Ramsar Advisory Mission No. 35: Trinidad & Tobago (1995)

Ramsar Convention Monitoring Procedure, Final Report
[Report No. 35, May 1995]
Nariva Swamp, Trinidad and Tobago
Final Report, February 1996

Appendix I

Methods for rice farming with low environmental impact and wise use of Nariva Swamp Ramsar Site

taken from Mike McCoy's report

to be read with Map 3

Methods for rice farming with low environmental impact and wise use of Nariva Swamp Ramsar Site

The production of irrigated rice in close proximity to natural marshes can be a very compatible human activity with the natural environment. Irrigated rice culture is probably the one crop that provides more seasonal habitat to wildlife than any other commercial crop. Waterfowl, large wading waterbirds, fish, crustaceans and molluscs can benefit tremendously from this activity if it is done in an environmental friendly way, and following many of the practices described in this document. No doubt the 100 to 165 hundredweights/ha produced by local farmers in Sector A can be improved by almost 40% with better cultivation techniques.

It is possible to grow irrigated rice with no need for pesticide usage. However, in order to do this, fields need to be level, and a permanent water sheet employed which will eliminate, or severely reduce, the need for herbicide usage. The use of the permanent water sheet can also decrease nitrogen application by 40%, a tremendous savings to farmers, and reduce nutrient contamination of the Nariva Swamp. Disease and insect resistance is best solved by a readily available source of new rice varieties. This can only be accomplished by a dedicated government or privately-funded rice research effort, that needs to be developed in-country. Also the presence of an intelligently managed rice project adjacent to a major natural marsh system can ultimately enhance the biodiversity of the area since some waterfowl and waterbirds can benefit from the presence of some disturbed areas that produce exposed soil, open, shallow water and the first stages of plant succession. At the same time a sustainable livelihood can be obtained for the communities nearby.

The main problem of the Nariva Swamp -and of the rice farmers- is the excess of water during the rainy season and the lack of it during the dry season. This problem is strongly accentuated because of the very wrong use of water that has been taking place in the area.

The presence of this large marsh adjacent to the rice project (Sector A specially) and an adequate water management put into place could also guarantee a second rice crop during the dry season through irrigation of the fields.

PLEASE NOTE : While most of the methods and recommendations made herewith are referred to the Plum Mitan Rice Scheme, they can also be applied in Kernahan and elsewhere. It must be made very clear that they do not refer to Sector B since the Monitoring Procedure team feels very strongly about the need not only of an environmental impact assessment of this area, but also a management plan for the entire area of the Nariva Swamp (to be carried out as soon as possible) including a careful analysis of the potential (or not) for farming in Sector B. It is only possible to say - at this moment in time, and with the experience gained during the team's visit- that the environmental impact assessment and the management plan must take into consideration the fact that Sector B should only be planted if excess water exists from Sector A or if a reservoir upstream can be made that can supply water. The other alternative, during wet season, is the use of permanent water sheets from rainfall only for rice cultivation in Sector B.

Water issues, drainage and irrigation in Sector A

Rainy season. If farmers adopt the water-seeded method of rice planting, almost 100% of water needs during the wet season could be met just by rainfall. Farmers would not be draining all the water off and therefore, the water sheets can be maintained by rainfall if gates are closed at the lower end of each rice check.

Excess water from additional rainfall can be allowed to overflow the upper surface of each gate to maintain the same level of water permanently during the crop cycle. However, any water that is drained should be recycled back up the Mainline Channel, if possible during low rainfall periods.

This system of using a permanent water sheet, drastically reduces water demands on the irrigation system. Farmers probably would not need to do much pumping from irrigation canals into their fields if rainfall is normal, which could mean significant savings.

If Sector B is farmed in the future its drainage water must not run directly into the Nariva Swamp or down the Jagroma Cut into the marsh. Drainage water should be collected into the north-south drain along the eastern perimeter and then go under the Jagroma Cut by siphon and connect to the Periphery Canal. Any water coming down the Jagroma Cut and/or into the Nariva Swamp must be clean water from the upstream rivers and reservoirs.

