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Guatemala's Green Revolution: Synthetic Fertilizer, Public Health, and Economic Autonomy in the Mayan Highland

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Despite extensive literature both supporting and critiquing the Green Revolution, surprisingly little attention has been paid to synthetic fertilizers' health and environmental effects or indigenous farmers' perspectives. The introduction of agrochemicals in the mid-twentieth century was a watershed event for many Mayan farmers in Guatemala. While some Maya hailed synthetic fertilizers' immediate effectiveness as a relief from famines and migrant labor, others lamented the long-term deterioration of their public health, soil quality, and economic autonomy. Since the rising cost of agrochemicals compelled Maya to return to plantation labor in the 1970s, synthetic fertilizers simply shifted, rather than alleviated, Mayan dependency on the cash economy. By highlighting Mayan farmers' historical narratives and delineating the relationship between agricultural science and postwar geopolitics, the constraints on agriculturists' agency become clear. In the end, politics, more than technology or agricultural performance, influenced Guatemala's shift toward the Green Revolution.

You need poison to keep your farm going.
There is no harvest if you do not apply poison,
but there is also much disease in this poison.
Wuqu' Iq', a sixty-nine-year-old Mayan farmer[1]

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Over the past fifty years, demographic, environmental, economic, and political factors have compelled many Mayan farmers in highland Guatemala to embrace synthetic fertilizers despite their concerns about the sustainability of agrochemical agriculture and its association with deteriorating public health. Far from being ignorant of synthetic fertilizers' hazards, Mayan farmers are ambivalent about its use. Historical narratives of Maya-Kaqchikel (hereafter Kaqchikel), the third largest Mayan language group in Guatemala, reveal Kaqchikel reservations and hopes in using synthetic fertilizer as well as their analysis of its long-term impact on their land, communities, and income. Most Mayan farmers adopted synthetic fertilizers to increase their harvest yields and become more independent from the labor market. Although increased productivity initially affirmed their decisions and relieved many highland farmers from the need to supplement their income with migrant labor, in the 1970s fertilizers' rising costs forced many to renew their annual trek to coastal plantations. Paradoxically, synthetic fertilizer often trapped farmers in the very dependent relations from which they hoped it would relieve them.

Two aspects of the Green Revolution have received little attention in recent studies: synthetic fertilizers and indigenous farmers' perspectives. Though a rich literature both supporting and critiquing the Green Revolution has emerged since the 1970s, and scientific evidence has increasingly pointed to the health and environmental hazards associated with pesticide use, little is known about the effects of synthetic fertilizers. And since one of the main criticisms of the Green Revolution is that it attempted to provide universal solutions to problems that needed regional and local attention and flexibility, scholars' reluctance to engage small-scale indigenous farmers directly in the debate is particularly surprising. Though a number of studies have advocated small-scale agriculturists' input, often their voices remain muted and, as a result, much of their knowledge and experience remains untapped.[2]

Most grassroots development organizations, scholars, and policymakers agree that proposing alternative solutions without consulting local resources imperils the programs and intended beneficiaries. Yet even as farmers' perspectives have shifted the focus of both research and solutions, few scholars and agronomists allow agriculturists in developing nations to determine research agendas. The Kaqchikel case illustrates

how research agendas might be reoriented according to local needs and interests. For instance, Kaqchikel narratives indicate that for some farmers in the developing world, understanding the effects of synthetic fertilizers is as important as understanding the effects of pesticides and herbicides. Similarly, having attempted to incorporate Green Revolution techniques and inputs with limited, often ephemeral success, Kaqchikel farmers have their own alternative approaches to agricultural development. In contrast to essentialist portrayals of indigenous peoples, most Maya do not reject innovation (indeed the flourishing of their society has long been based on it); rather their skepticism points to the need for their local ethnic knowledge and experience to guide the development and incorporation of new technologies and resources.

Though occupations among contemporary Kaqchikel are diverse—teachers, office employees, artisans, tradesmen, factory workers—the majority of Maya in the Guatemalan highlands are agriculturists who continue to farm *milpa* (a polyculture of corn, bean, and squash crops) much as their forebears did. Even while their relationship with the land is constantly changing, their holistic approach to farming encompasses their lives. Though the Kaqchikel-speaking regions of the central highlands share a mountainous terrain and rainy (May to October) and dry (November to April) seasons, the climate and ecology of the municipalities vary in part due to their altitudes, which range from 2,313 (Tecpán) to 1,500 (San José Poaquil, hereafter Poaquil) meters above sea level. Differences in local agroecology aside, most Maya consider the land sacred; each time before they begin a new cycle of work in the fields, they make an offering to the *rajawal* (spirit of the land). That their year is based on the cycle of planting and harvesting corn hints at how important agriculture is in Mayan worldviews. In addition to forming a cornerstone of the Mayan diet, corn plays a religious and cultural role. Even Kaqchikel professionals who work in Guatemala City or other areas removed from their villages insist on planting corn in their communities to maintain a connection to the rajawal.

