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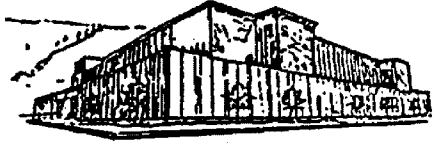
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Development of a School Gardening Environmental Education Curriculum for Rural Paraguayan Schools

by

Anna Moline

B.S. University of Wisconsin Green Bay, 1997

submitted in partial fulfillment of the requirements

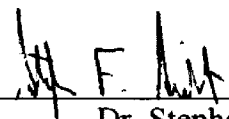
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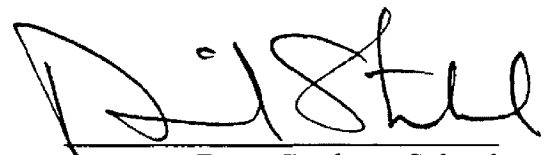
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May 2001

Approved by:



Dr. Stephen Siebert
Committee Chair



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Moline, Anna M. M.S. May 2001

Forestry Department

Development of a School Gardening Environmental Education Curriculum for Rural Paraguayan Schools

Committee Chair: Stephen Siebert SFS

This professional paper reviews a school garden-based environmental education project I developed during my two year Peace Corps service in Villa Ygatimi, Department Canindeyu, Paraguay. I worked with 9 teachers and 200 students in 4 schools to implement the environmental education mandates of the education reform outlined by the Paraguayan Ministry of Education. My work involved training primary and secondary school teachers to incorporate environmental education into the curriculum through demonstration and team teaching of environmental science classes. The culmination of these efforts was the publication of a teaching manual illustrating how teachers in rural Paraguay can use the school garden as an educational tool to implement the environmental education reforms. Peace Corps volunteers and teachers in schools nationwide currently use the manual to teach the environmental science concepts outlined by the Ministry of Education. The manual also supports agriculture extension agents of the Fundacion Moises Bertoni in their efforts to achieve sustainable agricultural development in the buffer zone communities of the Reserva Natural del Bosque Mbaracayu, the largest remaining tract of primary forest in the country. An assessment of the extent to which this manual addresses Paraguay's environmental concerns and succeeds in implementing the teaching reforms are included. I review the current state of Paraguay's natural environment, demographic status, economic system, threats to the country's environmental integrity, and conservation efforts by the Paraguayan Ministry of Education, the US Peace Corps and the Fundacion Moises Bertoni, as background information to the project.

Acknowledgements

I would like to express my deepest gratitude to the Gimenez-Samaniego family – Juanita, Filipe, Virginia, Carina, Lilian, Miguel, Oscar, Rosa, and Nuni. I am greatly indebted and sincerely thankful for your hospitality. You opened your house and your hearts and welcomed me in as a member of your family. I will never forget you.

To my colleagues in Paraguay, the teachers and students of the Education Area 6 and the Fundacion Moises Bertoni, I thank you for your generosity, patience, and understanding. With out your hard work, this project would never have been possible. I would also like to thank my friends and family who supported me throughout my Peace Corps experience and the completion of this professional paper.

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Chapter 1. Environments and Peoples of Paraguay

Introduction

The purpose of this paper is to review a project which used the school garden as a focus for implementing environmental education reforms I developed while serving as a Peace Corps environmental education volunteer in Villa Ygatimi, Canindeyu Department, Paraguay. I developed a teaching manual that illustrates how teachers in rural Paraguayan schools can use the school garden to teach the national science curriculum and implement environmental education mandates as outlined by the Paraguayan Ministry of Education. I review background information relevant to the project including: Paraguay's eco-regions, demographic and economic status, current environmental issues, local and international conservation efforts, challenges to implementing environmental education mandates in rural schools, its context within the Peace Corps Paraguay environmental education project plan, cultural relevance and possible acceptability. The potential of the school garden project to address educational and environmental issues is also discussed. This manual and my analysis of opportunities and constraints to its use in rural Paraguayan schools and its potential to achieve environmental objectives of the Peace Corps and the Paraguayan Ministry of Education comprise the basis of this professional paper. The teaching manual *La Huerta Escolar como Herramienta de Enseñanza* is included in a pocket insert after the text.

Eco-regions of Paraguay

The Paraguay River divides Paraguay into two vastly different regions, the Oriental and the Paraguayan Chaco. The Oriental is characterized by gently rolling forested hills broken by open grasslands and crisscrossed with rivers and streams (Caceres, 1983, Rios and Zardini, 1989) while the Chaco is a flat alluvial plain covered with scrub forest, saline marshes, and sand dunes. Ache Indian hunters can distinguish 54 different types of vegetation in the forested hills of northeastern Paraguay (Hill et al., 1997), and scientists have previously described the Oriental as six distinct eco-regions (Keel et. al., 1993). The advance of agriculture into previously remote areas has lead to the conversion of the Oriental's original vegetative cover to agricultural crops; a recent delineation identifies four eco-regions (Hayes, 1995). These eco-regions consist of the dry open wood and grasslands of the *Campos Cerrados*; the tall sub tropical forest and marshes of Central Paraguay; the savannas, open woodlands and expanses of partially inundated wetlands of Neembucu; and the tall humid deciduous forests of the endangered Atlantic Interior Forest in the Alto Parana eco-region (Keel et. al., 1993, Hayes, 1995, Hill et al., 1997).

The Chaco can be divided into three eco-regions (Spinzi, 1984): the short but nearly impenetrable dry thorn scrub forests of the Alto Chaco, the extensive palm savannas and marshes of the Bajo Chaco and the periodically flooded forests and wetlands of the Matogrosense Chaco (Norman, 1994, Hayes 1995, Thigpen, 1996, Willig et al. 2000). Created by deposits washed down from the Andes (Norman, 1994), this flat

dry alluvial plain is one of the largest biomes of South America, second only to the Amazon Basin (Bucher and Huszar, 1999).

