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Water supply and crop selection : a study of Almolonga and Zunil, Guatemala

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WATER SUPPLY AND CROP SELECTION: A STUDY OF ALMOLONGA AND ZUNIL, GUATEMALA

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ABSTRACT

WATER SUPPLY AND CROP SELECTION: A STUDY OF ALMOLONGA AND ZUNIL, GUATEMALA

By John Andrew Falkowski

This thesis addresses local variations in agricultural systems within the highlands of Guatemala. Highland agriculture is experiencing a transition from subsistence *milpa* cultivation to vegetable production for domestic consumption and export. The communities of Almolonga and Zunil are adapting differently to this transition due to differences in water resources.

The irrigated valleys of the *municipios* of Almolonga and Zunil have a perennial water supply and are dominated by vegetable agriculture. The hillsides of Almolonga and the mountain slopes to the north of Zunil are dominated by *milpa* agriculture and have intermittent water supplies. The hillside to the south of Zunil, with a perennial water supply, is cultivated in both *milpa* and vegetables. A statistical analysis of the two basins revealed that water supply appears to have a statistically significant influence upon crop selection strategies.

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Lastly I would like to thank my fellow students Ken Baurmeister, Michael Barbour, and William Harmon for pushing the geographic envelope. Through our collective efforts, I feel we laid a foundation that will carry us wherever we choose to go.

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Chapter One - Introduction

Shifts in agriculture, from subsistence to commercial production, can be found throughout the developing world. In the highlands of Guatemala, a shift from subsistence *milpa*, an indigenous system involving the inter-cropping of maize, beans, and squash, to commercial vegetable production is underway. In *municipios* such as Almolonga and Zunil, the best land has been turned over to commercial vegetable production, while subsistence *milpa* cultivation has been relegated to hillside plots of marginal quality. The Guatemalan *municipios* are equivalent to a small county in the United States. Despite competition from vegetables, the cultivation of *milpa* is still popular in this region and dominant throughout most of highland Guatemala.

The unique agricultural landscape of the *municipios* of Almolonga and Zunil presents an interesting example of the changing economy of Guatemala. In this area, a subsistence agricultural system is interacting and evolving with a powerful commercial economy. Analysis of the agricultural evolution in Almolonga and Zunil will provide insight into the possible future of both the region and the nation.

The *municipios* of Almolonga and Zunil are located in the highlands at elevations of 2,300 m and 2,077 m respectively. The climate is mild at this elevation, with daytime high temperatures in the range of 25 °C, and little rainfall in the dry winters. Nighttime temperatures can fall below freezing, leading to crop damage and limitations upon the cultivation strategies of farmers.

As elevation decreases, temperatures and humidity increase to the point that vegetable production is again limited by climatic conditions. The constraints upon vegetative growth, imposed by climatic conditions associated with changes in elevation, define a narrow band of highland Guatemala where vegetable production is likely to succeed. This phenomena known as altitudinal zonation, has a strong influence upon cultivation strategies and regional economics in Guatemala.

In the vicinity of Almolonga and Zunil, the volcanoes: Santo Tomás, Cerro Quemado, and Santa Maria (see the inset on Figure 1 and Figure 2) dominate the landscape. These volcanoes are part of the volcanic arc that parallels the Pacific coast between the piedmont and the highlands. Earthquakes and volcanic eruptions that are typically minor occur frequently in southwestern Guatemala, though powerful events have been known to wreak widespread devastation.

The valleys of Almolonga and Zunil (see Figure 3) support a mosaic of fields dedicated to the cultivation of vegetables for local, national, and international consumption. Local consumption is dominated by the markets of Quetzaltenango, the capital of the region, located 10 kilometers to the north. Nationally vegetables are sent to Guatemala City and the inhabitants of the Pacific coastal plain. The remaining produce is exported still further to El Salvador and Mexico.

In Almolonga and Zunil, vegetables are cultivated year-round despite the lack of rainfall between November and April. A network of irrigation canals distributed throughout the valley support vegetable production. The canals are fed by springs in Almolonga and the Samalá River in Zunil.

The hillsides of Almolonga and Zunil were found to have intermittent water supplies and were dominated by the wet season cultivation of *milpa*. Some of the produce of the *milpa* is sold in the markets and by street vendors throughout Quetzaltenango. Flowers are also grown here but this crop, unlike the subsistence-oriented *milpa*, appears to be cultivated primarily to generate cash income.

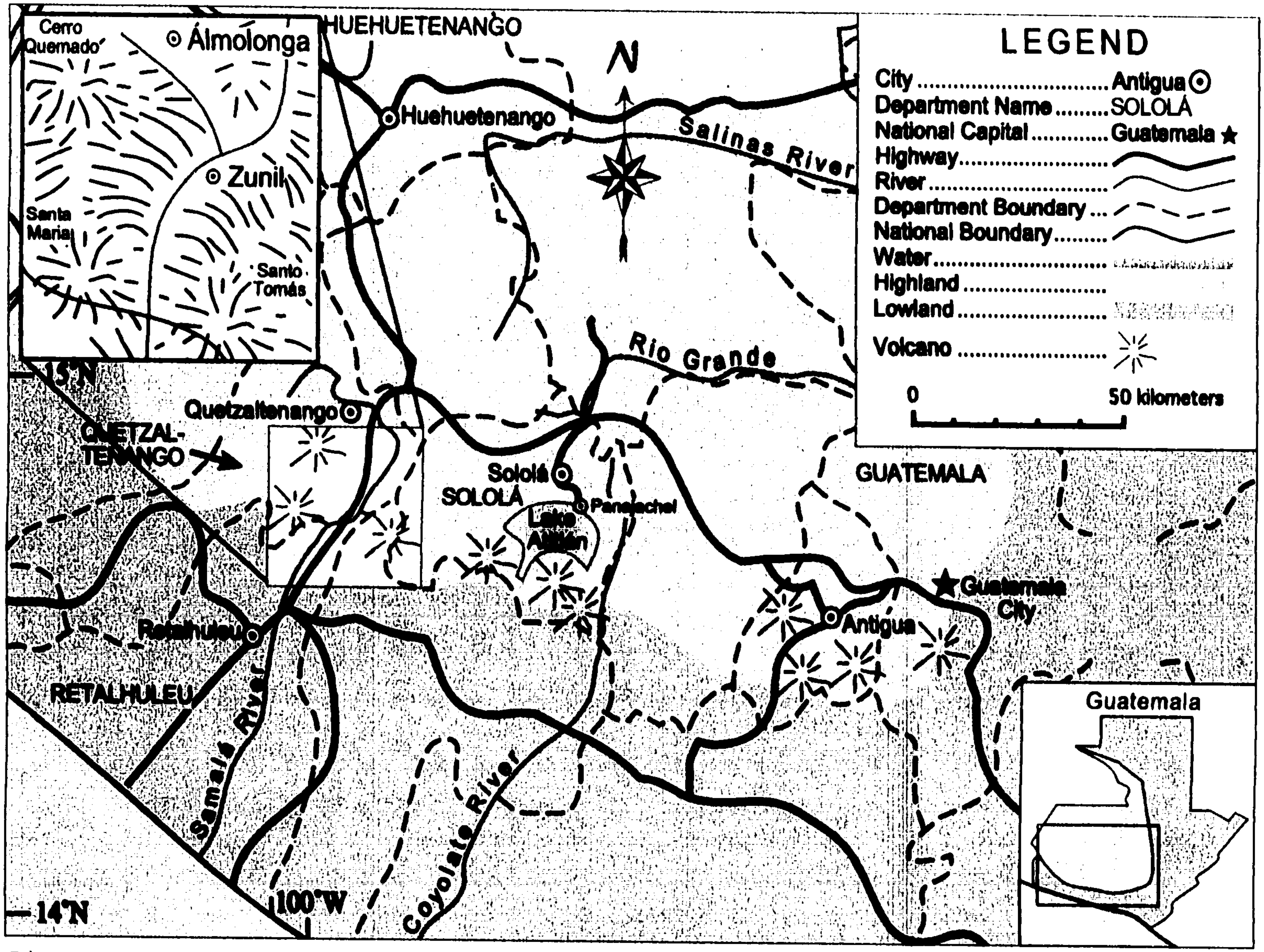

Figure 1. Map: Southwestern highlands of Guatemala.