For these reasons, the introduction of synthetic fertilizers, which Kaqchikel historical narratives date to the late 1950s and early 1960s but archival materials place a half century earlier, was a pivotal moment for many Mayan farmers. Many feared introducing a non-native substance would upset their harmonious balance with nature. However, in response

to famines, droughts, population growth, and low harvest yields, their initial resistance receded. While some Maya hailed synthetic fertilizers' immediate effectiveness, many lamented the long-term deterioration of their public health, soil quality, and financial independence. As a result, like their forebears once did, some Mayan agriculturists today apply only organic fertilizer. By instilling fear, hope, and frustration, synthetic fertilizers' successes and failures have left a complex mark on Maya.[3]

In general, research supports Kaqchikel observations that agrochemical application has jeopardized public health. The chemicals from synthetic fertilizers can spread through food (particularly fruits and vegetables), water, and air supplies. Since many Mayan farms are located close to homes and water supplies, once applied, agrochemicals (from fertilizers, pesticides, and herbicides) can readily spread and contaminate the food and water Maya ingest. Despite using only about 20 percent of the agrochemicals produced in the world, developing countries claim over half of the agrochemical-induced deaths each year. The most haz-

Figure 1. Panabajal, Comalapa, Department of Chimaltenango. A Rural Kaqchikel Village Surrounded by Farms. Source: photograph courtesy of David Carey Jr.

ardous elements in the synthetic fertilizers applied by Kaqchikel farmers are nitrogen or nitrogen compounds (nitrites, ammonium, and nitrates), phosphorous, and potassium. Phosphorous and potassium remain in the upper soil layer, but nitrogen easily migrates through the soil and into groundwater. As the most concentrated element in most of the fertilizers that Kaqchikel use (see Table 1) nitrogen is the main environmental pollutant and can rapidly increase to toxic levels. Several studies indirectly link the consumption of nitrates through groundwater to brain cancer in children and stomach cancer in adults. Recent, albeit inconclusive, research also indicates a causal relationship between the maternal ingestion of nitrates through drinking water and developmental problems in their infants. Excessive nitrate consumption also can cause methemoglobinemia, a physiological disorder that reduces the blood's capacity to carry oxygen. Common among infants who drink water contaminated by nitrates, this condition is known as "Blue Baby" syndrome. But water is not the only conduit of these chemicals. The ingestion of nitrates through vegetables and legumes, particularly beans, have led to high rates of gastric cancer in Chile and Colombia.[4]

Figure 2. A Water Well Surrounded by Milpa. Source: photograph courtesy of David Carey Jr.

Table 1. Chemical Fertilizers Sold in Kaqchikel Towns

Name	*Ingredients*	*Weight*	*Price*
"Hydro" 20-20-0, Fertilizantes Barco Vikingo, Hydro Nordic SA**	Phosphorous (P) 20%, 20% Nitrogen (N), 8.7% Nitric (NO3), 11.3% Ammonium (NH4+), Vegetable development, Calcium (Ca), Magnesium (Mg)	47 kilograms	90 quetzals ($ 11.70)
Urea 46%, UXSA	Not listed (white powder)	45.5 kilograms	77 quetzals ($ 11.00)
Pelicano, Sulfato de amonio (product of USA)	21% Nitrogen (N), 24% Sulfur (S)	46 kilograms	
Mayafert NPK 15-15-15	Not listed, but says it is a mix of chemicals. Perhaps 15% Nitrogen (N), 15% Phosphorous (P), 15% Potassium (K)	46 kilograms	
Mayafert 20-20-0	Not listed, but says it is a mix of chemicals	46 kilograms	
NPK 20-20-20 (made in Europe)	Not listed, but perhaps 20% Nitrogen (N), 20% Phosphorous (P), 20% Potassium (K)	46 kilograms	
Ferigua 20-20-0	6% Sulfur (S), 22% Calcium (Ca)	46 kilograms	87 quetzals ($ 11.30)
10-50-0, Hydro Nordic SH***	Ammonium (NH4+), Phosphorous (P), Calcium (Ca), Magnesium (Mg), Sulfur (S)	46 kilograms	118 quetzals ($ 15.35)
15-15-15	Not listed	45.5 kilograms	73 quetzals ($ 9.50)
18-6-12-5-4-1.8-0.2, Fertilizante Banco Vikingo, Hydro Nordic	Nitrogen (N), Phosphorous (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Sulfur (S), Zinc (Zn)	46 kilograms	

* Grupo Disagro is the name of the company that packages most of these fertilizers.

** This package has a sign on back that says oxidant agent.

*** According to one vendor this is the strongest chemical fertilizer.

Though the Green Revolution played out differently depending on national and local contexts, in many ways, the Guatemalan experience provides an insightful model of the revolution's framework, goals, and consequences. Since the Green Revolution favored large landowners over small landowners and monoculture over diversity, Guatemala was an ideal setting for its experiment. In the nineteenth century Guatemalan leaders encouraged agricultural export production, at first cochineal and then coffee. By 1900 what would become the United Fruit Company (UFCO) was established in Guatemala. As the twentieth century wore on, Guatemala included sugar, cotton, cattle, and non-traditional fruits and vegetables as part of its agroexport portfolio partly in response to pressure and aid from various international and US lending agencies.[5]

To stimulate this economic strategy, during the nineteenth and twentieth centuries, the government and private speculators dispossessed small-scale farmers (mostly Maya) of land, which in turn was transferred to large landowners, both foreign and domestic. The effects on Mayan communities varied over time and region. In contrast to the Caribbean