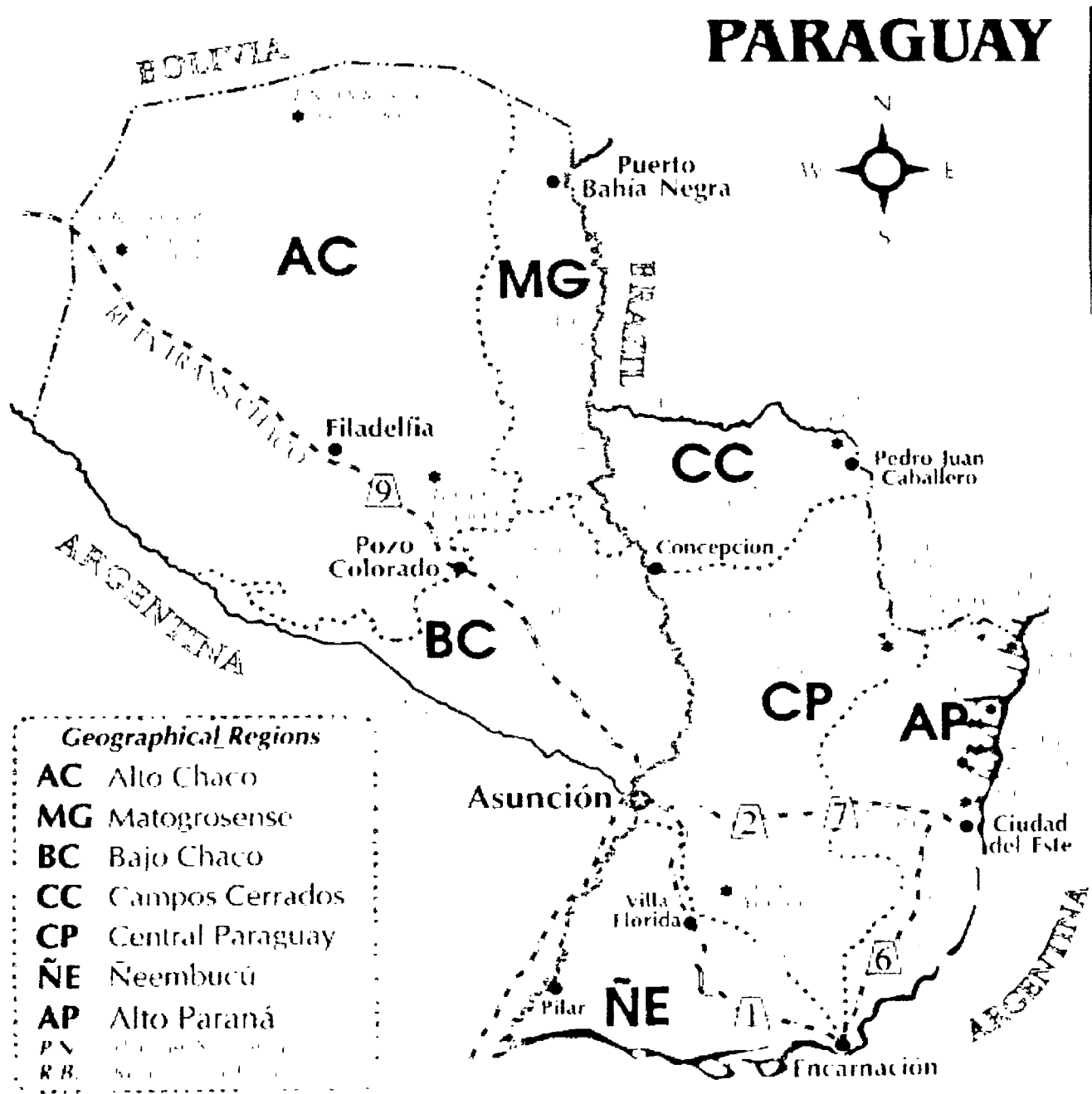


Figure 1. Map of Paraguay

Weather patterns are unpredictable in both the Oriental and the Chaco. Monthly rainfall patterns are so variable that any month of the year could be the wettest or driest (Hill and Hurtado, 1996). In the Chaco periods of drought are unpredictably punctuated by heavy rainfall. It is not uncommon for six to nine months of total drought to be interrupted by an intense rainfall totaling up to 21 cm of precipitation in a 24-hour period (Hayes, 1995). The extreme flatness of the landscape and the impermeability of the dense clay soils cause extensive flooding, often for several months (Hayes, 1995).

With no defined rainy season (Hayes, 1995), seasonality is determined by temperature rather than rainfall (Hill and Hurtado, 1996). The summer temperatures of October through March often exceed 38°C (Hill and Hurtado, 1996) particularly in the Chaco, the region known for the hottest temperatures in South America (Stallings, 1986, Hayes, 1995). The mid-continental humidity remains at a constant 90 % year round (Hill and Hurtado, 1996) which in combination with the summer heat creates daily convective thunderstorms or “*aguaceros*”. These cloudbursts can be a spectacular display of nature’s energy and provide a welcome break from the late afternoon heat. High-powered winds rip leaves off of trees and scatter chickens as they boil black, purple, and orange clouds into a storm. Farmers stop their fieldwork and calmly duck under cover to wait for the “*tiempo vai*” or bad weather to pass.

The winter months of April to October are known for the opposite extreme: an inescapable damp coldness as temperatures plunge below freezing with several days of hard frost each year (Caceres, 1983, Hayes, 1995). Spells of freezing weather and damp, bone-chilling winter rains can last for several days. Family farmers do not have adequate clothing for this type of weather and these spells of winter weather put a stop to most

activity, including school classes, as families huddle around the cooking fire drinking hot tea or “*mate*”.

Demographics

Paraguay’s population of 5.4 million people (World Bank, 2000) is not equally distributed through the two regions of the country. Although the Chaco comprises 61 % of the nation’s land area, its harsh desert environment is practically devoid of human habitation; only about 1.4 % of Paraguay’s population lives there (Hayes, 1995). While the Oriental comprises 39 % of the country’s land area, it is home to over 98 % of its people (Rios and Zardini, 1989). Historically, the concentration of human population is not skewed only to the Oriental, but to the 60 km area around the capital city of Asuncion (Zoomers, 1988, US Department of State, 1999).

Paraguay’s population has one of the highest growth rates in Latin American. Population growth rates rose from 2.8 % in 1960-1980 to 3.2 % during 1980-1987 (Bravo-Ureta and Evenson, 1994). The current population growth rate has fallen to 2.6 % per year (World Bank, 2000).

Most of the people of Paraguay are of similar ethnic heritage. Ninety-five percent are of mixed Guarani Indian and Spanish decent (US Department of State, 1999). The remaining 5% of the population are Indigenous peoples and Mennonite colonists who fled religious persecution in Europe and other countries (Thigpen, 1996, USAID, 1996, Reed, 1997). The high degree to which the Indigenous people have maintained their culture is illustrated by the fact that one of the official languages spoken in rural Paraguay today is Guarani, the same tongue spoken by the Indigenous Guarani (Reed, 1995).

Economics

Paraguay is the only country in Latin American that continues to rely on agriculture as the basis of the economy (Baer and Birch, 1987, Weisskoff, 1992, Van der Glas, 1998). Wood products and beef have historically accounted for the majority of Paraguay's exports. Although timber harvest in land-locked Paraguay was traditionally limited to areas where logs could be transported by river to Buenos Aires (Cooney, 1979), The country ranked as one of the world's top 20 exporters of timber products during the 1950's and 1960's when about 20 million cubic meters of timber were exported annually (Kleinpenning, 1992).

The rapid colonization of the eastern frontier regions for agriculture in the 1960's and 1970's changed the structure of Paraguay's agro-export economy. Beef and traditional forest products of wood, tannins, and yerba (a green tea) were replaced with the cash crops of cotton and soybeans. The 1970's economic growth rate of 8.1 % was fueled by the development of small-scale cotton farms and large mechanized soybean agro-businesses in the previously forested eastern frontier (World Bank, 1979, Van der Glas, 1998). As forests were converted to agriculture, soybeans and cotton production increased 350% and 470% respectively, while subsistence food crops hardly kept up with population growth. These two cash crops accounted for 50% of all exports in the late 1970's, an increase from 18% a decade before (World Bank, 1979, Baer and Birch, 1987). The expansion of agricultural lands continued and by the mid to late 1980's, agriculture accounted for 98% of the nations export earnings and employed 51% of the populace (Welton, et al, 1987, Rivarola, 1990). Eighty percent of this was generated from the export of soybeans and cotton (Hanratty and Meditz, 1990).

The dominance of cash export crops continued in the 1990's. Of the 1,183 metric tons of cotton grown in Latin America in the 1996-1997, Paraguay produced 76,000 metric tons (In the red zone, 1998). Only 13,000 of these metric tons of cotton were consumed in Paraguay. The remainder was exported, primarily to neighboring Brazil, the world largest importer of cotton (Cotton imports rise, 1997).