Dry season. The solution found by the MALMR (Mr R Salandy, pers comm) for dry season cropping at Plum Mitan is the right one, however we would like to add an observation. With four propeller pumps available, it might be possible to get water even up to Block I and enough not only for the water table, but enough to grow irrigated rice with water sheets.

This would involve putting one pump at the low point where now planned, but with provisions for being able to also pump water both into and from the Nariva Swamp just east of the Periphery Canal. We believe this scheme is highly feasible since the difference in elevation between high and low points of Sector A is only about 2.5 meters (according to Ministry topo maps).

During the wet season if the marsh is low on water, water should be pumped from this low point of the Mainline Channel out into the marsh. Water should be preferably from the Mainline Channel with little drainage water from rice fields in order to minimize contamination of the marsh with pesticides and nutrients. The marsh should be kept as full as possible to assure a surplus amount of water during dry season for irrigation, and to counteract salt infiltration from the sea.

It is advisable to widen and build higher embankments on each side (specially the south side, and not allowed to have breaks in it) of the Petit-Pool Cut, and to build a gate at its outlet. During the onset of the dry season the Petit-Pool Cut should be closed with the objective of holding the cut full of water. This will ensure the highest level of water in the marsh by the onset of the dry season. It is possible that the marsh is lacking in water now because of escape through this south bank of the Petit-Pool Cut during wet season.

Another gate must be constructed at the end of the Mainline Channel near the low point pump. Then water from the Petit-Pool Cut can be back-pumped back up the Mainline Channel. The other three pumps should be spaced along the Mainline Channel with the objective of backing up water to the high point of Block I where the Jagroma Cut starts. It will be necessary to construct a series of gates or have the existent ones repaired, in order to allow back-pumping and holding of water. Thus all of Sector A should have access to gravity-fed irrigation water.

The Nariva Marsh should be holding an excess of water at the onset of dry season, from the pumping of water into it during the wet season at the low point pump. So in the dry season a certain amount of marsh water could also be back-pumped up the Mainline Channel to help meet irrigation needs.

When, during the dry season, the water level of the marsh reaches a certain minimum critical point, then the pumping of marsh water should cease. However, at least 80% of the marsh area should be allowed to dry out by the onset of the rainy season as a measure to set back plant succession and increase the marsh productivity. From interviews with older residents, this is about how much of the marsh normally dries out during the dry season.

In order to help cover the pumping costs, all farmers could be charged a fee.

Weed control

The most important step, as indicated above is to establish an adequate water management scheme that will allow farmers to maintain control and use a permanent water sheet of 8-10 cm over the soil. Followed by a 0° slope laser levelling of all plots in order to get rid of all low and high areas in the fields. With the completion of these two phases farmers will need to use virtually no herbicides -if they use the water-seeding method, planting into the water sheet and not draining it, and allowing rice to emerge through the water sheet.

Precautions with the water-seeded method. Some precautions must be made for when using this method. Algae may start to develop on the soil surface under the water sheet right after planting, and if not treated, it will grow, start to break apart during the mid-day sun, float to the top of the water, and dislodge seeds and seedlings from the soil surface, diminishing the density of rooted seedlings. To avoid this, an application is needed of 11 to 15 kg/ha of $CuSO_4$ (medium-sized crystals) into the water sheet, no later than one week after planting. Also one must be careful not to leave too much time between application of the water sheet and planting. If it takes a long time to get the water sheet established (more than two days), due to lack of water for instance, then one should apply the copper sulphate before planting, when the algae are just visible in its formation on the soil surface under the water.