Figure 3. A Family-Owned Agricultural Store in Comalapa that Sells Synthetic Fertilizer. Source: photograph courtesy of David Carey Jr.

and Pacific coasts, which came to be dominated by plantations, the highlands remained a mix of large and small-scale farms. Nevertheless by the mid-twentieth century, highland Mayan livelihoods had been severely compromised thereby creating fertile ground for Green Revolution technologies. By 1979, 88 percent of the farms covered only 16 percent of the arable land, while 2.5 percent of the farms embraced the remaining 65 percent. Along with Haiti, Brazil, and Sierra Leone, Guatemala suffered from one of the world's most unequal landholding patterns. If they increased harvest yields as promised, Green Revolution technologies could solve Guatemala's domestic agricultural crisis without having to address its unjust landholding tenure.[6]

Yet land distribution alone did not explain Mayan plights. After 1870 economic reforms and the development of coffee export production increased demand for Mayan labor. Concurrently, periodic scarcities of foodstuffs, which had plagued Guatemala since the colonial period, persisted into the twentieth century. Between 1871 and 1940 Guatemala suffered repeated corn shortages and, as a result, remained dependent on corn imports until 1930. A decrease in production affected farmers directly in their own fields but also indirectly through rising prices of other staple goods in the market. For example, in 1915 an author from Tecpán noted that, while corn and bean production did not reach the extreme scarcity expected after a drought, the shortage in the market resulted in expensive corn that year. Low harvest yields meant many people could not afford to buy enough corn to supplement what their own fields failed to produce. The severity of the problem is evident in correspondence during the 1930s from governors who, concerned about the supply of corn in highland towns, asked *alcaldes* (mayors) to regulate the sale of maize. In 1933 President Jorge Ubico (1931–1944) declared a "special discounted tariff" of 25 percent for railway shipments of corn to the nation's interior to address the corn shortage.[7]

In addition to environmental factors, population growth beginning in the late nineteenth century also increased pressure on food supplies. For example, the population of San Juan Comalapa (hereafter Comalapa), Sumpango, and San Martín Jilotepeque (hereafter San Martín) more than doubled from 1880 to 1950. Likewise, Patzicía and Santa María de Jesús experienced population increases of 35 and 43 percent respectively during the same period. Partially due to increased access to improved

biomedicine, population growth was especially dramatic in the middle third of the twentieth century, which in turn increased pressure on the land. And since parents generally distributed land among their children, inheritance patterns fragmented family holdings. This decreasing land supply further marginalized Mayan farmers. In contrast to one elder's assertion that, "A long time ago we could let the land lie fallow because there were not as many people," by the early twentieth century, some communities complained they no longer had enough land to support themselves.[8]

In response to demographic pressure, low yields, drought, locusts, and policies designed to foment coffee exports, many Maya migrated seasonally to the Pacific Coast where they suffered horrendous working and living conditions on coffee *fincas* for paltry wages. Upon investigation, labor inspectors generally confirmed (and condemned) these exploitative conditions. That Maya put up with these conditions for so long demonstrates the extent to which they had become dependent on the cash economy. These conditions made the promise of the Green Revolution attractive.[9]

In Guatemala, agricultural changes of the type associated with the Green Revolution were part of two phenomena and periods. The first was Guatemala's effort to present itself as a modern nation during the first half of the twentieth century. The second was the fervent anticommunism that came about in response to President Colonel Jacobo Arbenz Guzmán's (1951–1954) land reform. Beginning with the Liberal revolution of 1871, the new leaders had sought to modernize Guatemala. Even though their Conservative predecessors had already set Guatemala on a path toward agricultural export production and other processes associated with liberal reforms, it was the Liberals who emphasized modernization in their discourse. By the first half of the twentieth century, such dictators as Manuel Estrada Cabrera (1898–1920) and Ubico made progress a cornerstone of their administrations. Though often these changes were more indicative of image than reality, at times actions accompanied rhetoric. In political and intellectual leaders' eyes, increased harvest yields were key to the nation's progress. During the 1930s agronomists contributed articles to the Guatemalan newspaper *Diario de Centro América* extolling the virtues of scientific studies and their practical applications. Even before the Green Revolution took off in the postwar

years, Guatemalan farmers were experimenting with agrochemicals, new seed varieties, and scientific approaches to agriculture. By the 1920s farmers in San Antonio Aguas Calientes (hereafter Aguas Calientes) had already incorporated synthetic fertilizers into their farming techniques. In many ways, the Estrada Cabrera and Ubico regimes' discourse about progress and order during the first half of the twentieth century set the stage for the Green Revolution and its emphasis on modernization and science.[10]