Paraguay is also unique in that it is one of the only Latin American countries to survive the decade of the 1980s with out economic difficulties. Paraguay's economy grew at an annual average rate of 2 % during this time, which was exceeded only by Chile (Richards, 2000). This relative economic success was due in part to low external debt, the construction of two world-class dams, and continued expansion of cotton and soybean production (Baer and Birch, 1987, Richards, 1997, Richards, 2000). Economic growth slowed in the 1990s. Regional economic instability, the closing of the agricultural frontier due to an exhaustion of uncultivated land (Richards, 2000), and continually growing population pressure (Bravo-Ureta and Evenson, 1994, Hernan, 1999) account for this economic slowdown.

Chapter 2. Environmental Issues in Paraguay

Deforestation

Deforestation is perhaps the most obvious of Paraguay's environmental problems. Originally, eastern Paraguay had nearly 85 % forest cover (Kleinpenning and Zoomers, 1988, Rios and Zardini, 1989, Kleinpenning, 1992). By 1945, that cover was reduced to 45 % and by 1984 only 22 % of Paraguay's original forest cover remained (Kleinpenning and Zoomers, 1988, Keel et.al., 1993). Deforestation continued at the rate of over 1,000 square km a year in the early 1990's (Keel et. al. 1993, Van der Glas, 1998), almost twice

Amazonian deforestation rates (Willig et al., 2000). It is estimated that Paraguay will be completely deforested by the year 2005 (Goethals, 1990).

Perhaps the most significant cause of deforestation in Paraguay, particularly in the area around Villa Ygatimi, were programs of the local government and the United States Agency for International Development (USAID) aimed at reorganizing Paraguay's agricultural system. The goals of this effort included addressing the inequity of farmland distribution, lack of land tenure and easing crowding in areas around Asuncion by relocating landless people to forested areas in eastern Paraguay and transforming the country into an agricultural export power (Zoomers, 1988, Kleinpenning and Zoomers, 1991, Van der Glas, 1998).

These issues have deep historical roots. After the Republic of Paraguay established independence in May 17, 1811 it expelled the Spanish and Jesuits and seized their land, giving the government title to nearly 60 % of the country's land area (Hanratty and Meditz, 1990). More than half a century later, the crippling defeat of the War of the Triple Alliance left the country desperate to raise money and the government sold its land holdings to finance war debts (Hanratty and Meditz, 1990, Rivarola, 1990, Kleinpenning and Zoomers, 1991). This land sale resulted in inequitable land ownership, shifting land from the government to a few wealthy people. In the 1956 agricultural census Paraguay had more land per capita than any other country in the western hemisphere (Arnold, 1971), but one percent of the populace owned over 86 % of all agricultural lands (Kleinpenning and Zoomers, 1991).

The same census illustrated growing land crowding. The size of land worked by each family was shrinking due to land concentration and the subdivision of remaining

land due to rapid population growth. Seventy-five percent of the farmers subsisted on less than five hectares (Zoomers, 1988), and most lacked title to the land they worked (Arnold, 1971, Kleinpenning, 1984, Kleinpenning and Zoomers, 1988, Van der Glas, 1998). This lack of access to land led to the concentration of 60 % of the population residing in the Asuncion area and a decline in soil fertility (Arnold and Espinosa, 1968, World Bank, 1979, Van der Glas, 1998). Inequitable land holdings and declining soil productivity were not alleviated by the March East.

The March East colonization effort was facilitated by the Instituto de Bien Estar Rural (IBR) with World Bank, USAID, and domestic government funds (World Bank, 1977, Bray and Borda, 1988). Created by law 853 in 1963, the IBR restructured Paraguay's agricultural system and helped frontier farmers become economically and socially integrated into the national economy (Arnold and Espinosa, 1968, Kleinpenning, 1984, Zoomers 1988). From 1963 to the late 1980's this agency relocated nearly one quarter of Paraguay's population to the frontier, where they converted 7.4 million hectares of primary forest to agriculture (Hanratty and Meditz, 1990). This resulted in the population of the Departments Alto Parana and Canindeyu, including the area around Villa Ygatimi, to increase from 24,000 in 1962 to 266,000 in 1982 (Van der Glas, 1998) and cultivated land to increase from 520,000 hectares in 1963 to 1.8 million by 1980 (Kleinpenning, 1984, Weisskoff, 1992, Van der Glas, 1998).

The value of land in neighboring Brazil did not change during this time which resulted in Paraguay land values one tenth that of neighboring Brazil (Carter and Barham, 1996). For Brazilians living near the border cheap, virgin land in Paraguay (World Bank, 1978, Kohlhepp, 1984) was more attractive than relocating to the distant Brazilian

agricultural frontier in Amazonas (Kohlhepp, 1984, Van der Glas, 1998). Many Brazilians sold their farms and crossed the border to Paraguay (World Bank, 1979, Bray and Borda, 1988, Van der Glas, 1998). By the mid-1980's, half the population in the eastern border departments of Canindeyu and Alto Parana was Brazilian (World Bank, 1978, Kleinpenning, 1984, Hanratty and Meditza, 1990).

While the colonization scheme succeeded in moving both Paraguayan and Brazilian families to the frontier and clearing forests for agriculture, it did not address the underlying land tenure inequities that prompted the "March East" and in fact replicated the problem (Parbery et al., 1976, Kleinpenning and Zoomers, 1991, Van der Glas, 1998). Inequities in land distribution remained virtually unchanged. The amount of land controlled by 1 % of the population decreased from 86.7 % in 1956 to 78.5 % by the end of the colonization project (Kleinpenning and Zoomers, 1991). Migration did not alter land tenure conditions near Asuncion (Kohlhepp, 1984, Kleinpenning and Zoomers, 1991, Van der Glas, 1998) or in the newly colonized areas. By the early 1980's, only 30 % of newly settled families had obtained property titles (Kleinpenning, 1984). Furthermore, colonization did not keep pace with population growth. The number of people engaged in agriculture increased from 835,000 in 1955 to nearly 2 million in 1988 (Weisskoff, 1992), and the capital remained as densely populated as before the colonization scheme (Zoomers, 1988).

Contrary to the objectives of the March East, colonists were poorly integrated into the national economy. Under funded and plagued with corruption, the IBR offered little financial support per farm by relying on farm family labor to clear the forest and plant crops (World Bank, 1979, Kohlhepp, 1984, Van der Glas, 1998). Considering the fact

that many colonists arrived to the frontier with little or no resources (Zoomers, 1988, Zoomers and Kleinpenning, 1991, Van der Glas, 1998), the lack of assistance underestimated settlers' needs.

Some theorize that the migration program was a scheme by dictator Alfredo Stroessner to maintain power (Bray, 1991). In order to prevent discontent, people were moved out to the frontier before a working urban class could establish (Richards, 1997). People isolated in remote areas with little infrastructure such as roads, schools or health facilities are less likely to resist oppression than an urban working class.

The opening of the eastern forests by the March East led to extensive timber extraction. The number of sawmills in the newly settled area increased from 32 in 1965 to 209 in 1975 (Kohlhepp, 1984). Because the Paraguayan frontier lacked the infrastructure to process and market this wood, almost all sawmills were owned by newly arrived Brazilians (Van der Glas, 1998). During colonization, the illegal export of wood to Brazil was five times that of legally exported timber (Kohlhepp, 1984).