An exception to the typical spatial separation in cultivation strategies between hillside and valley agricultural systems was discovered in a hillside region to the south of the *municipio* of Zunil. This area is home to a mix of both *milpa* and vegetable production that is supported

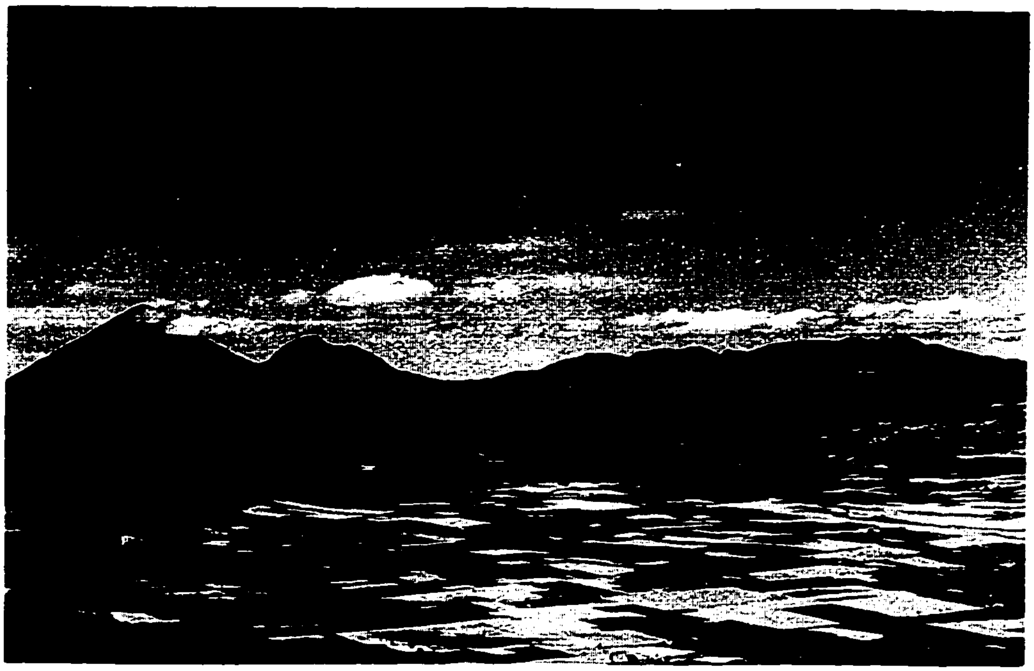

Figure 2. Basin of Quetzaltenango as viewed from the northeast.

by an innovative irrigation network. Gravity-powered irrigation systems utilizing PVC pipe tap a perennial water supply high in the mountains and divert water to hillside fields. The presence of vegetable production in a

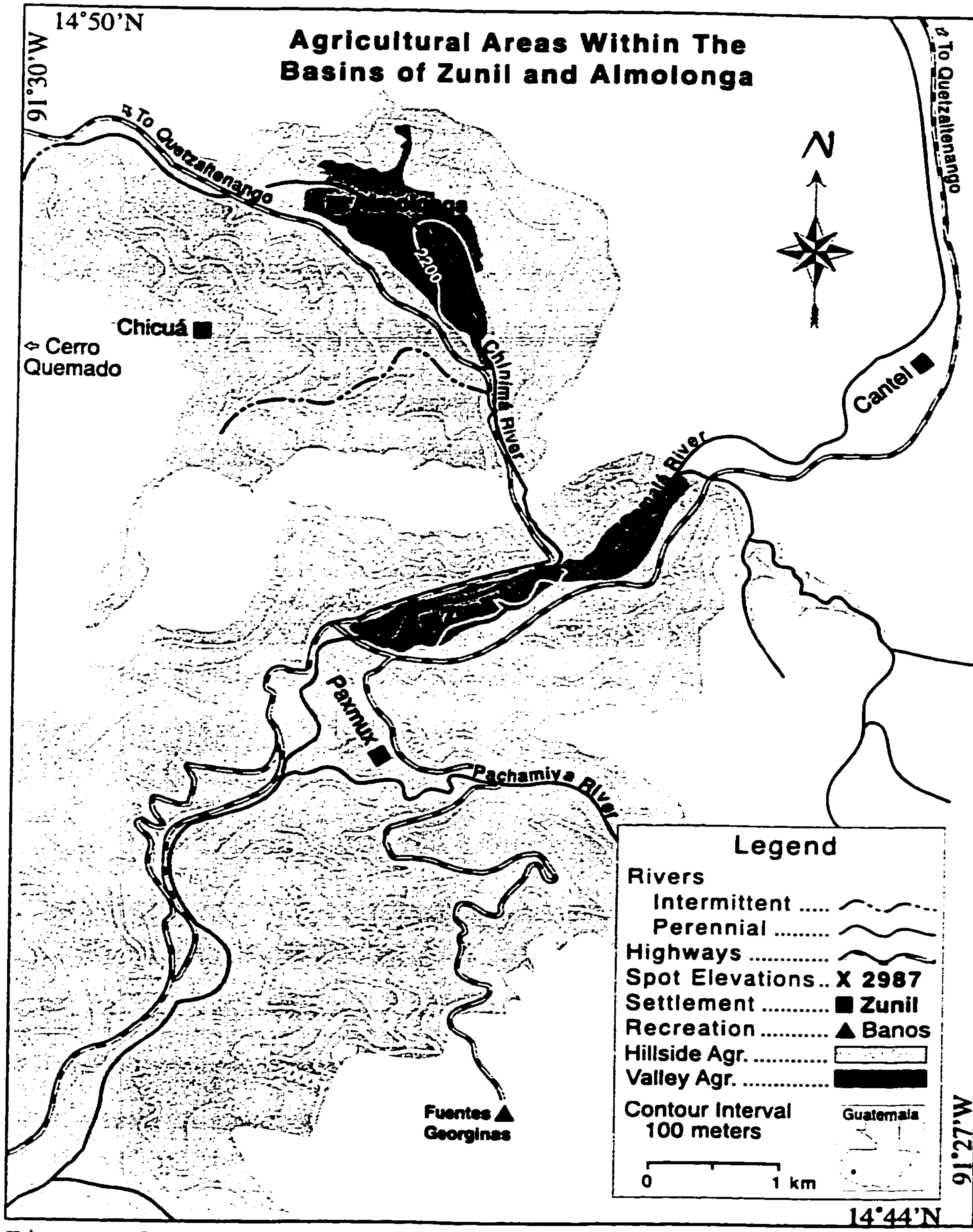

Figure 3. Map: Basins of Almolonga and Zunil.

perennially watered hillside region, in comparison to the distinct separation between agricultural systems throughout the rest of the region of study, suggest that spatial variations in water availability are manifest in crop selection strategies. Based upon these observations, it was theorized that local differences in hydrology were responsible for the variations in crop location. As a result, this study analyzed cultivation strategies between and within the hillsides and valleys of the *municipios* of Almolonga and Zunil with respect to reliability and allocation of the water supply during the dry season.

The contrast between subsistence versus commercial agricultural production in Almolonga and Zunil is a reflection of a national issue within the highlands as more regions are attempting to supply fresh vegetables. As these regions convert to commercial agricultural production, use of agro-chemicals and inclusion in the debt economy will rise as well. The reliance of the peasant class upon uncertain commercial prices for their crops could place the poor in an even more vulnerable position. Examination of the interaction between these agricultural systems on a local level will aid in the understanding of the future of Guatemalan highland agriculture.

Chapter Two - A Geography of Southwestern Guatemala

Southwestern Guatemala is a region of contrast characterized by the relatively uniform Pacific coastal plain, the gradually increasing altitude found in the piedmont, and the widespread mountains and volcanoes of the highlands. The extreme topographic relief of southwestern Guatemala influences the formation of numerous microclimates that, in turn, allow for the cultivation of a variety of crops. Examples of these systems are lowland rubber plantations, piedmont coffee plantations, and in the highlands, *milpa*, flowers, and vegetables.

A broad coastal plain, traversed by several rivers, defines the Pacific shore of the nation. Considerable agricultural production is found on the coastal plain. Though much produce is destined for export, the population centers of the highlands utilize a good deal of the agricultural production of the coastal plain. Consequently, transportation corridors between the highlands and the coastal plain are crucial to the regional economic geography.

Along the coastal plain there are few natural routes to access the rugged highlands (see Figure 3). A small number of bridges cross the rivers, concentrating transportation at a few key locations. McBryde (1947), when he described the terrain of this region, stated, "Except for limited plateau areas, and the open, level basin around Quetzaltenango, the Highlands may be characterized as a land of barranca (ravine or gorge) landscapes in dissected mountains" (p. 6). Most transportation routes between the highlands and lowlands have been established through these gorges.

Volcanic and Tectonic Activity

The importance of volcanism and tectonically influenced topography cannot be overstated in this region. An active volcanic arc created by subductive tectonic activity between the North American, Caribbean and Cocos plates, crown the highlands of Guatemala. A trench, marking the subduction of the Cocos plate beneath the Caribbean plate, lies offshore paralleling Guatemala's western coast. The active volcanic arc of the highlands, along with an ancient extinct volcanic arc further inland, lie parallel to this subductive trench. Historically, the Department of Quetzaltenango has been significantly influenced by volcanic and tectonic activity.

The proximity of the department to active volcanoes and earthquake faults (McBryde, 1947) has greatly influenced the geological and cultural histories of the region.
Disruptions upon the landscape in the form of earthquakes,

Figure 4. Terrain of the highlands east of Lake Atitlán.

lava flows, ash clouds, and other pyroclastic events have been common and, at times, catastrophic.

In reference to the history of volcanic activity in Guatemala, Conway, Johns, Paniagua, Rose, and Vallance (1992) reported that "subduction related volcanism began in Guatemala in early Miocene times (Reynolds, 1987). Volcanism of the middle Quaternary (roughly 500,000 yr. B. P. to 84,000) was characterized by voluminous ... eruptions" (p. 304). Evidence of these Pleistocene eruptions, in the form of calderas such as Atitlán, Almolonga, and Quetzaltenango, are found along the path of the active arc. The extinction of the ancient arc was followed by the emergence of a new arc parallel to the ancient one and closer to the Pacific coast. "The ages of ... the present arc are poorly known, but are probably all younger than 50,000 years old" (Conway et al., p. 304).