When Guatemalans overthrew the Ubico dictatorship and ushered in democratic reforms in 1944, they envisioned alternatives to political, economic, and (to a lesser extent) social relations. In an effort to address Guatemala's economic disparity and low agricultural yields, Arbenz instituted a program of redistributing fallow lands. Despite a number of shortcomings, in its short life the program increased national agricultural production and improved rural livelihoods. Peasant beneficiaries generally diversified crops for their own and the nation's consumption. Though Arbenz made it clear that his administration was committed to capitalistic development by protecting private property, his opponents painted him and his land reform as communistic. By targeting large unused landholdings (and mobilizing the rural population), Arbenz gained the ire of Guatemalan elites (particularly landlords and the hierarchy of the Catholic Church) and the UFCO personnel who argued such holdings were essential for agricultural export. After the US-engineered coup deposed Arbenz in 1954, the operation's figurehead Colonel Carlos Castillo Armas immediately reversed the land reform. As part of a strategy to bury alternative development models and undermine the agrarian movement, leaders of the military government and Catholic Church promoted the Green Revolution. In Tecpán, for example, Catholic Action—an outspoken anticommunist organization—began pushing synthetic fertilizer in 1957.[11]

The notion that agricultural technology was a valuable weapon in the battle against communism emanated from private foundations in the United States. An internal memorandum at the Ford Foundation written just a few months after Arbenz's resignation in June 1954, both reflected the hope that the Green Revolution could stem communism and warned of the dire consequences if it failed to do so: "If our aid is lacking or wasteful, the Communists will do the job on their own. . . . in their current

efforts to modernize, the underdeveloped countries will lean toward the West, adapting its technology and political ideas to suit its special needs, or instead, accept the Communist promises and eventually the Communist system." Similarly, the Rockefeller Foundation, which had already established a presence in Guatemala via its public health campaign, framed its financial commitment to the Green Revolution in anticommunist rhetoric. In a reflection of the influence of these foundations, as part of President John F. Kennedy's Alliance for Progress, the US Agency for International Development (USAID) began promoting Green Revolution fertilizers and pesticides in Guatemala in the 1960s. Concerns about national security also motivated Guatemalan leaders' turn toward this new technology.[12]

Like its application in other nations with burgeoning agrarian movements such as Indonesia, India, Pakistan, and the Philippines, the Green Revolution provided Guatemalan elites with the potential to increase economic growth without recognizing small-scale farmers' demands and strategies as legitimate. As historian Keith Griffin observed, "Technical progress was regarded as an alternative to land reforms." In turn, particularly after the Cuban Revolution in 1959, the United States had to present its intervention in Guatemala as beneficial. For that reason, the promise of high yields through agricultural modernization was especially appealing. In the end, politics, more than science or agricultural performance, influenced Guatemala's shift toward the Green Revolution in the 1950s and 1960s.[13]

By increasing agricultural production in the highlands, which in turn created more jobs and surplus grains to fend off famines, synthetic fertilizers suspended (at least temporarily) coastal migration. According to oral histories, Kaqchikel communities were no exception to this trend. Prior to the introduction of synthetic fertilizers, famines plagued Kaqchikel communities where small-scale (5–10 cuerdas) milpa agriculture dominated the landscape. "Until about fifty years ago corn was always scarce. In June, people had to begin to buy corn and famines struck. But now, thank God, that no longer occurs because of chemical fertilizer," recalls one elder. In addition to mitigating, if not eliminating famines, informants credit synthetic fertilizers with facilitating economic independence. "A long time ago our people suffered because the agriculture did not give enough to support us. . . . The people suffered until the chemical

fertilizer came and they did not have to go to the coast again," attests Waqi' Iq', a sixty-seven-year-old former mayor of Comalapa. Lajuj Kan, a seventy-one-year-old farmer, explains how synthetic fertilizers affected migration patterns and diet:

> We farmed four to six cuerdas but it did not give much maize; of the forty *varas* [Spanish yard or thirty-three inches] we barely got one *costal* [sack]. So around August through October, we went to the coast. But thanks to God, science, and studies, I do not know where it came from, but the chemical fertilizer helped the harvest. Sincerely, since then there has been no hunger and now almost all the children eat well.

In the same way broccoli production fit into Mayan farming in Tecpán, by counteracting "the oppositional practice . . . of labor migration," synthetic fertilizers upheld traditional Mayan livelihoods. Since maintaining control over their means of production was important to them, Maya had long learned to adapt to changing circumstances. For some farmers such as Lajuj Kan, synthetic fertilizer seemed an almost mystical panacea.[14]

In truth, synthetic fertilizer was neither a panacea nor the sole reason for increased agricultural production. B'eleje' K'at, a forty-two-year-old artist recalls: "The most important thing for us was the arrival of chemical fertilizer so people could farm better. Now there is a good harvest and you can even have laborers work for you. They can also farm in the hills where they could not before." Even while recognizing synthetic fertilizers' ability to expand highland employment, B'eleje' K'at points to another reason for increased harvests: expanded cultivation, often as a result of deforestation on steep mountainsides. Since Kaqchikel were farming more land at the same time they were incorporating synthetic fertilizers into their farming techniques, it is difficult to know to what extent each factor increased aggregate yields. Nonetheless, most informants associated abundant harvests and their communities' increasing self-sufficiency with synthetic fertilizers. After his harvest increased seven-fold, one agriculturist hailed synthetic fertilizer for "giving strength" to the land. Ixwatzik', a sixty-year-old woman who works in the fields as well as her home concurs, "Chemical fertilizer has helped us significantly . . . without it you cannot farm. If there is no fertilizer, there

is no food." One rural elder succinctly opines, "Chemical fertilizer gives us life."[15]