The illegal flow of timber to Brazil continues today. In the Villa Ygatimi area, trees of the Atlantic Interior Forest ecosystem are being felled and illegally exported to Brazil (Baer and Birch, 1987, Fogel, 1994, Van der Glas, 1998). In the early 1990's, an estimated 170 trucks filled with Paraguayan logs illegally crossed the Brazilian border each day (Moderno contrabando de madera, 1993) which represents about 65 million dollars of timber smuggled to Brazil each year (Corruption attacks forests, 1993).

After the commercially valuable trees have been extracted, the remaining forest is commonly cleared with fire to make way for soybeans and cotton (Van der Glas, 1998, Kammesheidt, 1999). Introduced in 1967, soybeans are currently the most widely

planted crop in Paraguay (Bray, 1991, Weisskoff, 1992, Carter and Barham, 1996). The rapid expanse of soybean production is due to the National Soy Program, which supported mechanization and the use of agrochemicals in an effort to increase the export of soybeans by 100 % (World Bank, 1977). Foreign investors took advantage of the support offered by this agency and bought vast tracks of land in eastern Paraguay and burned the forest to establish large mechanized farms (Zoomers, 1988, Richards, 2000).

The more traditional crop of cotton also relies on burning forests, but on a much smaller scale. Cotton has been cultivated in Paraguay since early colonial times and its production became significant during the 1860's when the British textile industry looked to Paraguay to meet the shortfall caused by the US Civil War (Wigham, 1994). Cotton is grown almost exclusively by small family farmers who depend on it as their sole source of cash income (Bray and Borda, 1988, Hamilton and Bliss, 1998, Richards, 2000). In the 1980's, almost all of the cotton cultivated in Paraguay was planted on farms of less than 50 hectares and 48.8% was planted on farms of less than 10 hectares (Bray, 1991). While farm families often have access to 20 hectares of land, most only have the means to cultivate 2 or 3 hectares (Evans, 1988, Bray and Borda, 1988, Hamilton and Bliss, 1998), resulting in cotton farms averaging only 1.75 hectares (Weisskoff, 1992).

The conversion of forests for cotton and soybeans cultivation results in declining soil fertility. The fertility and organic matter levels of forested soils in Paraguay are high, but decline each year following forest clearance (Riezebos and Loerts, 1998, Van der Glas, 1998). Erosion tends to increase after burning causing a loss of organic matter and resulting in a further decline in soil fertility (Fogel, 1994, Van der Glas, 1998). Forest removal in the Chaco results in the exposure of salt and can render soils useless for

agriculture (Thigpen, 1996). The results of these processes are continual pressure to extend agriculture into remaining frontier areas in both the Chaco and Oriental (Riezebos and Loerts, 1998).

Pesticide Use

Forests are converted to cotton fields because it is the only option farmers in remote areas can obtain the resources to grow. The lack of roads and infrastructure leaves farmers with little option but to grow cotton through credit arranged by a “*Patron*”. Through this system, cottonseed, agro chemicals, and backpack sprayers are obtained from foreign sources (Harvest of Shame, 1999, Delta and Pine, 1999, Richards, 2000) and delivered to farmers by a “*Patron*”, typically a shopkeeper or a trucker, who promises to return and haul the harvested cotton to market (Jameson, 1985, Turner, 1998). “*Patrons*” often check on their investment and instruct farmers to liberally apply pesticides to the growing cotton (Personal Observation). Often these chemicals are illegal in their country of origin (Kleinpenning and Zoomers, 1988, Weisskoff, 1992, Fogel, 1994). Under section 17 of the U.S. Fungicide, Insecticide, Rodenticide Act, pesticides that cannot be legally sold in the United States can be exported to other countries (Percival et al., 1996), such as Paraguay. Once on foreign soil, the chemical exporter turns all responsibility for the pesticides over to the local department of Agriculture (Keifer et al., 1997) and the proper use of these chemicals are rarely shared with rural farmers (Personal Observation).

Although the “*Patron*” system maintains the poverty of rural farmers, the government, one of the principle buyers of the cotton, supports it because it ensures a steady supply of exportable cotton at a reasonable price (Bray, 1991). Farmer resistance

to this system by organizing cooperatives for economic support has historically been met by imprisonment, torture, and even death at the hands of the military police (Turner, 1998, Kleinpenning and Zoomers, 1991, Weisskoff, 1992)

Endangered Species

Because several very different ecosystems overlap in Paraguay - the wet Chaco, the dry Chaco, the Pampas grasslands, the Atlantic Interior Forest and the Pantanal wetlands, the country houses many temperate and tropical species as they reach their ecological limits (Willig et al, 2000) and the country is an important resting stop for both North American and Austral migrating birds (Hayes et al., 1990, Hayes et al, 1994, Hayes, 1995). The forests of the Alto Parana eco-region house 90 % of Paraguayan rare and endangered species and one of the most diverse bird populations in South America (Kleinpenning, 1992, Hill et al., 1997, Clay et al., 2000). Called the “great hunting ground” by the native peoples, the Chaco has more mammal species per square mile than the Amazon Basin (Thigpen, 1996, Yahnke et al., 1998, Bucher and Huszar, 1999) and the highest diversity of large and medium sized mammals in the neo-tropics (Taber, 1991).

The integrity of this biodiversity is threatened by habitat loss and hunting. Aerial photos from the mid -1960’s reveal that 90 % of the Alto Parana eco-region was originally covered with mature forests (Hill and Hurtado, 1996). Since this time the area has been targeted by The March East colonization program and much of this forest has been converted to agriculture. Although Paraguayan biota is the most poorly known in all of Latin America (Rios and Zardini, 1989, Yahnke et al., 1998), scientific research suggests an increasing risk of species extinction due to habitat destruction and

deforestation (Yamashita and Valle, 1993, Collar et al., 1994 *a*, Collar et al., 1994*b*, Willig et al., 2000).

Wildlife hunting is one of the main economic activities in the Chaco because the drought prone climate makes agriculture difficult (Bucher and Huszar, 1999). While indigenous groups have hunting rights in some protected areas (Homer, 1992), non-native peoples often enter national parks and reserves to hunt deer, tapir, peccaries and to collect bird species for the cage bird trade (Beissinger and Snyder, 1992, Norman, 1987, Taber, 1991, Fitzgerald, 1994).

Hydroelectric Projects

Another cause of habitat loss was the construction of two huge hydroelectric projects on the 200-foot deep Parana River (Cotrim et al., 1984): the Itaipu and Yacyreta dams. Generating more electricity than any other dam on Earth (Caric et al., 1982, Dixon et al., 1989, Luxer, 1991), Itaipu impounds 29 billion cubic meters of water to flood over 1,000 square kilometers of the Atlantic Interior forest of the Alto Parana eco-region. It also covers the water falls of Salto Guaira, once known as one of the wonders of the natural world (Hayes, 1995, The Powerhouse, 1996). The water falls of Salto Guaira and tracts of virgin forest were sacrificed to provide 80 % of Paraguay's electrical power needs and to export electricity to Brazil (Cotrim et al., 1984).

Down stream from Itaipu, Paraguay's second huge hydroelectric project, Yacyreta, can boast no such achievements. Environmental and social impact studies were not started until the project was 85 % complete and 109,000 hectares of unique river islands, wetlands, marshes and grasslands had been flooded forcing the relocation of 50,000 people (World Bank, 1997, Treacle, 1998). Nearly a decade behind schedule and

overrunning the original budget by almost 8 billion dollars (World Bank, 1997), the Yacyreta dam remains unfinished (Treacle, 1998). The mismanagement of this project contributes to Paraguay's World Bank credit record ranking as one of the world's ten worst (World Bank, 2000).