Climate

Climatic variations associated with altitude are significant in southwestern Guatemala. Human populations are well adapted to the variations in climate as are the crops they cultivate. Each crop has distinctive temperature and rainfall needs, which help delineate the altitudinal zonation of southwestern Guatemala.

Environmental conditions in the Guatemalan highlands, in the opinion of McBryde (1947), could hardly be better for human habitation. "The high basins...offer almost ideal conditions for human settlement, with cool climates the year around, volcanic ash of enormous depth, which weathers to excellent soils, and abundance of streams, fed by heavy rains from May through October" (p. 6). The Köppen climate type for the highlands, provided by McBryde, is "*Cwg*": "*C*" describes "mesothermal" with mean temperature of the coldest month less than 18 °C (66.4 °F), but more than -3 °C (26.6 °F); "*w*" is defined as winter dry with nearly all rain coming during summer months; and "*g*" identifies ganges type with the hottest month coming before the summer solstice. Subtle variations of the Köppen classification for the Guatemalan highlands, as applied by McBryde, are found throughout the region.

Milpa

Farming methods and maize are well adapted to the climatic variations in the highlands. Many sub-species of maize, each adapted to unique climatic and temporal niches, are available for varying cultivation strategies. Within present-day highland Mayan communities *milpa* is the dominant agricultural system whose origins are estimated as far back as 3000 B.C. (Morley, 1947). Horst (1989, p. 13) defined *milpa* as a form of traditional subsistence agriculture consisting of various species of maize, intercropped with beans (European broad bean and black bean) or squash (*mocun* and *chilacoyote*). In regard to the antiquity of *milpa* agriculture, Harrison and Turner (1978, p. 14) stated "maize was important to the Maya and has been cultivated in the lowlands since Preclassic [2000 B.C.] times if not earlier."

The longevity and popularity of maize cultivation was described well by Stadelman (1970) when he wrote:

> Among the mass of uncertainties regarding the early history of Indian corn the following points are worthy of credibility: that maize has been under cultivation for a very long time; that it was the chief food source throughout a large part of aboriginal America and was directly responsible for the development of the great pre-Columbian civilizations; and that it is still the most important agricultural product of the New World. (p. 91)

The persistence of the *milpa* in local agriculture is reinforced by its historic role in the welfare and development of the Mayan community.

The origin of maize is much discussed in academia. The prevailing opinion is that maize originated from an annual variety of the wild grass, *teosinte* (*Zea mays* subsp. *parviglumis*) found in Central Mexico (Smith, 1995). The present distribution of *teosinte*, from Mexico City to Honduras, consists of several varieties of this wild grass (e.g., *Zea perennius*, *Zea mays* subsp. *mexicana*). *Zea mays* subsp. *parviglumis* has been genetically tested by Doebley (1990) and, in comparison to other varieties of *teosinte*, confirmed to be the closest relative to present day maize. If the origins of maize can be attributed to Central Mexico, then it is no wonder that *milpa* agriculture infuses present-day culture and folklore of Meso-America.

Mayan mythology claims humanity originated from the *milpa* and is bound within a cyclical relationship of death, fertilization, rebirth, sustenance, and again death. *Milpa* agriculture has evolved with Mayan culture and historically they certainly seem inseparable. The city-states that governed Mayan culture have long since been abandoned (Morley 1947), yet the cultivation of the *milpa* in the modern community has persisted.

The *milpa* is more than a simple cropping system cultivated to feed the family. Respect and reverence are reserved for maize, as evidenced within the rituals and customs of the Mayan community. For example, farmers of Zunil and Almolonga occasionally cultivate a few stalks of maize in a field of a different crop group (e.g., vegetables or flowers), perhaps signifying fertility with its presence.

Horst (1989, p. 21), in his discussion of the persistence of *milpa* agriculture, hypothesized a "*hut-milpa*" relationship where homes were frequently surrounded by *milpa*, while fields of wheat were located away from the home. Horst went on to argue this may have had something to do with the harvest of the *milpa* throughout the growing season. *Milpa* produces only one harvest of mature corn per year. However, during the seven-month maturation period of maize, a good deal of produce is gleaned. In reference to the season-long harvest of the *milpa*, Horst wrote the following:

> In early to mid August immature beans (ejote) and broadbeans may be sold or become a part of the family fare. Two weeks later the peasant is afforded the luxury of consuming immature ears of maize (elotes), either boiled or served in a thick gruel called atole. (1989, p. 23)

The persistence and cultural importance of the *milpa* is due, in some measure, to the trust placed upon it to provide food until the final harvest at the beginning of the dry season and to its integration with the household throughout the growing season. When delineating the utility of *milpa*, Horst (1989) stated "the *milpa* is a horticultural unit, comparable to the kitchen gardens that once graced the doorsteps of rural American homes" (p. 23). Despite the persistence and utility of the *milpa* in the lives of the Guatemalan highland farmers, the government has pushed for increased production in wheat at the expense of *milpa* (Horst, 1987). In spite of this, *milpa* has survived. In fact "the *number* of peasants devoted to the cultivation of *milpa* continues to increase notwithstanding either a decline or significant lack of expansion in acreage devoted to *milpa* agriculture" (Horst, 1989, p. 25).

Other forces have influenced the persistence of *milpa* agriculture in the highland economy. "In 1902 a volcanic eruption blanketed the southern sector of the region [basin of Quetzaltenango] with a thick cover of pumice. Although *milpa* agriculture was ultimately reestablished it brought to an end the production of wheat" (Horst, 1987, p. 9). This case illustrates how the agricultural systems of the highlands are influenced by the dynamic physical geography of the region.

Rainfall periodicity plays an important role in the cultivation strategies of highland farmers. "A pronounced dry season from November to May makes irrigation mandatory for year-round cropping and advisable on a standby basis even during the rainy months" (Wilken, 1987, p. 180). In areas where it may be economically unfeasible to supply water, through one form of irrigation or another, crops will be planted acknowledging an approximate seven-month growing season that coincides with the rainy season. A scenario that illustrated how maize was used to mitigate unexpected environmental conditions was described by Horst (1989). "If an initial planting of maize fails because of frost or lack of rainfall, the milpa is replanted in a variety that may be lower yielding, but that allows for a harvest within the span of a shortened growing season" (p. 25).

Flowers

The abundance of flowers in the Guatemalan highlands is an endearing aspect of the landscape. The variety of cultivated species, particularly calla lilies, asters, and baby's breath (see Figure 5), add color to the markets and fields, rivaling the vivid hues of Mayan clothing. Flowers are typically cultivated in areas dominated by *milpa* agriculture. Consequently, flowers and *milpa* are competitors in a spatially limited agricultural landscape.

Like *milpa*, flowers are grown with ceremonial significance and are sold in the local markets, especially on holidays such as *El Dia de los Muertos* (Day of the Dead)

Figure 5. Vegetables, *milpa*, and flowers in the *municipio* of Almolonga.

on October 31st and *Todos Santos* (All Saints Day) on November 1st. During *El Dia de los Muertos*, the tombstones in the cemeteries are painted in pastel colors and flowers are laid on the graves of friends and family. Flower production may be seasonal in response to the periodicity of these holidays.

Vegetables

The agricultural system defined in this paper under the term *vegetables* consists of many species. Some of the vegetables grown include European broad bean, broccoli, beet, cabbage, carrot, radish, onion (see Figure 6), potato, leek, and cauliflower. Other crops such as Swiss chard, mint, *ruda* (medicinal herb), celery, watercress, and *cilantro* are grown along the margins between fields and canals.

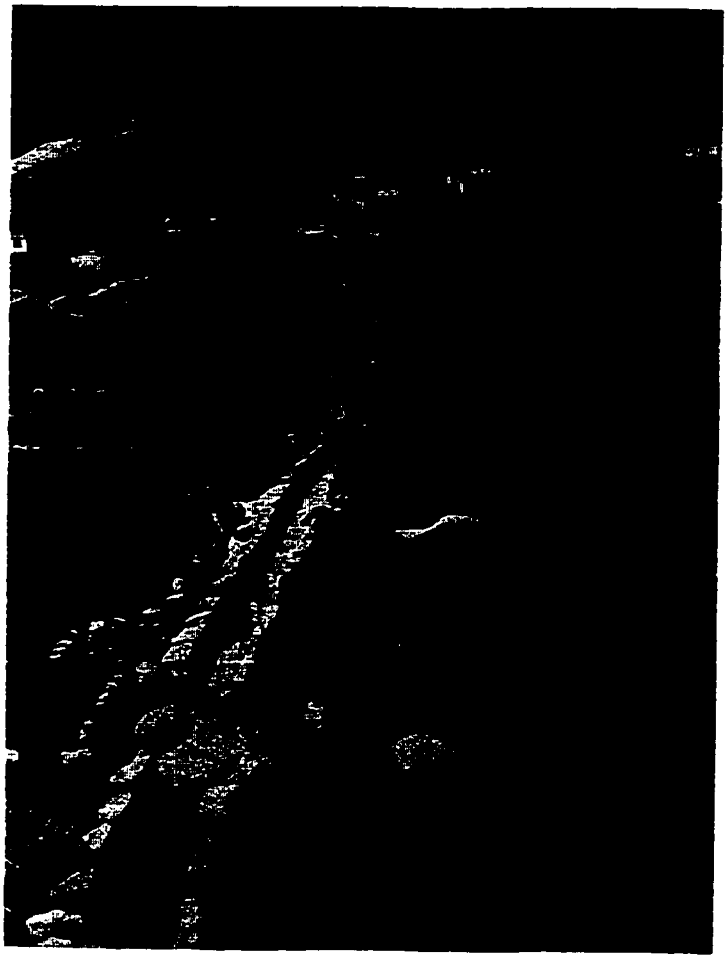

Figure 6. Pozos, canals, and vegetables in Zunil.