Other Kaqchikel made direct connections between synthetic fertilizers and improvements in their lifestyle. By attributing his lack of education to farming instead of studying as a child, one man ascribed his children's education to synthetic fertilizers. With fertilizer, harvests were more plentiful, and thus he could allow his son, who eventually became a teacher, to attend school. Like the broccoli farmers in Ted Fischer and Peter Benson's study of Tecpán, some Kaqchikel emphasized the benefits over the downsides of these changing agricultural strategies.[16]

Since the turn of the century, agricultural entrepreneurs in Guatemala had been promoting the use of synthetic fertilizers. "All plants without exception need chemical fertilizer. Chemical fertilizer is essential to vegetable life," reported the Guatemalan trade journal *Boletín de Agricultura* in 1903. By the early 1920s the Guatemalan Ministry of Agriculture stressed the importance of experimentation with chemical fertilizers, "to improve the land and augment and improve the harvests." When evangelical missionaries established an "agricultural store" in Aguas Calientes in the 1920s, farmers began to use synthetic fertilizers and pesticides there. That Kaqchikel town was the exception, however. In others such as Comalapa, municipal authorities encouraged farmers to use synthetic fertilizers in the 1920s to little avail. Though agronomists and academics continued to extol its benefits throughout the 1930s and 1940s, widespread use of synthetic fertilizer did not catch on in many Mayan communities until the late 1950s and early 1960s when USAID and agronomists trained at the Guatemalan National School of Agriculture pushed Green Revolution technology in the highlands.[17]

After years of adhering to their traditional knowledge and practices, many Mayan agriculturists approached agrochemicals with trepidation; some refused to use them. According to one elder from Sololá, when he first used synthetic fertilizer in 1956, he was accused of being a thief and told that synthetic fertilizer "was from the devil." In the K'ichee' town of San Antonio Ilotenango, synthetic fertilizer entered the community in 1959, but the majority of residents did not incorporate it into their farming until 1965. Likewise, in Totonicapán, K'ichee' farmers did not introduce synthetic fertilizer into their agricultural techniques until the 1960s.[18]

Figure 4. A Kaqchikel Boy Demonstrates Using a Backpack Sprayer. Source: photograph courtesy of David Carey Jr.

As skeptical farmers overcame their caution, synthetic fertilizers greatly increased agricultural production in Mayan communities. In Chimbal, Catholic Maryknoll priests introduced synthetic fertilizers in the late 1960s, and by the mid-1970s land productivity had nearly tripled. Increased harvest yields allowed Chimaltecos to farm fewer acres. Shortly after Peace Corps volunteers and Catholic priests introduced synthetic fertilizer in the Kaqchikel town of Patzún in the early 1960s, milpa yields increased. Similarly, once agriculturists in San Antonio Ilotenago began to use synthetic fertilizer on a regular basis, they realized a significant improvement in their corn and bean harvests.[19]

Like their Mayan counterparts, most Kaqchikel farmers began using synthetic fertilizer in the late 1950s and early 1960s. One eighty-year-old agriculturist noted in his journal that chemical fertilizer arrived in Comalapa on January 22, 1956. The Chuwi Tinamit Project monograph for the local Christian Children affiliate in Comalapa states, "The use of chemical fertilizers barely had been introduced in the decade of the 50's." By the mid-1960s most Kaqchikel residents of Comalapa were familiar with synthetic fertilizers. In 1966 a local newspaper reported a program

to "develop the use of fertilizers for the small agriculturist to counteract the low national . . . cultivation of basic foodstuffs." By emphasizing national as well as local needs, agricultural promoters convinced reluctant residents to use synthetic fertilizers to boost their harvests of corn, beans, wheat, potatoes, and garden vegetables. With an eye towards improving Mayan agricultural production, the Development of Indigenous Economy organization analyzed new forms of synthetic fertilizers and encouraged their widespread use. As one of the towns where it focused its efforts, Comalapa was the target of this organization's propaganda and programs.[20]

In general, the Guatemalan government's impact on small-scale farmers' use of synthetic fertilizer was marginal at best. Though the revolutionary governments of Arbenz and his predecessor Juan José Arévalo Bermejo (1945–1951) promoted domestic use agriculture by providing credit and loans to small-scale farmers, these administrations lacked the administrative and political capability to improve such agriculturists' access to resources. Even during Arbenz's land reform, the government made little effort to give beneficiaries access to agricultural inputs. Subsequent administrations lacked the political will. In the early 1970s USAID provided loans to support small-scale farmers, but its focus was primarily on encouraging smallholders to produce non-traditional agricultural exports (NTAs) such as broccoli, snow peas, zucchini, strawberries, and blackberries. These farmers received loan guarantees to purchase synthetic fertilizers and pesticides, among other inputs. In contrast, agricultural loans through national banks favored large-scale agriculturists. Even as basic grain yields rose rapidly, by the end of the 1970s it was clear these gains were achieved at the expense of small-scale farmers. Beginning in the 1980s, the International Monetary Fund, World Bank, US government, and some Guatemalan elites pressured the government to adopt neo-liberal economic reforms, which (among other austerity measures) discouraged government intervention in the economy in an effort to liberalize markets. In short, beyond some early efforts at marketing and more recent attempts to influence political leanings, the Guatemalan government seldom financially encouraged the use or distribution of synthetic fertilizers.[21]