Non-Governmental Organizations

There are several non-governmental organizations in Paraguay that work for environmental protection; the largest and most established being the Moises Bertoni Foundation. Concerned Paraguayan citizens founded the Moises Bertoni Foundation for the Conservation of Nature (MBF) in 1988 (Gauto, 1989, Thigpen, 1998). The main focus of this organization is the protection of the Reserva Natural del Bosque Mbaracayu, the largest intact tract of forest left in Paraguay (Hill et al., 1997, Zuercher, 2001) through sustainable agricultural development of communities in the reserve's buffer zone.

Domestic funding for non-governmental organizations is almost non-existent in Paraguay leaving the Fundacion Moises Bertoni little option but to look to foreign funding sources. Dependence on foreign income sources may lead to conservation programs being organized around concerns for foreign monetary sources. For example, the Fundacion Moises Bertoni has secured grants from the French government to fund their organization for several years. This money is to be used for specific projects such as the construction of model farms, bakeries, and a manioc processing plant. However, local Paraguayan socio-economic and cultural conditions are rarely considered in these programs decreasing their effectiveness to achieve social and environmental objectives (Personal Observation).

Chapter 3. School Gardening and Environmental Education in Rural Paraguayan Schools

School Based Environmental Education

The Paraguayan government addresses environmental issues by mandating environmental education in all primary schools across the nation. The Paraguayan Ministry of Education consulted with the Harvard University Institute of International Development to reform the national education system and mandated these reforms into law (Warwick, 1998). This education reform obligates teachers to educate students with the objective of developing values that lead to the conservation, defense and recuperation of the environment, foster respect for nature, and promote the rational use of natural resources (Ministerio de Education y Cultura, 1995). The education reforms are based on three foundations: education for democracy, education for the family, and environmental education. These mandates also state that education should involve community projects and be based in the context of students' local environment (Ministerio de Educacion y Cultura, 1995).

Peace Corps Paraguay Environmental Education Project

The focus of the Peace Corps Paraguay environmental education project is to educate teachers and community members on local and national environmental issues and empower them to take action (McDonald, 1998). To accomplish these goals, the project is organized around a national environmental education program. This promotes continuity in Peace Corps environmental education work throughout the country.

The plan instructs volunteers to initially complete a community analysis to determine local environmental and socio-economic concerns (McDonald, 1998). The

training then progresses to the volunteer and local teachers team teaching specific environmental themes in classes and teachers implementing environmental education in their curriculum without the volunteer's assistance (McDonald, 1998).

In addition to teacher workshops, Peace Corps volunteers are required to bring counterpart teachers to two training workshops in Asuncion. The purpose of these in-services workshops is to discuss the Peace Corps environmental education project plan goal of using the school as a base to broadcast environmental education in the local community. The objectives to accomplish this goal include environmental activities for students during summer and winter school vacations, environmental oriented clubs and groups, participation of community members and parents in environmental events and campaigns, and school based environmental projects in the community (McDonald, 1998).

The goals and objectives of the Peace Corps Paraguay Environmental Education project plan are noble efforts to address Paraguay's environmental issues, but the country's environmental problems are rooted in macro-scale political and socio-economic issues that Peace Corps volunteers are unable to address by working with teachers and students in rural schools. The poor, rural populations Peace Corps volunteers work with are victims rather than causes of environmental degradation. To better address environmental issues, Peace Corps should recruit volunteers that have a background in international development. Pre-service training should include classes on participatory rural appraisal and other community assessment tools to provide volunteers with the methodology skills and analytical framework to understand community issues and concerns and thereby to determine appropriate and acceptable development activities. If

three months of pre-service training volunteers receive before they go to their sites does not adequately prepare them to conduct a thorough community analysis. Although the process of asking community members questions makes the volunteer visible in the community and has the potential to help develop contacts with community leaders, this does not constitute a community analysis. The results of the survey may not be representative of all sectors of society, particularly under-representing marginalized populations such as women and minority groups. In order to effectively identify community issues, volunteers should use participatory rural appraisal techniques such as oral histories and ethno biographies, seasonal calendars, daily time use analysis, livelihood analysis, and participatory mapping and modeling that allow people from all sectors of society to voice their wants and needs in a culturally appropriate manner (Chambers, 1994). By using these types of community analysis techniques, volunteers can better identify causes of environmental concerns in the local community and develop successful programs that can lead to their successful alleviation.

The next project plan objective is to develop a series of teacher-training workshops to introduce the concept of environmental education, review local environmental problems, and introduce environmental teaching techniques such as songs, games, outdoor activities, didactic materials, special days (e.g. Arbor Day, Earth Day), theaters, wall murals, science corners, excursions, and school gardening (McDonald, 1998). Peace Corps volunteers show teachers how these methods can be used to accomplish the environmental education reform mandates. The training process begins with volunteers teaching model environmental science classes for teachers to demonstrate how the instructional methods outlined in the workshops can be implemented. The

success were measured in the quality of work completed rather than the quantity of volunteers placed, Peace Corps may actually succeed in “working themselves out of a job” rather than remaining in countries like Paraguay for over 35 years.

Volunteer Accomplishments

I was a Peace Corps environmental education volunteer placed in Villa Ygatimi, Department of Canindeyu, a community about 150 km from a paved road and 35 km from the Brazilian border. The schools I worked with are about 20km from the largest remaining tract of primary forest in the country, the Reserva Natural del Bosque Mbaracayu Reserve (listed as Parque Nacional Mbaracayu in Figure 1.). Although assigned to the primary school in Villa Ygatimi, I also worked with three nearby schools in newly established communities. In total, I worked with nine teachers and about 200 students in four schools.

I pursued several objectives of the Peace Corps Paraguay environmental education project plan to accomplish the goal of implementing the environmental education reform in these schools. I did demonstration and team teaching of environmental science classes in each of these four schools on a weekly basis. Local teachers and I worked together to create and use didactic materials (educational materials other than books) such as environmental theme posters, masks of animals and trees, and the development of environmental games, stories, and theaters. These materials were used to build awareness, appreciation, and understanding about Paraguay’s forests, plants and animals, endangered species, and bird migrants. We also taught classes on environmental theme songs, using recycled glass and other garbage in art projects, and celebrating special environmental days such as Arbor Day and Earth Day with school

projects. These teaching materials were also used during the months of summer vacation and winter break. With my assistance, high school students aspiring to become teachers organized environmental activities for students in each community during vacations.

I also pursued projects that fell outside the Peace Corps Paraguay environmental education project plan. I worked at a secondary school teaching Biology and Ecology classes and organized a community composting project. Because most of the students in these classes were planning on pursuing a teaching certificate, these courses included classes on how environmental concepts can be shared with primary school audiences. In addition to secondary teaching, I attended several meetings with the Fundacion Moises Bertoni, the environmental organization that owns and manages the Reserva Natural del Bosque Mbaracayu. The focus of these meetings was the development of an interpretation program and environmental educational materials for the protected area. I also organized cooking classes with local women.

The Teaching Manual “La Huerta Escolar como Herramienta de Enseñanza”

The Peace Corps environmental education project supports volunteers with information binders outlining examples of teacher workshops, classes, and projects. Volunteers are also provided with manuals that contain patterns of didactic materials and environmental theme plays, songs, stories, and games. The school garden is the only component of the project plan that did not have a developed curriculum. The Director of the Peace Corps Paraguay Environmental Sector reported to Peace Corps Washington that one of the biggest challenges of the Peace Corps Paraguay’s environmental education project plan was that most volunteers lack the skills and confidence to pursue school gardening projects (McDonald, 1998). While volunteers are required to do school

gardens during their three-month pre-service training, few have gardening backgrounds and often do not have the confidence to assume a leading role in a school gardening project (McDonald, 1998).