Information on the history of vegetable production in Guatemala is scarce, but much speculation exists. Early accounts of vegetable production in highland Guatemala refer to two areas: Almolonga/Zunil in the Department of Quetzaltenango, and Sololá/Panajachel, in the northern part of the Lake Atitlán basin, in the Department of Sololá. The Sololá/Panajachel area is home to the *tablón* or raised field agricultural system. Mathewson (1984), while discussing the antiquity of *tablón* agriculture in the Sololá/Panajachel region, stated:

> Quite likely, tablones were used by highland Maya for intensive vegetable gardening in a manner not unlike they are used today. The assemblage of crops would have been different, but not radically so. Humboldt (1966:274) felt that aboriginal Americans grew onions and possibly garlic: "We know with certainty that the Americans have always known the onion (in Mexican, Xonacatl)." Therefore, even the dominant crops of the Panajachel area may have been present in pre-Columbian times. (p. 19)

The antiquity of vegetable agriculture in the Almolonga/ Zunil area was supported by the Asociacion para el Avance de las Ciencias Sociales en Guatemala (1996). "In their work *Recordings of Flora*, Fuentes and Guzman (1690) described Almolonga as a place abundant in grains, birds, and vegetables" (p. 3). In reference to the findings of a survey by Gall in 1881, the Asociacion para el Avance de las Ciencias Sociales en Guatemala added, "there are small swamps and some areas with corn, cabbage and onions" (p. 4).

Additional information on the history of vegetable agriculture in Almolonga and Zunil was provided by Horst (1982), when he wrote, "in the 1870's the involvement of Europeans in establishment of coffee fincas on the nearby Pacific piedmont generated a demand for vegetables that came to be provided for by the peasants of Almolonga" (p. 53). Information from Horst on the emergence of the Almolonga/Zunil region as a significant contributor to vegetable production in highland Guatemala differ with the dates provided by McBryde (1947):

> Other than the Sololá-Panajachel area, there is only one major vegetable producing center in Southwest Guatemala, namely, Almolonga, in a tributary valley of

> the Rió Samalá, southeast of Quetzaltenango. This is said to be a recent center-important only since about 1910. (p. 31)

McBryde's assertion that the historic production of vegetables in the Almolonga/Zunil region has been "important only since about 1910" does not account for the dates given by Horst and the Asociacion para el Avance de las Ciencias Sociales en Guatemala (1996).

In any case, transportation of vegetables from this region of Guatemala eventually moved into foreign markets. According to the Asociacion para el Avance de las Ciencias Sociales en Guatemala (1996, p. 5), exportation of the produce of Almolonga and Zunil, to Mexico and El Salvador, began sometime after 1930 and prior to 1945. Horst (1987, p. 6) reported that during World War II, vegetables were produced for export to the defense forces deployed at the Panama Canal Zone.

Vegetable production continued to expand as a commercial crop throughout the Guatemalan highlands after World War II. Research by Mathewson (1984, p. 13) showed that as of 1974, *tablón* culture vegetable production had spread into four areas: Antigua, Huehuetenango, Panajachel/Sololá, and Almolonga/Zunil in the Quetzaltenango region. Currently, vegetables are being produced in the areas mentioned above as well as other more recent areas such as San Carlos Sija, a community residing a short distance north of Quetzaltenango, and La Cienaga, a former outlier of Quetzaltenango, which has become an agricultural island in the urban community. Coincidentally, all of these vegetable-producing regions are near major transportation corridors (see Figure 1).

Chapter Three - Agricultural Geography of the Basins of Almolonga and Zunil

The *municipios* of Almolonga and Zunil are small agricultural communities (see figure 7) growing vegetables, *milpa*, and flowers in varying spatial patterns. The proximity of Almolonga and Zunil to one of the few major transportation corridors between the lowlands and highlands, and to Quetzaltenango, a historically significant market for their products, probably stimulated the progressive agricultural innovation of these *municipios*. This innovative history in turn has helped to develop one of

Figure 7. Quiché family from Almolonga.

the most complex and distinctive agricultural landscapes of Guatemala.

Almolonga

The landscape of the basin of Almolonga is dominated by the irrigated valley, which stands out as a discrete agricultural area (see Figure 8). In the winter, the valley

Figure 8. Basin of Almolonga, view from the west.

is a vibrant green in comparison to the brown, maize-covered hillsides. This scene is visible from many vistas along the perimeter of the basin (i.e., from the northwest, along the road to the hamlet of Chicúa: see figure 3 and figure 5). The color of the bottomlands in Almolonga is the result of the intensive year-round vegetable agriculture. Vegetable fields are supported by a perennial water source, the Chinimá River, which enables the valley floor to be irrigated in the dry winter months as well as periods of inadequate precipitation during the rainy season.

The irrigated portion of the valley of Almolonga is three quarters of a kilometer at its widest point and runs for two and one-half kilometers of the five-kilometer valley. Throughout the irrigated valley of Almolonga, mini-canals or *zanjás* (no deeper than two feet) have been constructed. Other larger canals, which may be eight feet deep and equally as wide, are used for washing produce and possibly for quick discharge of severe storm waters to prevent large-scale flooding during the rainy season.

According to the Instituto Geográfico Nacional (1973a), intermittent streams bind all sides of the *municipio*. The lack of a perennial water supply apparently forces the slopes of the basin into a dry season fallow. During the rainy season, hillside fields are planted predominately in *milpa*, while vegetables and flowers compete for the remaining arable land. The hillsides are watered solely by the rain, which limits, due to the five-month dry season, the productive period of the hillsides to the rainy season.

During this dry-season the only sign of vegetables and flowers is the occasional unharvested plant, which may be left in the field to mature for seed (see Figure 9). The *milpa*, left to dry on the stalk until as late as January, dominates the hillsides of the Almolongan basin. The contrast in the spatial distribution of agricultural systems, as described in the basin of Almolonga, is not as distinct in the neighboring basin of Zunil.

Zunil

Agriculture practiced in proximity to and below the confluence of the Samalá and the Chinimá rivers are within the boundaries of the *municipio* of Zunil (see Figure 10). As in Almolonga, a system of canals along the valley is employed in support of vegetable agriculture. The mountains to the north of Zunil, a boundary shared by the two *municipios* under study and planted with *milpa*, lacked perennial streams and consequently were in dry season fallow at the time of the survey (see Figure 9).

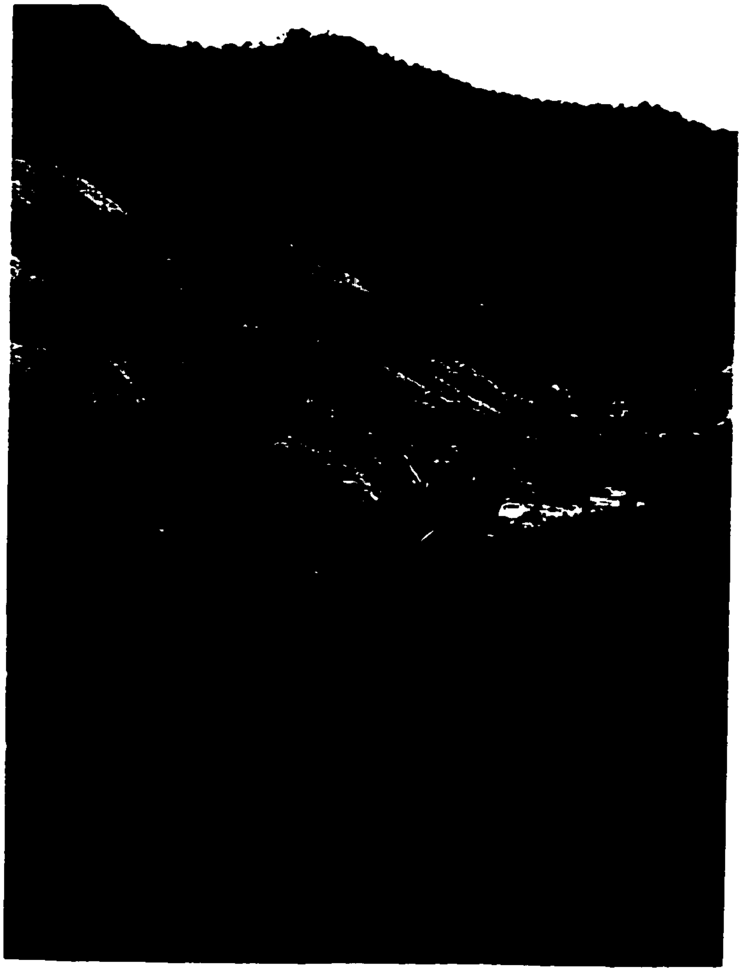

Figure 9. Vegetables of the southern hillside of Zunil.