Despite propaganda and synthetic fertilizer's immediate benefits, some Kaqchikel still refused to use it because they did not understand

fully its ramifications. Given the increasing returns in the 1960s and early 1970s, certainly some informants' memories are clouded by the current dangers agrochemicals pose. One indication of how Kaqchikel perceptions of fertilizers have changed over time is that some of today's detractors were yesterday's advocates. Since synthetic fertilizers have degraded the soil, compromised the social fabric of Mayan communities, and adversely affected public health, the majority of Kaqchikel now claim initial trepidation was warranted. Maya K'ichee' Nobel Peace Prize laureate, Rigoberta Menchú agrees with Kaqchikel warnings and is particularly concerned with the ecological effects: "If you use chemicals on a cucumber or a *merliton* [*chayote* or Mexican squash] they will certainly grow quickly, but the natural process will have been interfered with." Other Mayan farmers found that eventually some vegetables, such as those in the squash family, would not grow without the assistance of synthetic fertilizer.[22]

Though most Kaqchikel farmers are concerned about synthetic fertilizer's effects, few have the luxury of foregoing its use. In Kaqchikel communities, the existence of small anti-synthetic fertilizer factions—comprised mostly of those with the resources to use organic fertilizers or those whose education levels or other opportunities have released them from daily toil in the fields—belies a majority whose ambivalence recognizes both the advantages and risks associated with synthetic fertilizer. Such differences of opinion are largely related to class.

Mayan perceptions of synthetic fertilizers must also be understood in the context of Guatemala's civil war (1960–1996) during which the military and to a far lesser extent insurgency groups terrorized the population. Kaqchikel informants claim that some agronomists from the United States and Europe wanted to organize an "army of the poor," and thus synthetic fertilizer became associated with insurgents. According to some interlocutors, these foreigners sowed "seeds of subversion," and massacres resulted. When aid workers held meetings to disseminate Green Revolution technology, they often espoused Marxist ideology. Although most Kaqchikel participated in these programs for agricultural not political purposes, the Guatemalan military accused them of sedition and summarily executed and disappeared many. Since the overwhelming majority of the two hundred thousand killed and over one million displaced during Guatemala's civil war were Maya, this aspect of their past

strongly influences their historical narratives. As a result, synthetic fertilizer carries the pernicious association of the outsiders—aid workers, Green Revolution agronomists, Peace Corps volunteers—who pushed it and the revolutionary ideology that stoked the ire of the Guatemalan military.[23]

In contrast to these recollections, Green Revolution technology generally was associated with anticommunism and attempts to weaken social movements, particularly those promising to improve the quality of life of the poor and dispossessed. That is, the Green Revolution was hailed as means to curtail not foment revolutionary change and land reform. Although the relationship between the Green Revolution and political movements in Guatemala is too complex to be addressed here, both insurgents and counterinsurgents used synthetic fertilizers to entice Mayan farmers to support their cause. Regardless of ideology, such shared strategies point to the paramount role synthetic fertilizer played in highland farming by the 1970s and 1980s. For some, the perceived associations between foreigners, synthetic fertilizers, and increased violence during the civil war discouraged the use of or even an interest in synthetic fertilizers. Certainly its association with violence contributes to its baneful reputation in Kaqchikel memories today. But, at the time, many farmers were ambivalent, recognizing yet another risk in the quest to control their means of production.

Most Kaqchikel, especially in Aguas Calientes, assert that synthetic fertilizer has compromised public health; some attribute deadly diseases to it. According to oral accounts, when people eat agricultural goods produced with chemicals, they become sick. Based on Kaqchikel analyses of their past, people are not as physically strong and resistant to disease as they once were and thus do not live as long. Some people attribute cancer and diabetes to the ingestion of these agrochemicals. A bone-setter and artist explains the long-term detrimental health effects of synthetic fertilizers:

> A long time ago there was no chemical fertilizer and because of that men were tougher; they did not fall ill. They farmed and ate the pure strength of the land. Now chemical fertilizer weakens us. The corn is bigger but it has chemicals in it. The land is no longer strong. It has disease in it. Furthermore, the underground insect population and waste have increased. These insects

> and waste eat the harvest. When there was no chemical fertilizer, nothing hurt. My grandfather lived to be eighty-five and when he died he was never hurt. He had great teeth, but now people's teeth are worse.