To address the lack of school gardening materials available to volunteers and to help teachers implement the environmental education reform, I developed a teaching manual illustrating how the school garden can be used to teach environmental science concepts in rural primary schools. The school garden represents an ideal, readily accessible, and culturally relevant sample ecosystem with the potential to illustrate the natural science concepts outlined in textbooks that the Ministry of Education has distributed throughout the country. I re-organized the existing lesson plans in the natural science textbooks into classes that use school garden activities and experiments to teach the concepts. I refined and modified the school garden lessons by consulting with teachers in each of the schools in which I worked and team taught at a variety of grade levels. Through this process, I improved the lessons after each use and developed a manual that effectively illustrates how the school garden can be used to implement environmental education reforms.

Cultural Context

The school gardening project compliments the existing educational framework and culture of rural Paraguay. The concepts used in the manual are those specified in the Fourth, Fifth, and Sixth grade textbooks provided to teachers by the Ministry of Education as part of the educational reform. Both students and teachers in rural Paraguay are familiar with gardening because nearly the entire rural population is employed in agriculture (Inoussa, 1996) and most farm families have a home garden (Hamilton and

Bliss, 1998). Most schools already have a garden supported by the Parent's Commission who supply seeds, garden plants, fencing materials, and labor. Students typically bring machetes, hoes, shovels, and cow manure to school to prepare soil for planting (Personal Observation). While most schools maintain a school garden with the support of parents and community members, it is not normally used as an educational tool. Students working in the school garden do little more than grow lettuce. The development of this teaching manual sought to transform the school garden into a culturally appropriate educational tool to assist in implementing the environmental education mandates of the teaching reform.

Assessing Student Learning

Methods to assess student performance are poorly developed in Paraguay. Tests are not a tool typically used to assess student learning or measure academic progress. The only concept of testing that exists in rural Paraguay is that of an exercise in rote memorization (Personal Observation). Exams consist of exact regurgitation of material teachers practice with students prior to exams. If they cannot acceptably regurgitate the material on exam day, they are given another opportunity to do so before classes are dismissed for summer vacation. If they still do not pass on the second examination, they have the option to pay a fee and take the exact same test again the week before classes begin the following school year or they have to repeat the grade (Personal Observation). Considering that less than satisfactory test results are a bad reflection on teachers, a tremendous amount of pressure is put on students to memorize the material and pass these tests. Any type of testing that does not fall into this framework makes both teachers and students nervous. The pre and post testing efforts of this project were

greeted with white faces and sweating palms by students who looked to their teachers to give them the test answers.

Because the existing system for evaluating students in Paraguay does not effectively assess student learning, I decided to measure student understanding of environmental concepts taught with the school garden curriculum by asking students to demonstrate their knowledge through drawings. Students were asked to draw the concept being taught before and after the lesson. The pre-lesson drawings often resulted in nothing more than a blank sheet of paper while the post lesson drawings were depictions of the concept correctly labeled with vocabulary words. These drawings reveal what students knew before the lesson taught with the school garden and what they likely learned from it. (Figure 2). The food chain is the concept of how food is passed through the ecosystem. The example food chain drawn in the post-lesson drawing in Figure 2 is cabbage plants making food from the sun, a bug eating the cabbage plant, and a bird eating the bug. The degree to which students enjoyed the school garden lessons is also apparent in these drawings. For example, in the sample drawing in Figure 2, the student has depicted in great detail interactions in the school garden and included a smile on the sun.

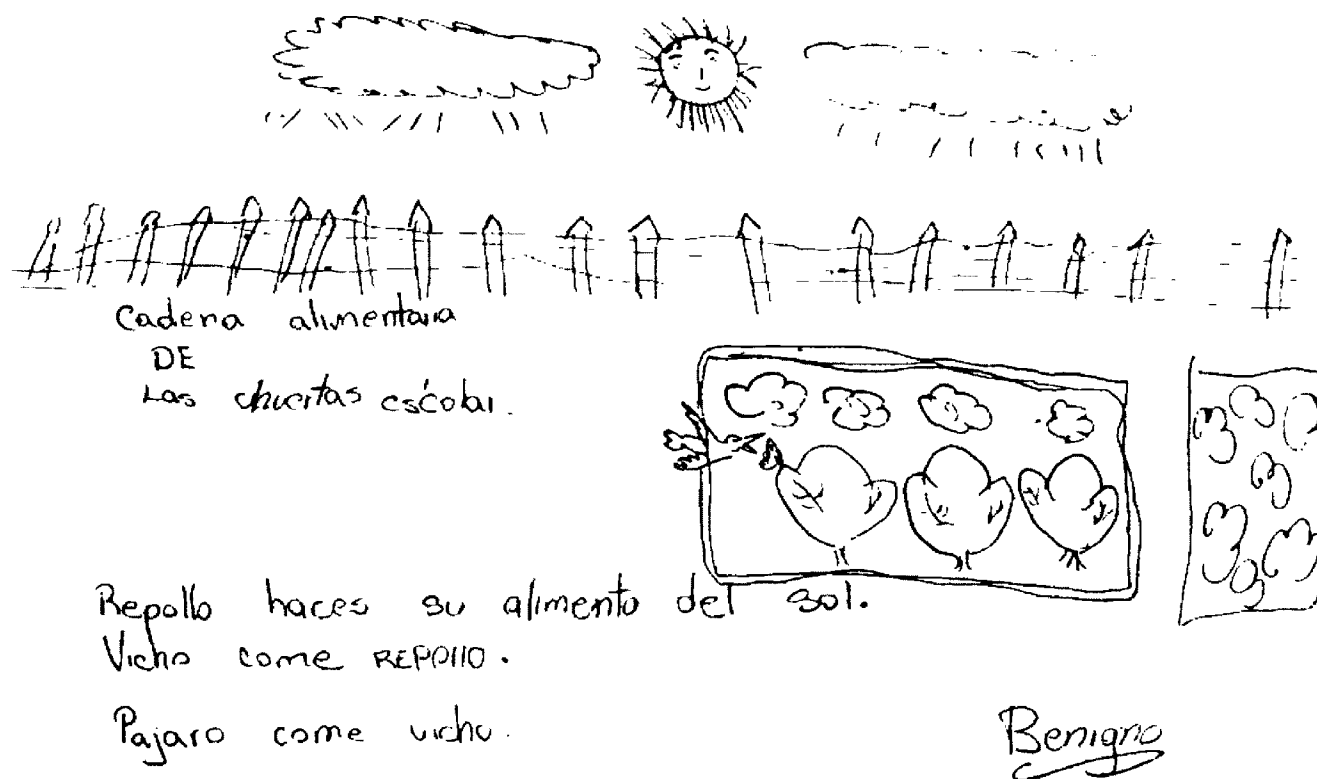


Figure 2. A Post-test Drawing of the Food Chain Lesson. The student has written - cabbage plants makes food from the sun, a bug eats the cabbage plant, and a bird eats the bug. He has also illustrated this food chain in the school garden by drawing the sun, the bug eating the cabbage, and the bird eating the bug. The pre-lesson drawing was a blank sheet of paper which suggests that the student learned this concept through the school garden lesson.