Interestingly, this is not true of the mountain slopes to the south of Zunil. The southern hillside of Zunil has a perennial water supply and a more varied system of agriculture. Three of seven streams contained within the southern territory of the *municipio* are perennial (Instituto

Geográfico Nacional, 1973b). Local farmers utilize these perennial streams as a dry-season water supply (see Figure 3). As a result, the mountain slopes to the south of Zunil are host to a year-round intensive system of vegetable agriculture and wet-season *milpa* cultivation. The farmers of this area have constructed small-scale dams, canals, paddies, and other elaborate irrigation technologies and networks in an effort to distribute and manage their perennial water resources.

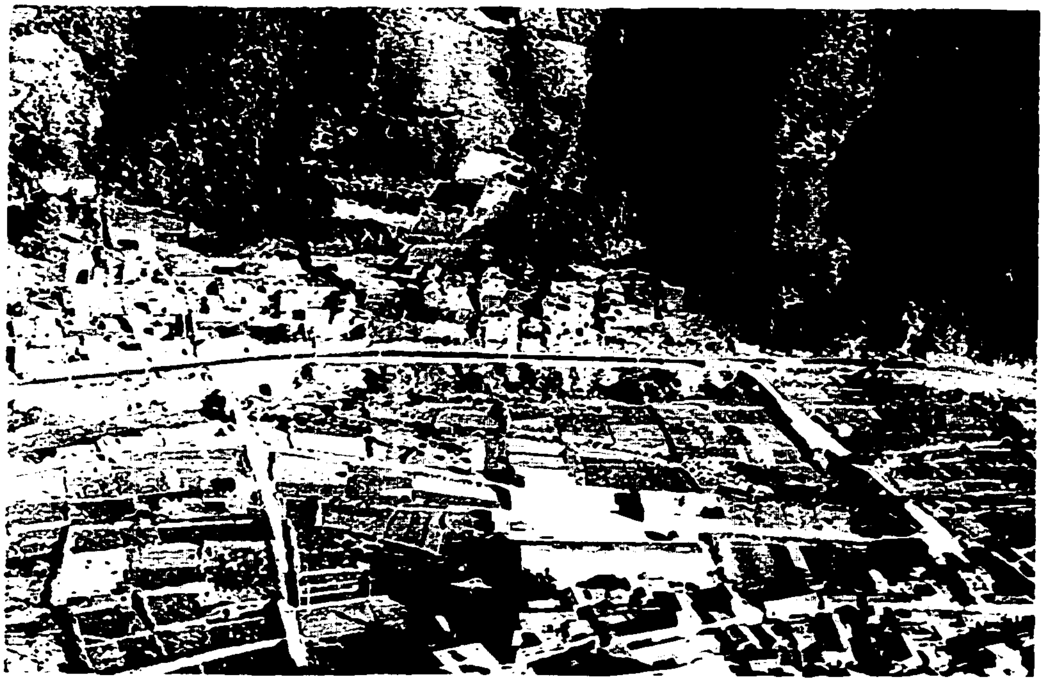

Figure 10. The *municipio* of Zunil, a planimetric perspective.

Factors Influencing Agricultural Systems

The selection of crops for agricultural systems is influenced by many different factors in the physical and cultural environment. Uhlig (1995, p. 200), in his comparative analysis of high mountain agricultural systems in the European Alps and the Himalayan Arc, and Wilken (1987, pp. 1-9) in his observations of Mesoamerican agricultural systems, described factors influencing crop selection strategies that have been summarized in Table 1.

During the course of the field research, an evaluation of the influences of the factors noted in Table 1 was undertaken in order to better understand the morphology of agricultural systems in the basins of Almolonga and Zunil. The need for this examination was based on the observation that within the basins of Almolonga and Zunil each of the factors listed in Table 1 played differential roles in crop selection strategies. While all of the factors in Table 1 have influenced cultivation strategies to some degree, transportation corridors, volcanic activity, soils, climate, and water availability appeared to exert the most significant influence upon the unique spatial cropping patterns found in this region.

Table 1

Influences upon Cultivation Strategies within Agricultural Systems

Ecological	Socioeconomic
Degree of slope	Ethnic and social organization
Altitude	Economic practices
Relief	Adaptation strategies
Water reliability	Distance from the village
Climate	Transportation corridors
Geology	Cultural tradition
Soil	
Presence of rocks	
Orientation	
Vegetation cover	

Note. Table based on studies by Uhlig (1995, p. 200) and Wilken (1987, p.45).

Transportation Corridors

One of the busier transportation routes, following the water gap formed by the Samalá River, is the highway from Retalhuleu, on the Pacific coastal plain, to the highland home of the second largest city in Guatemala, Quetzaltenango (McBryde, 1947). The agricultural communities of Almolonga and Zunil are situated in a prime location to maximize the opportunity provided by the transportation corridor.

Produce can be transported easily to the coastal plain for sale or export, or to Quetzaltenango and other markets.

Neither *municipio* enjoys a significant advantage in this respect. Almolonga, located in a tributary basin of the Samala River basin, is a few kilometers closer to Quetzaltenango, but Zunil is located on a quality highway that runs directly to the regional economic hub. Access to the Pacific coastal plain is once again a matter of kilometers with Zunil having a small advantage. In both cases, situational differences were minimal and do not support the conclusion that proximity to either the market or the transportation corridor has differentially influenced cultivation strategies.

Volcanic Activity

The course of the Samalá River and the highway paralleling the river are defined by the volcanoes Santa Maria (elevation 3,772 m) northwest (see Figure 11), Santo Tomás (elevation 3,505 m) southeast, and the "inactive" Cerro Quemado (translated as "burnt hill," elevation 3,179 m) to the north (see Figure 2). Further upstream along the Samalá River, past the bases of the Santa Maria and Santo Tomás volcanoes, are the *municipios* of Zunil (elevation

2,077 m) and Cantel (elevation 2,300 m), followed by Quetzaltenango (elevation 2,000 m; see Figures 2 and 3).

The nearby volcanoes influence the basins of Almolonga and Zunil positively and negatively. Each *municipio* receives deposits of ash and pumice from time to time that, over the long run, fertilize the soil and enable the farmers

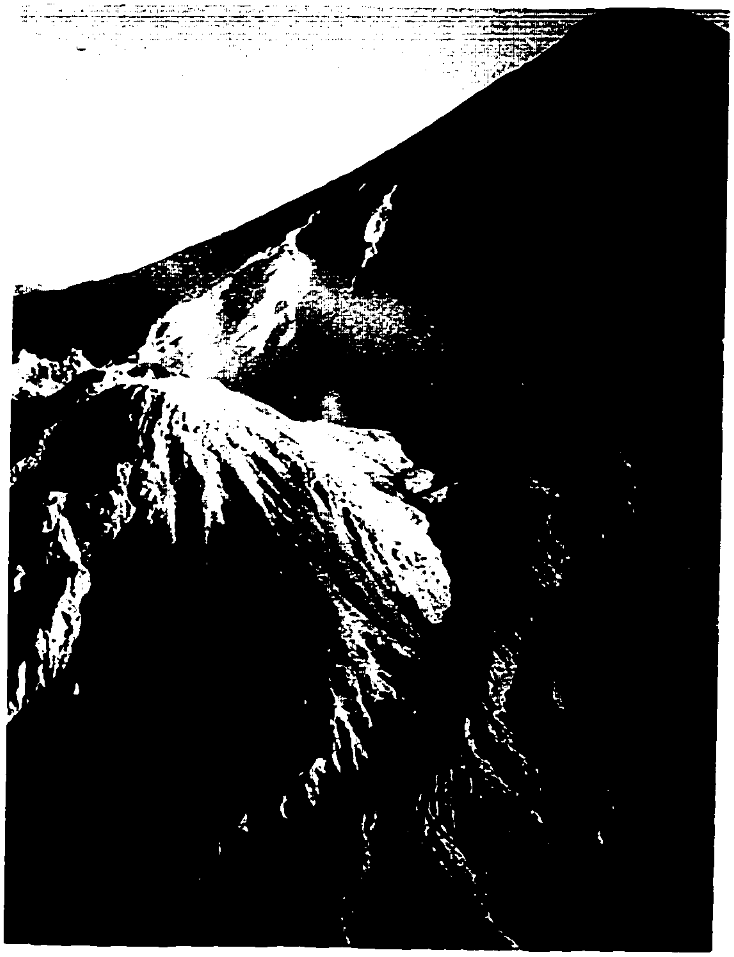

Figure 11. Santa Maria Volcano.

to operate an intensive agricultural community. Almolonga and Zunil appear equally influenced in this respect.