Ixxeq, a forty-seven-year-old woman who has tended to her family's crops since her husband was killed during the civil war, concurs:

> We only use a small amount of chemical fertilizer and we never spray [with pesticide], but others do. A long time ago my grandfather did not use chemical fertilizer, he only used natural fertilizer from chickens and goats. He carried it in a sack when he went to his land in the hills and then he would throw a little under each corn stalk. My grandfather said that chemical fertilizer gives illness. That is why so many people are sick now because of the poison from chemical fertilizer. In fact, there is more poison than fertilizer. Now people only use poison. A long time ago there were not many diseases because people did not use pesticides. Cancer is one of the grave diseases that this poison provoked. Now people die young because there are so many diseases. A long time ago people lived much longer.[24]

Though pesticides' impact on health is well established, less is known about the relationship between synthetic fertilizers and public health. The tendency of Kaqchikel to conflate agrochemical inputs by using the term *itzel aq'om* (poison) to refer to chemicals in fertilizer, pesticides, and herbicides complicates attempts to isolate the effects of synthetic fertilizer. Yet since far more Kaqchikel use synthetic fertilizers in their agricultural practices than pesticides and herbicides, their narratives emphasize fertilizers. The few studies that examine the health effects of nitrogen fertilizers support Kaqchikel claims that they have contributed to increased cancer rates and other health problems. Children are particularly susceptible to the poisons that leech into groundwater. Born in the late 1950s and early 1960s when Maya began using synthetic fertilizers regularly, the first children to ingest these chemicals through their food and water are now in their mid- to late forties.[25]

Of course, other factors contribute to Kaqchikel perceptions of public health and mortality in their communities. A change in diet since the 1960s, partly caused by the introduction of NTAs in the early 1980s in the central highlands of Guatemala, has affected public health. NTAs also drastically increased the use of pesticides, which in turn had adverse

health effects, particularly for the farmers who used them. Furthermore, the thirty-six-year civil war, which devastated the Kaqchikel regions in the late 1970s and early 1980s, made death a common occurrence. Despite these losses, morbidity and mortality rates for the department of Chimaltenango (which houses most of the towns in this study) actually have decreased since 1964. However, a generational shift in the high mortality rate has occurred. Whereas previously children between the ages of one and five were most susceptible, more recently the age group of forty to seventy-five years maintains the highest death rate. This phenomenon stems from increased access to medical attention: fewer children die, so more of the deaths are among older people. Ironically, Kaqchikel perceptions of increased death rates can be explained partly by this reality. People who have lived longer may have a greater impact on the community's awareness of death than the loss of young children who have yet to circulate significantly throughout their village. Nonetheless, the most susceptible segment of the population is precisely the group that has been exposed to and ingested agrochemicals for sustained periods. In this sense, these data support Kaqchikel assertions of a relationship between the introduction of agrochemicals and declining public health.[26]

Since many synthetic fertilizers are poorly labeled, farmers often are unaware of their active ingredients. Even when the elements are listed, no instructions accompany the packaging as to the proper precautions to use when applying fertilizer, such as wearing protective clothing, washing after handling the product, and warnings about other hazards. In general, Kaqchikel farmers apply synthetic fertilizer twice a year: once in late June or early July after the rains have begun and the milpa is about a foot high, then again in August or early September. The first synthetic fertilizer to arrive in the area was a liquid, which farmers mixed with water and spread around the base of the plant. Kaqchikel note they had to apply this formula carefully because direct contact would "burn," and in most cases, kill the plant. As the liquid fertilizer lost its potency, dry fertilizer became more common. Today, farmers continue to use their hands to apply a substance that looks like tiny white balls (20-20-0) or tiny white and dark balls (15-15-0) (see Table 1). The dry chemical fertilizer is not mixed with water, and most farmers do not have the means to wash their hands and clothes until they return home at the end of the day.[27]

Because Mayan agriculturists do not use pesticides on their milpa, many farmers use very little if any pesticides in their agricultural practices. However, both pesticides and herbicides are common with tomatoes, potatoes, and most NTA crops such as peas, broccoli, strawberries, and blackberries, all of which are present in Kaqchikel farming communities. The application of pesticides varies considerably depending on the crop and individual farmer. Some farmers claim they only use pesticide once or twice a year, while others use it as often as the insects or weeds return, at times once a week. Farmers apply pesticides (which come in liquid and powdered forms) with a backpack sprayer. While some farmers place a nylon bag between their backs and the backpack sprayer, many fail to wear even this minimal protection. Even farmers who have attended courses sponsored by chemical companies admit they do not fully understand how to properly apply the agrochemicals.[28]

Since most Kaqchikel farmers who work with agrochemicals eat lunch in their fields without any access to water for washing their hands, they ingest these chemicals directly with their food. Similar practices contribute to the approximately twenty-five million occupational agrochemical poisonings and several thousand agrochemical deaths that occur worldwide each year. In Guatemala, about 1,200 cases of acute pesticide intoxication (short-term reaction) are reported every year. Quantifying long-term health effects is more difficult because people do not generally die from agrochemical poisoning, but from infectious diseases. Nonetheless, agrochemicals may exacerbate the breakdown of the immune system.[29]

In addition to the adverse health effects, many Kaqchikel contend that the soil is not as fertile as it once was because synthetic fertilizers "consumed" or "burnt" its nutrients and vitamins. Like their Kaqchikel counterparts, farmers throughout Central America have observed that synthetic fertilizer exhausts the soil. Supporting these claims, a number of studies have shown that intensive use of synthetic fertilizers depletes the soil of such essential nutrients as phosphorous, zinc, sulfur, and iron. Many Kaqchikel agriculturists could no longer farm off the fecundity of the land alone. Without synthetic stimulants, they claimed, crops did not grow. Population pressure compounded this problem. Since Kaqchikel farmers could no longer allow land to lay fallow, the soil could not replenish its nutrients. One Kaqchikel man noted, "The land lost

strength because it was not allowed to rest, the synthetic fertilizer is just like a cup of coffee for breakfast, it wakes you up but it does not nourish you."[30]