Chapter 4. Challenges to Implementing the Environmental Education Mandates of the Education Reform

Despite the ambitious educational reforms mandated by the Paraguayan Ministry of Education, the distance between the exiting teaching system and that outlined in the reforms makes their nation-wide implementation difficult. The result is a pronounced gap in educational performance and competitiveness between Paraguay and the rest of the world (World Bank, 1999). Although First though Sixth grade is required for all children, 26.1 % of the county's people 15 years and older are illiterate (Inoussa, 1996). Less than 40 % of the population enrolls in secondary schools (World Bank, 1999) and

few finish. The result is an increasingly uneducated work force that lacks the skills to compete in a global economy (Education in Crisis, 2001) and who are likely to be economically and socially marginalized because they do not have the skills and abilities to adapt to change (World Bank, 1999). The Minister of Education is a politician whose primary intent appears to be seeking the position of national chairman of the Colorado political party rather than implementing educational reforms (Personal Observation). Lacking financial and political support, the environmental education mandates are not being implemented.

Inadequate Teacher Preparation

Perhaps the largest obstacle to implementing the environmental education mandates is that many teachers in rural Paraguay are not adequately trained. Teachers receive poor training throughout Latin America, and Paraguay is no exception (Reimers, 1998, World Bank 1999). Many practicing teachers have not attended the *Formacion Docente*, or teachers college, and most are unaware of the environmental education mandates of the teaching reform (Personal Observation). Even teachers who are certified and know of the education reforms do not know how to implement them because these curriculum reforms were written before teacher preparation reforms (Reimers, 1998). Typical of education reforms in Latin America, the Ministry of Education outlines admirable education goals, but fails to offer teaching preparation classes to achieve them (Reimers, 1998).

The Old System Persists

Lack of preparation among teachers is a reoccurring problem. Teachers are inadequately prepared because their teachers were also poorly prepared (Reimers, 1998).

The perpetuation of traditional teaching methods in Paraguay is evident when student teachers complete their practice teaching. Teachers who have been working for decades before the education reforms tend to be resistant to new ideas. When student teachers enter these classrooms to do their practice teaching, they are shown by example and tested on traditional teaching methods, not the mandates of the teaching reform. There are no rewards or incentives for implementing reforms and little tolerance for other teaching philosophies or instructional methods (Reimers, 1998). Teaching positions and promotions are awarded on the basis of years of service, friends, and political connections (Reimers, 1998), not on demonstrated ability or the implementation of educational reforms. The result is a perpetuation of traditional teaching methods rather than reforms.

Challenges Specific to Teaching in Rural Areas

Education in rural schools is an important issue in Paraguay because half of the primary school children live in rural areas (Inoussa, 1996). Students in Asuncion commonly complete ninth grade while students in the countryside rarely make it to fifth (Inoussa, 1996). Insufficient schooling is the reality for most of Paraguay's rural primary school population.

Part of the inadequacy of rural education is due to the lack of trained teachers in rural schools. Certified teachers generally do not want to live and work in remote schools far from their families and without the comforts of developed areas (Winker, 1980, Reimers, 1998). Uncertified teachers have fewer options and often have no choice but to accept teaching positions in rural schools; 40 % of the teachers in the rural Latin American countryside are not trained (Reimers, 1998). It is also difficult for teachers in

rural areas to get training even if they desire it. In-service training is expensive, does not address rural teaching needs, and takes place in urban settings that are inaccessible to teachers in rural areas (Reimers, 1998).

Another challenge to education in rural areas is the working student population. Most students in rural areas serve as laborers on their family's farm (World Bank, 1999). In rural Paraguay children are expected to help with household chores such as hauling water, gathering and cutting fire wood, tending animals, working in the fields, and caring for younger siblings. This leaves rural children with less time and energy for school and is one of the reasons illiteracy rates in rural Paraguay are four times those in Asuncion (Inoussa, 1996, World Bank, 1999).

Poverty in rural areas also limits access to school. About 70 % of people in rural Paraguay live in extreme poverty (Albert, 1999). Rural students are absent three times as often as students in Asuncion not only because they have to work, but because they do not have the resources to buy notebooks, pencils, school uniforms, exams, and other school materials (Inoussa, 1996).

The actual time students spend in the classroom is low in rural Paraguay. The Ministry of Education requires 180 four-hour school days for a total of 720 hours of instruction per year (Inoussa, 1996). This is one of the lowest school attendance requirements in the world. In comparison, most developed nations have a seven or eight hour school day and average 1,220 hours of schooling a year (World Bank, 1999). The target of 720 hours of yearly instruction, already inadequate, is seldom reached because classes are cancelled when it rains, for teacher meetings, and when teachers travel to the nearest bank to receive their monthly pay.

Lack of Resources and Infrastructure

Schools in Paraguay suffer from a lack of resources and infrastructure. Lack of paved roads and rain gear make everything, including school classes, teacher workshops, and meetings difficult when it rains. Weather permitting, classes are held in schools without electricity or running water and that are poorly supplied with desks, blackboards, and learning materials (Cooney, 1983, Lizarraga, 1991, Inoussa, 1996, World Bank, 1999). There are no didactic materials or teaching manuals for teachers and the books supplied to schools by the Ministry of Education are inadequate (Personal Observation). These books were written for a primary school audience, but are written in a form of Spanish more appropriate for educating adults. While most students in rural Paraguay can manage some Spanish, their first language is Guarani and the advanced level of Spanish in these books is often beyond their reach. In addition, the subject matter is presented with complicated and confusing graphics and unrelated photographs that fail to explain concepts to either teachers or students.

Reason for Hope

Poor teacher preparation, resistance to reform, lack of resources and infrastructure, and inadequate school instruction time combine to make the implementation of education reform in rural schools very difficult. In the face of all of this adversity, there is nevertheless some reason for hope. Education spending in Paraguay has increased 192.4 % since 1991 (Education in crisis, 2001) and over 62 % of Paraguayans now finish primary school (OECD, 2000), up from less than 18 % in 1970 (USAID, 1983). Participation in secondary schools has also improved; 43 % of 20 –24 year olds have completed lower secondary school (through ninth grade) while only 16 %

of 55-63 year olds reached the same level of education (OECD, 2000). Considering that neighboring Bolivia and Brazil have primary education graduation rates of only 34.1 % and 54.3 % respectively (OECD, 2000), Paraguay boasts some of the best educational participation statistics in Latin America.

Chapter 5. How the Teaching Manual “*La Huerta Escolar como Herramienta de Enseñanza*” Addresses Paraguay’s Environmental and Educational Issues

Implementing Teaching Reform

The teaching manual that resulted from my work as a Peace Corps volunteer seeks to raise awareness of teaching reforms and assists teachers to implement them. The manual has been published by the Fundacion Moises Bertoni and is now used nationally by teachers in rural schools and by agricultural extension agents that assist buffer zone communities of the Reserva Natural del Bosque Mbaracayu in sustainable agricultural development.

The manual provides lessons and activities for teachers in rural Paraguay to use the school garden as a tool to teach textbook concepts and implement the environmental education mandates of the teaching reform. Almost all students in rural Paraguay come from an agricultural background and the school garden is an excellent way to pursue the reform mandate of educating students about the environment in a culturally relevant context.

Natural Sciences Unit

The Natural Science unit uses the school garden as an example of an ecosystem to guide student discovery of the components, processes, inter-connections and interdependence of the natural world. Collectively, the lessons encourage students and teachers to think of agricultural fields as an ecosystem of plants, soil, weather and people acting together to make the ecosystem function. Through the realization of the ecological importance of each species in the environment, people may be more inclined to support their conservation.

