: Stabilizing and maintaining the integrity of the pond banks is essential but not normally expensive once a grass crop is established.

Benefits: Water for livestock, irrigation, and small fish ponds, domestic washing, and washing farm produce especially root crops for the market.

Institutional support: Subsidized equipment for pond excavation, more advice on site selections, and micro dam construction.

2.27 Water transportation and pumping system

Place: Amish and other small farms in the West and North of Belize.

Historical perspective: Introduced with the horse drawn system of the Amish. Traditional part of other small farms where water is transported from the rivers in drums and tanks in trailers, on trailers drawn by tractors and pickup trucks.

Hazard context: Drought.

Description: Water is pumped or manually extracted from rivers or creeks into mobile containers of a variety of sizes for conveyance to farms. The traditional Amish, in the West, use a water turbine pump to fill a pond/reservoir which is then gravity fed to a filling location where tanks are filled by faucet. The small Mennonite farms of the north use small pumps to fill tanks on carts and in motor transport systems.

Suitability: All areas with period of low rainfall, and non accessible groundwater supplies, located in close proximity to active waterways, rivers, or creeks.

Possible beneficiaries: Small farmers, residents in areas lacking wells and centralized water supplies.

Cost estimate: Generally the equipment costs, pump and mobile tank, which could be considerable depending on the capacity of the system.

Implementation: The system is usually activated in the dry season stored water is running low.

Maintenance: Servicing trailers, greasing bearings and other moving parts, tire pressure, pump is functioning and all hoses have requisite gaskets and are free of holes.

Benefits: Water for domestic use, small irrigation systems, manual watering of some plants, water for livestock.

Institutional support: Families in remote areas are supplied with water from municipal managed water trucks.

2.28 Water storage systems, tanks, troughs, and cisterns

Place: Most small farms throughout rural Belize.

Historical perspective: Traditional part of Belizean rural life to have cisterns or vats, wooden and later galvanized metal, as collection units for water harvested from roof catchments. Later with the opening of Spanish Lookout in the seventies people used more galvanized vats, and in the last 20years concrete troughs and heavy duty plastic vats have been added to enhance water storage..

Hazard context: Drought.

Description: Water storage tanks are an integral part of all farm infrastructure. The most common at this time are galvanized metal and ferro concrete tanks. In many locations these structures are being replaced and/or augmented by heavy duty plastic tanks. They are normally used to collect water from roof catchments for domestic and farm use. Elevated tanks are and supplied with water from wells or mobile water containers by pumping. The elevated water is delivered to sites of utilization, for example a concrete tank fitted with a float valve and located in pasture, by gravity feed.

Suitability: All farms without a non exhaustible source of water such as an abundance of easily accessible ground water, nearby stream/creek or river which flows year round, or natural pond which rarely dries.

Possible beneficiaries: Farmers and farm workers.

Cost estimates: The low cost options are the plastic tanks at about $400 for a 300 gallon tank.

Implementation: Storage tanks are normally purchased or constructed in time for the rains.

Maintenance: Tanks with intake orifices that are well screened would be cleaned once every five years.

Benefits: Increases storage capacity and reduces haulage time and costs, provides an available source of water for farm animals and small irrigation and domestic purposes, source of water for fire emergency arising from natural forest fires and/or indiscriminate burning.

Institutional support: Training in water treatment methods for domestic use, and vector control, especially where malaria is a definite risk factor.

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