The other major caution would be during dry season water-seeding if trade winds are strong and create a lot of wave action on the water sheet. If waves are excessive, then seeds can be moved underwater and piled up against dikes. Also, young seedlings can be thrashed about and ultimately uprooted. In California, this problem has been solved by use of a roller wrapped with angle iron sections at six-inch spacing and pulled by a tractor. This creates parallel furrows in the soil which are deliberately run perpendicular to the wind direction. When seed is dropped into the permanent water sheet, it accumulates into the bottom of each furrow where the seed cannot be pushed by waves. When seedlings are present any wave action will push a little soil around the base of the seedlings and prevent them from being uprooted.

In March, 1995 in Costa Rica we tested water seeding in a 10 ha plot where wind is usually very strong, but we were not able to first furrow the soil with a roller. Since the soil was a heavy clay, similar to that at Plum Mitan Sector A, the cloddiness of the surface did not allow seeds to be moved by waves. However, a 72-hour windstorm of up to 100 k/hr gusts hit when seedlings were 2-5 cm high. We left the water at its original depth of 8-10 cm and stuck it out. Some seedlings were uprooted but the damage was not bad. We believe that had we lowered the water level during the high wind, the waves would have done more damage. It would seem that to counteract the loss incurred we should plant a bit more seed, up to 4.5 to five 100 lb sacks/ha rather than the usual four sacks. Harvest yield was not affected by the slightly lowered density of plants in this plot, however. Thus, it is possible to water-seed highly clay soils with wind problems, without use of a roller.

Dry season planting. During the dry season planting, farmers should burn the last crop's rice straw and then disk or rototill the soil. Before the last pass of soil disking, 100% of the total urea needs should be applied by hand or spreader, as well as 100% of the phosphorus and potassium. Then this fertilizer should be incorporated into the upper 10 cm of dry soil with a disk or rototiller on the final pass. Then the 8-10 cm water sheet should be put onto the fields and then pre-germinated rice sown into the water sheet. The water sheet should never be drained off the field. If it is, then five detrimental things will happen:

1. upon exposure of the soil, weed seeds will germinate, including red rice, Echinocloa, and other weeds. A 10% infection of red rice weeds in a field will reduce yield by 25%;

2. the nitrogen fertilizer, urea, will be lost as it is oxidized to $NO3-$ and then ultimately denitrified to $N2$ gas by anaerobic bacteria when the field is reflooded;

3. if shallow puddles are left on the field after draining, then the solar radiation will heat these puddles to extreme temperatures that along with the heat, also drives off oxygen from the water and kills rice seeds and seedlings;

4. upon drainage of the water sheet, much soil and nutrients are lost and are potential contaminants in this case of the Nariva marsh, as well as the fact that much water is lost unduly;

5. when fields are drained and shallow puddles left, conditions are perfect for seed depredation by waterfowl.

Account should also be taken of the fact that only 60-70% of the usual nitrogen level used needs to be applied with the water sheet method. Thus, if 100 k/ha of nitrogen is normally used with the top dressing method, then only 60-70 k/ha need to be used with the water sheet method.

Red rice. Of all weed species, red rice is the most damaging to commercial rice farming. It is by far the most competitive weed with commercial rice. Since rice seed quality is not yet well controlled in Trinidad and Tobago, most seed will be contaminated with red rice or other wild rice types.

Farmers in Costa Rica control these weeds in dry season by wetting fallow fields at intervals, provoking these weeds to germinate, dry the fields and then disking the young seedlings. After four or five diskings at 10 cm of soil column depth, little viable seed remains. This same method is used in wet season with wet cultivation (cage wheels or rototillers), but has the disadvantage of having to take the field out of production for a season.

In both wet and dry seasons, a better procedure to eliminate red rice is to use the water-seeding method. Any viable red rice seeds (or other wild rice types) that are below the soil surface cannot germinate and cannot emerge through both a soil layer and water sheet. Also, if they are on the soil surface and a water layer is placed over them before they germinate, they cannot emerge through a water sheet (unlike commercial rice).

Red rice was eliminated from California by two methods:

strict control of certified rice seed producers, and

use of the water-seeded method (Flint et al, 1993; Hill et al, 1992).