Every lesson in this unit is based on a concept from the Fourth through Sixth grade Natural Sciences textbooks provided by the Ministry of Education. The unit begins by introducing the ecosystem concept: explaining how to recognize both living and non-living parts of the ecosystem, their function in the environment, and how the physical and biological components of the environment together make up an ecosystem. The issues of species diversity and deforestation are addressed within the context of ecosystem processes and functions by raising awareness of role and importance of each species. This theme continues with a lesson that introduces the species concept and how to differentiate individual species in the school garden. The next lessons explain the food chain and by asking students to draw examples of both from the school garden. Helping students recognize differences between species and the role and importance of every organism in the garden ecosystem seeks to foster a sense of the importance of all biodiversity and its conservation.

Understanding relationships among parts of an ecosystem is further developed with lessons on the organization of living things, competition, interspecific relationships,

and cooperation and competition between individuals of the same species. The experiments in these lessons encourage students to identify individuals, populations and communities of plants in the school garden and how they relate to one another in an ecosystem context. Students mark their identified plants and record how and why population numbers change over time. Observing these concepts in action helps students understand the dynamic nature of ecosystems and the importance of maintaining functioning ecosystems and conserving diversity. The garden lesson on population density introduces students to differences between populations. It uses experiments from the school garden to illustrate how and why these populations are influenced by physical factors, such as weather and climate, as well as by biological factors such as weed invasion or harvesting.

The lessons on ecological succession and factors that affect ecosystems introduces the concept of environmental change and how humans influence these processes. Experiments and observations in the school garden and in nearby agricultural and forested lands in various stages of succession illustrate the mechanics, time scale, and human influence of this process. Experiments are used to address physical components of the ecosystem, such as weather and climate, and observe their effects on vegetables in the school garden, and how humans can mitigate these effects by building shade structures and covering plants before frosts.

In the lesson about natural resource conservation, students learn the difference between renewable and non-renewable resources and the importance of conservation. This exercise introduces the concept of resources and asks students to list all of the resources used in the building and maintenance of the school garden and their origin.

Students then classify these resources as renewable or non-renewable and explain their classification criteria. The wise use of resources in the school garden such as soil, water, and fertilizer are used as examples to illustrate the difference between sustainable and unsustainable resource use.

The concept of resource use and conservation continues with a lesson on the water cycle. This lesson explores what happens to the water students give to plants in the school garden as they trace its path through the water cycle.

The unit concludes with an exercise in garden planning and the concept of companion planting. It demonstrates how chemical pesticide inputs can be avoided if vegetables that have symbiotic relationships are planted in close proximity. Students plan and plant their garden beds and observe the effects of companion planting during the school year.

Soils Unit

The soils unit focuses on soils in the school garden and local community and soil conservation. By teaching soil conservation methods, this unit has the potential to provide students with tools to address environmental problems resulting from deforestation and agriculture expansion in regions susceptible to erosion and runoff. The unit begins by introducing soil and its origin. Students learn about the lengthy process of soil development and how soil lost through erosion or degradation is not easily replaced when they try to make garden soil with their own hands. The exploration of soil continues with a lesson that distinguishes soil types in school gardens and the community, and the implications of different soil types for crop cultivation. Students are

introduced to erosion as they perform watering impact experiments on exposed soils and learn how soils covered with organic matter are less impacted by erosion.

Through experimentation in the school garden, students also learn what they might do to improve soil productivity through the use of green manure cover crops and contour planting. The unit also includes a lesson on organic fertilizer and how students can make it by composting organic wastes.

The lessons on soils and their conservation are relevant to the everyday life of students in rural Paraguay. By emphasizing the maintenance of soil fertility, the school garden lessons address unsustainable farming practices and the pressure to continually convert forests to agriculture. The unit also includes experiments on how pest problems can be controlled without using chemical pesticides.

Through improved understanding of nutrient and water cycling, plant biology, and the maintenance of soil fertility, students are provided with the knowledge to become more productive and sustainable farmers. Considering that agriculture, especially small-scale cotton production, is the backbone of Paraguay's economy, these lessons are important to environmental conservation and the national economy.

Plant Parts and Functions Unit

Some of the lessons in this unit are taken from the textbooks written by the Ministry of Education, but most are lessons on plant biology and ecology that can be taught with the school garden. These lessons introduce students to the diversity of plants, their role in the environment, and the importance of their conservation.

The Plant Parts and Functions unit starts with a lesson that uses the different shapes, sizes, and colors of garden seeds to illustrate the diversity of life. The different

strategies plants use to move their seeds through the environment are illustrated through the observation of the seed dispersal strategies in the school garden. These seed lessons reinforce the importance of species diversity because they illustrate the individual roles different species have in ecosystem processes such as seed dispersal. The unit continues with lessons that describe the function of various plant parts (roots, stems, and leaves) and their importance to plant integrity and function. The next group of lessons addresses the functions of the leaves - photosynthesis, respiration, and transpiration – and the role of plants in the environment and to life on Earth. The unit concludes with lessons on phototropism, geotropism, and gymnosperms and angiosperms. Through experiments students learn how plants adapt to environmental conditions and their strategies for reproduction.

Health Education Unit

The Health Education lessons provide students with the opportunity to make vitamins and parasite medicine from vegetables grown in the school garden. The nutrient content of foods made with garden produce and the role of these nutrients in the body is also reviewed. While they do not have a direct connection to environmental issues in Paraguay, these lessons promote health and well-being. Improved health may help students learn more in school and make more informed decisions as adults (World Bank, 1999).

Conclusion

This manual is a culturally relevant teaching tool to implement national environmental education mandates in rural Paraguayan schools. It provides a bridge between the existing educational system in rural schools and the education reforms

outlined by Harvard University and mandated into law by the Paraguayan Ministry of Education. Applications to the environmental mandates include addressing local environmental issues, instigating community projects, and educating students in a familiar setting. The project builds on the agricultural background of most students and the presence of gardens in many schools to implement the environmental education reforms.

The school gardening project assists the Fundacion Moises Bertoni in their efforts to introduce sustainable agricultural development in buffer zone communities of the Reserva Natural del Bosque Mbaracayu. This manual provides extension agents with a tool to teach concepts such as the use of cover crops, green manures, contour planting, and organic fertilizers and pesticides. This may enable farmers to cultivate land longer and there by reducing pressure to covert remaining primary forest to agriculture. The teaching manual also assists extension agents in working with primary school teachers and students, populations the organization was previously unable to reach.

School gardening can be used to address Paraguay's environmental concerns not only by implementing environmental education mandates and teaching sustainable farming practices, but by raising awareness of local environmental issues in general. Environmental awareness and knowledge may progress to empowerment and lead to social change. Public participation in the planning of future public infrastructure projects may help avoid the repeat of corruption and oversights involved in the construction of the Yacyreta dam. Deforestation resulting from government sponsored projects such as the March East may be avoided by people empowered with the skills and abilities to identify the underlying causes of environmental degradation and to demand

land reform rather than further colonization of primary forests. Educated and thereby empowered people may seek a stop to the illegal export of timber products to Brazil and uncontrolled forest burning. Through education small farmers may even be empowered to organize more profitable means of marketing their products to seek alternatives to the Patron credit system, and to develop more productive, sustainable, and socio-economically appropriate farming systems.

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