The volcanoes remain a source of concern for residents of the Department of Quetzaltenango. Both Almolonga and Zunil lie at the foot of Cerro Quemado and are relatively equidistant to the active Santa Maria volcano. Santa Maria's last major eruption in 1902 "blanketed a large expanse of the southern portion of the region with up to four feet of pumice" (Horst, 1989, p. 15). In addition to the activity of Santa Maria, the volcano "Cerro Quemado last erupted in 1818 A.D., producing a lava flow that extended 2.5 km to the east and a blanket of tephra up to a meter thick" (Conway et al., 1992, p. 304). Events of the later Holocene attributed to Cerro Quemado have influenced the course of the Samalá River. "The Paxmux flow (Qpa) extends 2.5 km from its vent 0.5 km east of the dome and temporarily dammed the Rió Samalá" (Conway et al., 1992, p. 305). Evidence of a dam exists in the form of a waterfall supported by erosion-resistant rock crossing the Samalá River less than a kilometer downstream from Zunil.

<u>Soils</u>

The modification of soil properties is an area in the agricultural geography of this region where both nature and culture influenced the development of agricultural systems. Wilken (1987) qualified this expectation when he wrote of Almolongan soil properties:

> The artificiality of valley-floor soils complicates analysis and discussion. Basically the soils consist of the same volcanic materials found in the hills but modified by alluvial deposition to form complex mixtures. The real differences, however, are due to human alteration. (Wilken, 1987, p.43)

The word "*artificiality*" in the statement above refers to the composition of the valley-floor soils as a result of the addition of amendments such as organic and inorganic fertilizers, leaf litter, sand, or ash (Wilken, 1987). This statement supports the conclusion that farmers have altered the soils within the basin of Almolonga. In fact, according to Wilken, "Almolongans are masters of soil and water management in their valley-floor fields" (p. 41).

Hillside fields are rarely terraced even though slopes range from moderate to steep. Fortunately "the hill soils do not appear especially erodible, possibly because generally high porosities limit surface runoff" (Wilken, 1987, p. 41). Wilken quantified the upper limits of cultivation in the basin of Almolonga at 2,400 meters. Travelling perpendicular from an elevation of 2,190 meters on the Chinimá River, to the 2,400-meter elevation of the hills to the east, the average slope is 21%. Beyond this elevation the slope steepens and agriculture is replaced by conifer forest (see Figure 8).

The practice of soil modification would seem to eliminate soils from consideration as a primary agent of differential influence. If soils could be modified to accommodate vegetable production, why is the current area under vegetable production clustered in the valleys of the two basins and the southern hillside of Zunil? Intensive soil modification would be undertaken in areas where *milpa* currently dominates the local agricultural landscape, if enough benefit could be gained by altering the soils to allow for the cultivation of vegetables. The presence of vegetable agriculture within the hills to the south of Zunil, combined with its absence in the hills to the north, suggests something other than soil has contributed to the spatial variation of agricultural systems in the two *municipios*.

Climate

Climatic variations near Almolonga and Zunil are common. Mathewson (1984) referred to the influence of climatic variation upon cultivation strategies between the agricultural systems of Almolonga/Zunil and Sololá/Panajachel when he wrote:

> The Almolonga tablones occur at 2,300 m, and in Zunil they are above 2,000 m (McBryde, 1947:32). On the flood plain of the Panajachel River they occur between 1,570 m and 1,600 m ... most of the popular European vegetables are best adapted to temperate or cool climatic conditions. Therefore, it is not surprising that the Almolonga/Zunil area specializes in European introductions. (p. 18)

The Köppen classification for Almolonga and Zunil is "*Cwbgn*". The "*b*" indicates cool summer with the mean temperature of the warmest month less than 22 °C (71.6 °F), and "*n*" indicates frequent fog. The addition of the frequent fog classification to the Almolonga and Zunil area may refer to the rain shadow provided by the mountains of the northern Almolongan basin. Humid air masses from the

Pacific coastal plain frequently move up the Samalá River canyon in the afternoon placing thick fog over the region. Apparently the fog cannot progress past Almolonga due to the mountains separating this *municipio* from Quetzaltenango.

From the slopes of Cerro Quemado above the *caserio* of Chicuá (see Figure 3), wisps of clouds have been observed to move vertically up the gorges dissecting the volcanic field. The albedo of the reddish-gray rock of the volcanic field may have a strong influence on the air currents in the region. As the air heats and rises through convection, it may pull air masses into the Almolongan basin and up the slopes of Cerro Quemado. Both basins may benefit from the moisture released by the rising air currents.

According to Mathewson, in his discussion of regional agricultural specialization, the altitudinal differences between the Almolonga and Zunil are not great enough to encourage unique agricultural practices. Mathewson noted climatic differences exist between the Sololá/Panajachel and Almolonga/Zunil regions, but he did not mention a significant difference between the two basins under investigation. Observations by this researcher reinforce Mathewson's observation that the basins of Almolonga and Zunil do not appear to have any significant variations in climate or rainfall. The lack of variation in climate and rainfall between the two basins suggests that neither of these factors are a significant influence upon cultivation patterns.

<u>Water Supply</u>

The water supplies for the two basins have similarities and differences. Both basins have a perennial source of water running through their respective valleys, with the Samalá River flowing through Zunil and the Chinimá River flowing through Almolonga. In like turn, the hillsides of Almolonga and the hillsides to the north of the Samalá River in Zunil are fed by intermittent streams (Instituto Geografico Nacional, 1973a; 1973b). A unique area, the southern hillside of Zunil, was found to possess a perennial water supply and an unusual mix of vegetable and *milpa* agriculture.

The presence of perennial streams along the southern hillside of Zunil, combined with the presence of dry-season vegetable agriculture, heretofore not found in a hillside region, suggested that cropping patterns should be looked at in comparison to the spatial distribution of the water supply variable. That is not to say that other factors examined in this section: landforms, soils, and climate do not play important roles. At issue is whether any of the factors exert a greater influence in one basin versus another. Based upon field research, the influence of water supply upon cultivation strategies was determined to be the most significant factor influencing agricultural practices of the basins of Almolonga and Zunil.

Irrigation Technologies

In the highlands of Guatemala water is a precious commodity due to the severity and reliability of the dry season. The methods of water disbursement utilized in the *municipios* of Almolonga and Zunil are splash irrigation from pozos and canals; sprinkler irrigation from pumps and gravity-fed pipes; and flood irrigation. The *municipios* of Almolonga and Zunil (see Figures 5 and 11) differ considerably with regard to the availability and spatial distribution of these resources and technologies.

Splash Irrigation.

Splash irrigation is the direct application of water to crops using a shovel-like paddle (*pala*) to throw water throughout the field. Water for splash-irrigated fields is contained within either rock (see Figure 6) or cement-lined bowls (see Figure 12), called *pozos*, or in the canals bordering splash-irrigated fields. Figure 13 illustrates the technique of splash irrigation.

Wilken (1987) defined the spatial dynamics of splash irrigation when he wrote, "Because water cannot be scooped or thrown in any volume or with any accuracy more than 10 m, it must be available immediately adjacent to planting

Figure 12. Cement pozos of Almolonga.

surfaces" (p. 185). Due to these limitations it is likely that splash irrigation strongly influences the size and shape of fields. When a field is splash irrigated from canals, the field tends to be rectangular in shape, aiding the watering of the entire parcel. Other influences besides throwing accuracy, such as the amount of force generated

Figure 13. Technique of a splash irrigator.

when attempting to throw water long distances, may have influenced canal-irrigated field dimensions. Increased force, potentially damaging to seedlings and contributing to erosion and compaction around the root ball of more mature plants, would be necessary to deliver water across increasing distances.

Sprinkler Irrigation

Almolonga and Zunil utilize sprinkler irrigation as a method of water dispersal. Zunil uses a gravity-fed system while Almolonga relies upon motorized pumps. The location of water relative to the field forces Almolongans to tap aquifers, while the residents of some areas of Zunil benefit from streams at elevations higher than their fields. In the hills to the south of Zunil the cultivation of vegetables appears to be tied to the presence of PVC irrigation systems, introduced to the region mostly during the 1980s, that tap water from springs emerging high above the fields.

As many as 250 small-scale, gravity-fed irrigation projects similar to the one currently in use in Zunil were initiated and supported throughout Guatemala from 1977 to 1989 by the United States Agency for International Development (USAID: Lebaron, 1994). Under this program, collectives of farmers interested in increasing the return provided by their water supply pooled resources to procure loans from the local governmental agricultural office. The loans paid for the installation of PVC irrigation pipe for use in gravity-powered systems of sprinkler irrigation (See Figure 14: Lebaron).

Figure 14. Sprinkler watering circles in Zunil.

Lebaron (1994) suggested that following the installation of the irrigation system "most groups [follow-up study participants] had moved steadily in the direction of increased production of vegetable crops for cash sale during the dry-season" (p. 16). Another important component of the USAID project was that the irrigation networks were to be maintained and owned by the users. No direct evidence was found indicating whether or not Zunil was a member of this program, though their irrigation system appears to mirror the design objectives mentioned by Lebaron.

In the case of Zunil, PVC pipe is tapped into perennial springs that emerge, several hundred meters or more, above the fields being serviced. The diameter of the pipe is gradually decreased from a maximum of eight inches at the source to one-half inch in the fields (standard units of measurement were used by the installers of the pipe to describe its dimensions). A problem with this system is the need to coordinate watering schedules daily and hourly to avoid decreases in water pressure due to excessive peak withdrawal.