Aquatic weeds. If the water-seeded method is finally adopted by Nariva farmers, with several years application, a shift will occur towards the occurrence of aquatic weeds in rice fields. This problem can be attacked by two methods. One could go back to the old method of seeding and draining for a few cycles to make conditions worse for aquatic weeds. Or one could use commercial herbicides for these types of weeds, such as Londax. These types of herbicides can be applied directly to the water sheet, they break down readily and are much less harmful to the environment than are the dry weed herbicides. they are also very inexpensive compared to terrestrial weed herbicides.

Wet cultivation. This type of cultivation should be used in the interim before fields are laser-levelled enough to be able to use the water-seeding method, and also during the wet season planting.

To reduce the amount of germinating weed seeds, this method crushes the soil under 5-10 cm of water with wide, angle-iron cage wheels used on the rear of regular farm tractors. These wheels are presently used for rototilling in Plum Mitan. One can also rototill the soil in a layer of water, but it should be noted that one can do a good wet cultivation with only the cage wheels, which would -probably-reduce the costs. Only cage wheels are used in Costa Rica for wet cultivation (McCoy et al, 1995).

After cultivation, one should let the sediment settle for at least three or four days before draining and planting. With this method the fine sediment layer that forms on the soil surface inhibits the germination of weed seeds underneath and thus are less of a problem with the crop.

However, if fields are within a certain levelness, of no more than 10 cm difference between low and high spots in a field, or check, then the water-seeded method should be tried. For fields with more elevational differences than this, the wet cultivation method should be employed to reduce herbicide usage and production costs.

Many of the farmers in Plum Mitan cultivate their dry fields in the dry season with a rototiller before the rains hit. If they then plant rice on the moist soil surface and do not inundate the field immediately, a high density of weed seeds will germinate and compete with commercial rice plants.

Pests, insects, other invertebrates, birds, mammals

Insects. When young plants are exposed on drained fields, they are more susceptible to insect attack, than when covered with a water sheet. The use of the water-seeded method should help control the damage. Infection of white-leaf virus usually occurs during the first four weeks after planting. The virus is transmitted by the bite of a leaf-hopper insect (Segatoides spp) to the young plant stem. Therefore, water should be covering most of the young developing rice seedlings, making it physically more difficult for the leaf hopper insect to actually bite the young stem. Other caterpillars that cut young leaves during the first four weeks would also be inhibited by the presence of the water sheet.

There will be times when commercial insecticides will be needed. Insects (stinkbugs,Nesara spp, order Hemiptera) that attack the developing rice grains during the milk stage at about 14 weeks will have to be treated this way, until biological control methods can be developed. The use of pyrethrin-based insecticides (Karate, Cymbush, etc.) should be encouraged. These are less dangerous to the human applier and to vertebrates that may occur in rice fields during application. They also break down rapidly and cause little contamination. If stronger insecticides are used such as organophosphates (Tamaron, Malathion, etc.) then precautions should be taken by human appliers. Also if aerial application by aircraft is undertaken, use by helicopters is preferred over fixed-wing aircraft. Helicopters push the product downward onto the crop with less drift over non-target areas. One important practice should be the flying over of "to-be sprayed fields" first without spraying, to scare off any birds that may be in the field, prior to actual application of the insecticide. Most fields in the Plum Mitan scheme are so small that farmers will probably opt for manual application of insecticides with either manual pump applicators or motor-driven ones.

Ducks and waterfowl. Damaged fields are a problem because they must be reseeded which throws off the timing of maturation of the grain come harvest time. Some farmers will also lower water levels for the replant, allowing for weed seed germination and the need to use more herbicide later.

Ducks do not usually frequent fields at night with 8-10 cm of standing water, so if farmers in Nariva could be convinced to use the water-seeded method of rice planting, duck damage would be reduced. The most important management factor, however, no matter what method is used, is not to allow the ducks to find the seed during the first one or two nights. If ducks are kept off such fields during this time, then 80% of the battle is won. However, if the ducks are allowed to find the seed during the first nights, then they will come back to that field every night and it will be difficult to keep them off the field.