Wilken (1987, pp. 158-159) discussed a similar problem in other irrigation systems where a daily rotation in water use was necessary to ensure an adequate supply for all. The case Wilken discussed, the Tehuacán Valley of western Mexico, operated on a larger scale both temporally and spatially, but the issue was the same; a limited supply of water was under heavy demand obligating the users to coordinate their collective consumption. In response to over-consumption, the people of Zunil have coordinated watering schedules to maintain quality access for all concerned parties.

Almolonga does not have a gravity-powered irrigation system to either side of the canal-irrigated valley. In Almolonga, though PVC pipe is present, the sprinkler irrigation systems in use are powered either by motor or hand pumps. The pump-fed sprinkler systems in the basin of Almolonga pull water from a well and pressurize a sprinkler system or a hose. In other cases water is sent to fill a *pozo* for splash disbursement. The reasons behind the use of different technologies in the two *municipios* are due to the spatial distribution of their respective water supplies.

In Almolonga, wells by necessity are located close to the irrigated valley, while the gravity-powered systems of Zunil tap springs originating hundreds of meters above the irrigated valley. The location of the wells appears to be linked to the depth of the local aquifer below the hillside fields. Based on informal conversations with Almolongan hillside farmers, it appears that well digging is cost prohibitive due to the aquifer depth. When hillside farmers were asked why they did not have wells they said, "the water is too deep, we cannot afford it."

Wilken (1987) speculated on other restrictions that contributed to under-utilization of technologies such as motorized pumps when he wrote:

> A few farmers are experimenting with pumps and spray nozzles to irrigate tablones at Almolonga. But it is doubtful that many duenos [farmers] hold enough land to justify the investment in pumps and hoses, and pump-operating expenses may be greater than manual-irrigation labor costs. (p. 188)

The speculations by Wilken on the economic feasibility of mechanized irrigation should not be considered without looking at the spatial distribution of water supplies in both basins.

The fields adjacent to the Chinimá River in the irrigated valley of Almolonga have a consistent water supply. As distance increases away from the Chinimá River, depth to the aquifer and water availability decreases as well. Consequently the placement of the few mechanized pumping devices in the basin are concentrated along the periphery of the area defined here, and illustrated in Figure 3, as the irrigated valley (Horst 1982).

Flood Irrigation

The third water distribution technique is flood irrigation. This practice was observed in the perennially watered hillside of the *municipio* of Zunil. A farmer constructed terraced paddies along the Pachamiyá River and was growing watercress in small plots no larger than 35 square meters with the total area being no more than 300 square meters (see Figure 15).

Almolongan farmers do practice a version of flood irrigation. Planted along the periphery of fields bordered by *pozos* and canals, water-loving plants such as watercress, mint, *ruda*, and Swiss chard are cultivated. The economic value of the flood-irrigated crops of Almolonga may not be significant in comparison to the rest of the production in the basin; however, the collective economic worth of periphery crops, based on the total production within the community, deserved mention.

Figure 15. Flood irrigation, the southern hillside of Zunil.

The irrigation systems used by the farmers of Almolonga and Zunil: splash, sprinkler, and flood, enable farmers to cultivate vegetables year-round on fields where flowers or *milpa* normally would be grown. As a result, in this region, commercial vegetable cultivation for local, national, and international markets has increased in popularity. The perennial water supplies, and the irrigation networks that distribute water to fields in both basins, appear vital to the development of the agricultural landscape of the region.

The distribution of irrigation technologies between the *municipios* of Almolonga and Zunil vary considerably in the hillside regions and less so in the valleys. The use of these technologies have allowed farmers to expand agricultural production through the dry season and provided a supplemental resource during dry periods in the wet season. The development of this opportunity may have influenced a shift in cultivation strategies.

Chapter Four - Statistical Analysis of Spatial Variations in Agricultural Production

Within the basins of Almolonga and Zunil dry-season water reliability appears to exert considerable influence upon the cultivation strategies of farmers. A field survey of two variables, crops and reliability of the water supply, was chosen to supplement the qualitative reasoning presented in the previous chapter. The purpose of the survey is to test whether a statistically significant relationship exists between those two variables.

Several factors influenced the selection of a survey methodology. Access to a significant percentage of the fields in the valleys of Almolonga and Zunil can be accomplished only by wading through the irrigation canals. The presence of signs warning against personal contact with canal water suggested that a remote survey be considered. Additionally, access to fields in both basins met with significant objection by the landowners. A survey by transect, for nominal data, was chosen because it negated these obstacles.

This survey of two variables, sampling for nominal data, suggests that the non-parametric Chi-square test for independence would be an appropriate method. Chi-square tests whether two mutually exclusive variables, reliability of the water supply and crop selection, occur independently from one another.

In preparation for the test, the basins of Almolonga and Zunil were divided, based upon reliability of the water supply, into four spatial classes: Almolonga Hills, Almolonga Valley, Zunil Hills, and Zunil Valley. The crop category is defined by four crop classes: vegetables, *milpa*, flowers, and fallow. Every field intersected by each transect was sampled and assigned to the appropriate crop and spatial class.

The boundaries for the spatial classes were defined by the origin of the water supply. If the water originated in the canal system in either *municipio*, then the field cannot be far above the primary perennial water source, the Samala River in Zunil and the Chinima River in Almolonga. Fields in this situation were placed in the valley class for their respective *municipios*. All other fields were assigned to the corresponding hillside category.

The Almolonga Hills class, situated to the east of the Chinima River, is watered intermittently and is dominated by *milpa* that is left to dry on the vine into the dry season. The Almolonga Valley class is fed by a perennial water supply, the Chinima River, and is dominated by year-round vegetable agriculture. The Zunil Hills, situated to the south of the Samala River is watered by a perennial source, the Pachamiya River. Vegetables and flowers are cultivated year-round with *milpa* devoted to the remaining fields. The Zunil Valley class is watered by a perennial source, the Samala River, and is dominated by year-round vegetable cultivation.

The field survey was initially conducted from a distance where the path of the entire transect could be viewed. The remote survey was followed by a proximate verification of the classification of each field. The purpose for this was to ensure an accurate tally by verifying the status of "fallow" fields, which often were planted in seedlings that could not be seen from a distance.

The Almolonga portion of the field survey was undertaken during December 1997. Three transects, A'-A*, B-B', and C-C', within the foothills below the southeastern ridge of the basin, completed the Almolonga Hillside survey (see Figure 16). A fourth transect, an extension of the A-A* transect, continued to the west, sampling the Almolonga Valley section. Thirty tallies per spatial group were

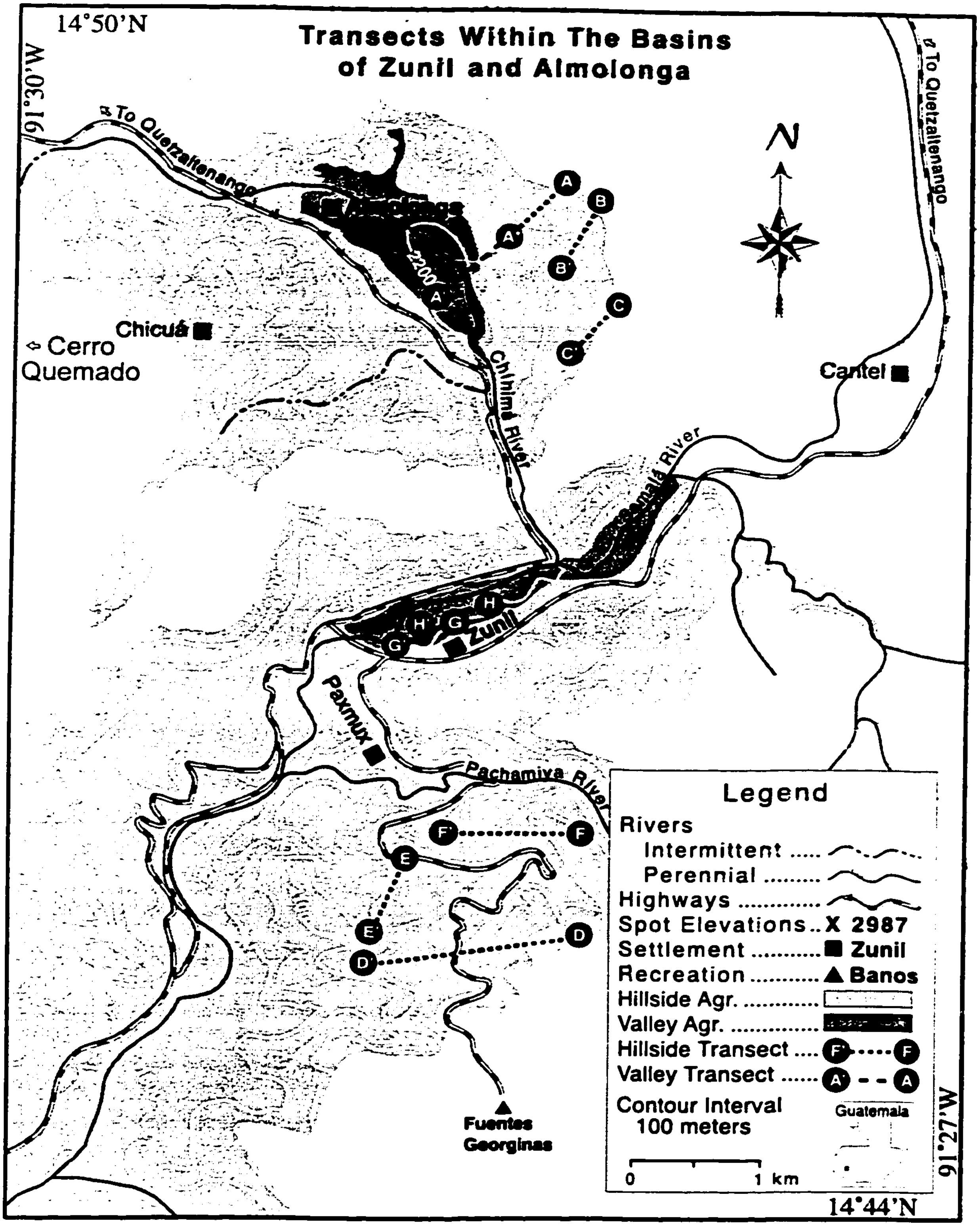

Figure 16. Transects within Almolonga and Zunil.

considered the minimum amount necessary to conduct a viable statistical analysis.

Zunil was surveyed in December 1997 as well, using the methodology established in Almolonga. Three transects in the hillside region and two in the valley were necessary in order to sample a similar number of fields among all of the spatial groups. The D-D′, E-E′, and F-F′ transects fell within the hillside class, while the G-G′ and H-H′ transects completed the Zunil Valley class.

Following the completion of the field survey an insufficient number of observations were determined to have been collected in the flower class across the entire spatial category. Consequently all tallies in the flower class were merged into the corresponding fallow class. The fallow class was chosen because many fields attributed to that class were often incompletely cleared of crops in a fashion similar to the incompletely harvested flower fields that lie fallow for the dry season.

The Chi-square test for independence compares a distribution frequency in a subset to the distribution frequency of the whole. If the assumption for the statistical test (all factors influencing cultivation strategies are equal throughout both basins) is true, then

Table 2

Chi-square Analysis of the Basins of Almolonga and Zunil

Hypotheses

Null: Location and crop type are independent events
Alternate: Location and crop type are not independent events

f_{obs} & f_{exp} (lower right in each cell)

	Milpa	Vegetables	Fallow	Total
Almolonga Valley	0 / *12*	37 / *27*	7 / *5*	44 / *44*
Almolonga Hills	32 / *9.55*	1 / *21.48*	2 / *3.98*	35 / *35*
Zunil Hills	16 / *14.18*	34 / *31.91*	2 / *5.91*	52 / *52*
Zunil Valley	0 / *12.27*	36 / *27.61*	9 / *5.11*	45 / *45*
Total	48 / *48*	108 / *108*	20 / *20*	176 / *176*

$(f_{obs} - f_{exp})^2 / f_{exp} = X^2$

Almolonga Valley	12	3.7	0.8	16.5
Almolonga Hills	52.82	19.52	0.98	73.33
Zunil Hills	0.23	0.14	2.59	2.96
Zunil Valley	12.27	2.55	2.95	17.77
Total	77.33	25.91	7.32	**110.56**

similar crop distribution frequencies should be found across all spatial classes. The greater the dissimilarity between the crop frequency of one spatial class with respect to the regional distribution, the higher the values will be in the chi-square matrix.

The final results of the field survey offered considerable insight into the relationship between crop selection and reliability of the water supply. The value of χ^2, 110.56, is significant at the .01 level (the critical value for α=.01 and *df*=6 is 16.81). Therefore, the decision was to reject the null hypothesis and accept the alternate hypothesis (see table 2). The division of spatial categories was based on the source and reliability of the water supply, therefore reliability of the water supply and crop selection may be inferred to not act independently of one another.

The Zunil Hills spatial class appears to be unique within the basins of Almolonga and Zunil because it is the only spatial class home to both *milpa* and year-round vegetable cultivation. In addition, it is the only spatial class with scores in the chi-square matrix near zero (See Table 2). The intermingling of agricultural systems exemplified the dynamic relationship between reliability of the water supply and crop selection. The reliability of the water supply ensured that crops would have enough water during periods of inadequate rainfall. The introduction of PVC irrigation technology, networks, and cooperatives in the 1980s made possible the distribution of a reliable water supply to areas previously unable to utilize this resource. A transition from *milpa* to year-round commercial vegetable agriculture progressed as the irrigation networks expanded.

The observed frequencies attributed to the Almolonga Valley and Zunil Valley spatial classes (See Table 2) support the observation that regions with perennial water supplies tend to be dominated by vegetable cultivation. Transitions from one agricultural system to another may have occurred in the past due to economic shifts but changes in water reliability probably have not been an ongoing issue. Seasonal agricultural production may have changed from year to year, favoring one crop over another, but all production would fall under the vegetable category. Based upon this observation, the agricultural production of the Zunil Hills may reflect a transition from *milpa* to vegetable production rather than the static intermingling of two systems.

The observation that the Zunil Hills spatial class is probably a region in transition from one agricultural system to another is important because the future metamorphosis of agriculture in that region may lead to further observations of the relationship between water reliability and crop selection in the Guatemalan highlands. The evaluation of existing projects and the planning of future projects, whose goal is to evaluate and improve the availability and reliability of hydrologic resources for agricultural communities, will be aided by a greater understanding of the evolution of agriculture in the Zunil Hills region.

The Almolonga Hills is the only spatial class in the study with an intermittent water supply. The lack of a reliable water supply has limited the adoption of vegetable cultivation in the dry season and may impact wet season cultivation strategies as well. Though a considerable amount of vegetables are produced in the wet season for this spatial class, *milpa* still dominates the landscape. This may be due to the availability of many species of *milpa*, each uniquely adapted to the vagaries of the rainy season. The complete absence of *milpa* in highland agricultural communities would seem to be an unlikely event given the strong connection to *milpa* in the culinary habits and folklore of the Mayan peasantry. Based upon these observations, *milpa* agriculture may be more reliable than vegetable cultivation when the deliverance of a successful harvest is considered.

The basins of Almolonga and Zunil may contain three levels of agricultural development and opportunism. Regions such as the Almolonga Hills appear to represent the standard cultivation strategy for intermittently watered regions in the Guatemalan highlands. Farmers have accepted the intermittent nature of the water supply and chose crops that minimized the risk of failure that could have lead to a food shortage or famine. Farmers of regions lacking a sufficiently reliable water supply may begin to adopt new cultivation strategies once a reliable water supply is secured. The introduction of a reliable irrigation network in the Zunil Hills appears to have been a catalyst in the process of transition from subsistence *milpa* to commercial vegetable production. Ultimately the agricultural landscape may mature to look something like the Almolonga Valley and Zunil Valley spatial classes once farmers' cultivation strategies have adapted to the available resources. One agricultural system, chosen to best maximize the return provided by a reliable water supply, would dominate the landscape.

Chapter Five - Conclusion

Dramatic variations in relief are a common characteristic of the Guatemalan highlands. Farmers over the millennia have adapted to the numerous environmental niches provided by the varied and oftentimes rugged topography. Three agricultural systems are prominent in the landscape: vegetables, *milpa*, and flowers. The relationship between these agricultural systems and the societies utilizing those crops has evolved over time, though modern innovations and technologies have heightened the pace of change.

Vegetable cultivation is growing in popularity as local and regional agricultural economics become influenced by national and international economies. Investigation of local variations and adaptations to changing economies, evolving technology, and shifting cultural values has proven useful in understanding the composition of traditional agriculture and the transitions to commercial production. Farmers in both Almolonga and Zunil cultivate vegetables, *milpa*, and flowers for both subsistence consumption and sale to local, regional, national, and international markets.

Vegetables and flowers are grown primarily for commercial sale while *milpa* is primarily a subsistence crop.

Vegetables have increased in popularity to the point that the best land is devoted to their cultivation. In an effort to maximize return through the dry-season, vegetables are typically cultivated near a perennial water source. The demand for vegetables is so high that irrigation technologies such as canals, pumps, and gravity-fed sprinkler systems have been constructed to support intensive year-round cultivation.

The long history of innovation in *municipios* of Almolonga and Zunil may have had considerable influence on the success of the most recent technological adoption, gravity-fed PVC sprinkler systems. This innovation has allowed farmers to bring land into year-round cultivation in areas where *milpa* formerly dominated the landscape. The southern hills of the *municipio* of Zunil have helped to redefine the local economy. Not only are farmers practicing dry-season cultivation upon the southern hills, but they have suspended PVC pipe across ravines, and even entire valleys, to allow farmers of the lower northern hills to cultivate vegetables year-round as well.

PVC irrigation technology has enabled farmers to better utilize and distribute a resource that was spatially restricted. Opportunities such as those utilized by the farmers of Almolonga and Zunil could inspire other communities to alter the management of their resources to improve their economic prospects. Grass roots development and innovation such as that under way in the *municipios* of Almolonga and Zunil may be representative of regional and national trends that are slowly changing the Guatemalan economy and identity. Peasant farmers are maximizing the return of their small landholdings and may emerge as a new middle class. Empowerment of the small landholder in a society historically governed by a wealthy minority may give a voice that carries weight for a sector of the population that has been long oppressed and neglected.

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