Waterfowl seed depredation in Costa Rica is currently being controlled with a combination of propane detonators and weekly spot-lighting with halogen spotlights (400,000 watts). Detonators are expensive to purchase initially ($350 to $1,000 depending on the model; recommended contacts for assistance : Mike McCoy and Montserrat Carbonell) but they pay for themselves over two or three crop cycles, if otherwise guards have to be hired to patrol the fields at night. Manual guarding of rice fields can be done with regular flashlights, but the more powerful halogen beams connected to automobile batteries work better. In a situation like Sector A where most fields have roads nearby, the farmers could unite and hire one person to drive around all night and from his/her vehicle spotlight the fields and keep the ducks off newly planted seed in the whole Sector.

Other birds. The other bird pest in rice is the dickcissel (Spiza americana) which migrates from North America in fall and can cause major damage to ripening rice throughout the Neotropical Region, from September to December. Some farmers in Costa Rica are controlling damage with propane detonators, but it has also been noted that fields in close proximity to forested areas receive less dickcissel damage. It may be that there is a higher density of predatory birds in these areas which may repel dickcissels. Research to test chemical repellent (methyl anthrilate) use on affected rice fields will be started in Costa Rica in the near future, to determine the feasibility of repellents for dickcissel control. Such repellents should be considered for testing in Nariva also.

Mammals. Small rodents increase their populations at intervals and cause damage to maturing rice by eating the stems, which then causes the drying out of the developing inflorescence. This occurs in Costa Rica about every five years. Information gathered in Nariva from local farmers seems to indicate that they also have periodic damage by small rodents. A completely satisfactory method of control has not been found. In Costa Rica most farmers use rodenticides (strong insecticides like lannate mixed with some form of bait made from corn kernels, or a mixture of animal fat and ground bone). This practice done at regular intervals may keep rodent populations from peaking, but can be detrimental when baits are thrown out freely along dikes. Dead, poisoned rodents can be later eaten by non-target predators and subsequently also killed, and the poison entering the food chain. Thus, if baits are used they should be placed inside what is called a "bait station", which is usually a section of PVC tubing with a diameter just large enough to let in the target rodent but too small for a predator to enter to consume the poisoned rodent. When each station is periodically re-baited, any dead rodents found inside should be buried.

We have found in Costa Rica that rodent populations are kept lower if dikes are maintained with short vegetation (by cutting) and it seems that when fields are more level (with laser-levelling) rodents are less prone to use these fields for nesting and other activities of their life cycles. They will normally use the higher areas of unleveled fields where water sheets are absent or very shallow. This same observation has been made in California (Flint et al, 1993). Dikes that separate rice checks should also be constructed as low and narrow as possible. Unnecessarily high and wide dikes provide more habitat for rodents, especially when the soil cracks in dry season, since these provide a suitable habitat for them.

We have also been testing the acceptance of raptors to artificial perches placed along dikes and have found that these birds readily accept them in Costa Rica. Rice fields normally don't provide many natural perches for diurnal and nocturnal raptors who use perches to hunt rodents from. The use of such perches seems promising and may help keep rodent populations in check.

Use of fertilizers

The best alternative so far seems to be that currently used in California, which we are trying in Costa Rica. This method implies that in the dry season, 100% of all nitrogen, phosphorus and potassium needs are incorporated into the upper 10 cm of soil before seeding. Only Zn fertilizer is applied and left on the soil surface (for use by rice seedlings). The water sheet is then applied and never drained off. By using the permanent water sheet, an anaerobic reduction zone develops in the soil below 1 cm soil depth. The urea is converted to NH_4^+ cation which bonds tightly to negatively charged soil particles. Thus the NH_4^+ cannot be lost by leaching as long as the water sheet stays on, the NH_4^+ stays in the upper 10 cm of soil and is available to the rice plant during the whole crop cycle. However, if the water sheet is drained, then the reduction zone becomes oxidized, and the NH_4^+ is oxidized to NO_3^-. When the field is reflooded and anaerobic conditions resume in the reduction zone, the denitrifying bacteria will convert much of the NO_3^- to N_2 gas, which is then lost to the atmosphere, thus, the importance in not draining the water sheet. Phosphorus and potassium should also be incorporated into the soil to reduce the growth of algae on the soil surface.

If top-dressing of nitrogen is the only alternative, then, at least for the first application, theurea should be applied to the dry soil immediately before the water is to be put on. Once the water is being put on, the urea will dissolve in the water and be drawn down into the soil as it absorbs the water.

We have found in two separate tests in Costa Rica, that less nitrogen should be used when incorporated into the soil before planting. Both farmers used 100 to 120 kg/ha of urea, which was the normal rate with top-dressing. However, since losses with the soil incorporation rate are up to 40% lower, this rate was too high for the rice, it grew too much and lodged (fell over) just before harvest. In one of these tests, however, (on 17 ha), they still were able to dry out the ground enough to be able to harvest and obtained 160 hundredweights/ha, the best harvest ever on that farm. With the soil incorporation method, rice plants seemed to be less stressed, and grew more evenly throughout the crop cycle. Better yet a tremendous savings of up to 40% in nitrogen fertilizer can be obtained by farmers using such a method. Soil incorporation of fertilizer also reduces the amount of nutrients available to aquatic, floating weeds, compared to top-dressing applications.

The same method should also be used during the wet season planting. However, it is more difficult to incorporate fertilizer under wet soil cultivation. Fertilizer incorporation can be accomplished with the tractor rear cage wheels, if they are not penetrating more than 10-15 cm. If the wheels are going deeper than this in the soil, then alternative methods must be developed. A potential system could be the dropping of the fertilizer behind the tractor but in front of a rototiller that is only tilling the upper 10 cm of wet soil, on the last cultivation pass. The rototiller must be as wide as the rear tractor wheels, however. The prior wet cultivation should be done with as little a water sheet as possible, so that the urea is not mixed in water, but in the soil on the last pass. The water sheet should be placed onto the fertilized fields and planting should be done as soon as possible after the cultivation so as not to allow weeds to germinate or algae mats to develop on the soil surface.

Thus in summary, to minimize the run-off of fertilizer to the Nariva Swamp, which could destroy the marsh due to the stimulation of excessive plant growth, it is imperative to incorporate fertilizer into the soil before planting, and the practice of top-dressing must be discontinued. However, to be able to use the soil incorporation method, farmers must first be trained in the method of water seeding. Many will be sceptical of this method, as they were in Costa Rica. Most farmers believe that pre-germinated rice seed cannot root and emerge through a water sheet. Progressive farmers must be identified, convinced of the method and then try it on their plots with the objective of convincing the other farmers. Most fields will probably need to be laser-levelled also in order to use the water-seeding method.

New rice varieties

A better method to reduce insecticide and fungicide usage is the continual development of new rice varieties resistant to insects and disease. This also brings an added benefit of crop improvement such as increased yields, better seedling vigor, resistance to lodging, and improvements to grain quality.

The CIAT in Colombia, has started a new policy, under which, any country that pays a yearly fee of US$ 40,000 to its new irrigated rice branch, will receive the visit of rice breeders to develop new varieties within that country. Such a program could be funded by a tax levied per sack of rice harvested by each farmer (such as in California, USA).

Government involvement

Several factors exist that should stimulate the Trinidad and Tobago Government to reconsider its support to national rice production:

a) world market rice prices are rising, thus making importation of rice more difficult;

b) it is estimated that world rice production must be increased by 60% over the next 35 years (Jim Hill, pers comm) just to keep up with world demand (Trinidad should contribute to this increase in production);

c) Guyana cannot continue to meet the import rice demand for Trinidad (Mr Victor, National Flour Mills, pers comm) and already experiences shortages of rice for local consumption;

d) small farmers need to be stimulated into legal farming activities; and

e) a serious unemployment situation exists in rural areas that needs to be addressed -rice farming could help alleviate this problem and reduce the pressure to deforest hilly areas with resultant erosion, and other associated environmental problems.

With the production of new varieties, over time, rice will be freer of insect and disease problems, yields can be increased, and farmers will need to use less pesticides.

Other uses of rice fields

The cultural importance that residents of Trinidad place on the fish, cascadoo and the large conch snail opens up the possibility of even greater economic returns to irrigated rice farmers. As done by at least one farmer, a long ditch can be built in the field to hold permanent water, which in the dry season will hold young cascadoo fish. When the rice field floods, the rice is planted and the fish swim out of the ditch living in the rice field during the crop cycle. There they also mate and reproduce. When the field is drained for harvest the fish move back to the ditch on their own since this is the only water left in the field. The farmer can then seine the fish in the ditch, keep the larger ones for sale and put back the younger fish for the next cycle. Such a scheme could be repeated by many farmers, which now do not take advantage of this possibility. Such a system also dictates the use of the less harmful pesticides in the rice field while the fish are there.

The situation in Kernahan

The number one problem in Kernahan is a serious excess of water during wet season and a total lack of such water during dry season. A reservoir is sorely needed to help alleviate this problem. We identified a potential site for a reservoir nearby (see Map 3).

If high water levels continue to plague rice farmers here, then use of floating rice varieties should be investigated. These do well in deep water and although less productive than medium dwarf varieties used now, would give more economic gain if total crop failure of dwarf varieties continues to be a problem due to high water levels. Again, this will not happen unless help is given to the community by extensionists or social workers.

Most of the recommendations made for rice farming in Plum Mitan can also be applied here, where we found a stronger tradition of water buffalo raising and a large extension ofPhragmites sp vegetation, to the north of their cropland area which should readily receive heavy grazing. A great potential exists to expand water buffalo activity and especially cheese production in this community.

On water buffalo, restoration of the marsh and cheese production

If the high biomass production common in such marshes is not extracted by grazing, the marsh habitat preferred by waterfowl and waterbirds is overtaken. Birds shun ungrazed, overgrown areas and are highly attracted to grazed areas. Grazing opens up the vegetation, and creates conditions for the formation of open water when rain restores the water levels. Floating vegetation develops in the open water. As the dry season commences, the floating vegetation dies back, and as water levels drop, exposed soil forms around the open water areas. This type of habitat is attractive to waterfowl and wading waterbirds. We have much experience with this in Costa Rica (McCoy 1994; McCoy and Rodríguez 1994) and cannot stress enough the importance of grazing toward providing the necessary habitat for waterbirds. Possibly, the least damaging to the marsh, restoration method, the cheapest, and most productive -in terms of economic help for the local communities, is the grazing of aquatic vegetation by water buffalo.

Additionally it is important to remember that some of the finest cheeses are produced from water buffalo milk (mozzarella and riccota). We believe that an even greater economic return can be made from this operation if ranchers with water buffalo produced cheese. Cheese is not produced much in Trinidad and Tobago, where it is mostly imported from New Zealand at a very high price.

In the case of the Black River Water buffalo operation, it is a good three hour walk from the closest town (Biche) also points to the feasibility, since cheese is much easier to transport out than the equivalent amount of milk used to produce such cheese. The people running this operation knew nothing on how to produce cheese. But in reality it is a very inexpensive and easy process. Recent work by Roshni Maharaj at the Food Technology Unit, Department of Chemical Engineering, University of the West Indies, St Augustine, has shown the feasibility to produce cheese from buffalo milk (Kassie 1995). This technology should be extended to future buffalo ranchers and projects in the Nariva Marsh.