According to research and Kaqchikel oral histories, synthetic fertilizer has a diminishing rate of return. Kaqchikel have observed that it is not as potent as it once was. Oral accounts attest that in the 1960s, a small capfull was sufficient, but now large quantities are needed to bring about the desired effects. Even with increased application of synthetic fertilizers, crop yields are declining. To cite one study, when nitrogen fertilizer applications were increased from two hundred to two hundred seventy kilograms per hectare or higher, crop yields were significantly reduced. In fact, studies from the Americas and throughout the world have revealed that exclusive use of synthetic fertilizer results in lower long-term harvest yields. Despite (or perhaps because of) declining yields, average rates of application of nitrogen fertilizers increased exponentially in developing countries from 1960–1990. Scientific evidence aside, these trends have produced numerous conspiracy theories among highland farmers. One Mayan agriculturist claimed producers extracted the active ingredients from fertilizers. Similarly, a sixty-two-year-old evangelical rural farmer from Comalapa asserted:

> In 1955 when chemical fertilizer arrived it was stronger and gave a good harvest. One *quintal* [one hundred pounds] provided for eight to ten cuerdas. Now it is not as strong. The Ministry of Agriculture analyzed chemical fertilizer from 1965 to 1970. They said it was the same, but that is not really true. They were lying to us. The price increases but not the strength. Now you pay one hundred quetzals [$16.67] for a quintal and it only lasts for one cuerda.[31]

The rising cost of fertilizers can be attributed at least in part to inflation and the devaluation of the quetzal. During his dictatorship, Ubico set the quetzal to the dollar, where it remained until the Guatemalan economic crisis of 1984. Since then the quetzal has lost value over time. For instance, the value dropped from 6 quetzals to the dollar in 1998 (when most of these interviews were conducted) to 7.5 quetzals to the dollar in 2008. Regardless of devaluation, like his counterpart from Comalapa, a farmer from Patzún suspected unfair practices:

> When they came to demonstrate the effects of the fertilizers, just one bottle cap grew tons, but now you need a handful and each day it is more expensive. I just use synthetic because the soil and the seeds are used to it. The organic is good; before we used garbage from the house and *choreque* [plant residue]. It was good and cheap, but the government and the damn gringos screwed us: they give away corn, and they sell the fertilizer more expensive. What the rich sell is expensive; what the poor sell is cheap.

Since the costs of fertilizer and pesticides increased faster than the price of corn, profits diminished. US assistance programs exacerbated this problem. Through the PL 480 program, for example, the United States sent surplus subsidized corn to Guatemala, which it sold for a price lower than the cost of producing corn in Guatemala. Under such circumstances, Mayan farmers could not compete. As a form of indirect technological determinism, the cycle of synthetic fertilizer (and the Green Revolution more broadly) prices out small agriculturists in favor of large ones and thereby usurps land from Maya.[32]

The increasing cost and decreasing effectiveness of synthetic fertilizers undermined small-scale agriculture. A former Comalapa mayor observed, "Each time chemical fertilizer is more expensive and less efficient. People should use organic fertilizer." Due in part to industry-wide overproduction, when Maya began using synthetic fertilizer regularly in the 1960s, the prices were low. Even as late as 1971, the cost of synthetic fertilizer was fifty dollars a ton. Since it takes somewhere between a half and three-fourths of a ton of oil to make the ammonia needed to produce one ton of synthetic fertilizer, the oil price explosions from 1973 to 1975 and 1977 to 1981 dramatically increased world synthetic fertilizer prices. When OPEC began raising oil prices in 1973, the price of synthetic fertilizer increased to $225 a ton and continued to rise thereafter. By the spring of 1975, the cost had increased another 215 percent. Like the fate of other farmers in the developing world, many Kaqchikel farmers had to sell their land and/or migrate in search of wage labor in response to this inflation. One Kaqchikel farmer, Wuqu' Iq', considered chemical fertilizer crucial enough to warrant government price controls. In a variant of this approach, recent administrations have used subsidies for and even distribution of synthetic fertilizer to boost their popularity, if not buy votes.[33]

To a large degree, internal class differentiation influenced how the vicissitudes of synthetic fertilizer affected Kaqchikel farmers and communities. Those with larger landholdings who could consolidate cultivation fared better. And those with domestic animals could supplement (if not replace) synthetic fertilizer with manure. In contrast, some small-scale landholders became so indebted that even migrant labor did not make up the losses and eventually they lost their land. In communities where residence and membership are tied to agricultural practices, some simply became *jornaleros* (day laborers). Just as the introduction of synthetic fertilizer increased the disparity between large- and small-scale coffee farmers in Costa Rica, it also exacerbated the gap between resource-rich and resource-poor farmers in highland Guatemala.[34]

By demanding additional inputs such as pesticides, synthetic fertilizer use compounded costs. Kaqchikel farmers who insisted that agrochemicals produced new pests and microbes were observing how agrochemicals disrupted effective natural biological controls. When pesticides destroyed beneficial natural predators (which scientists estimate account for between 50 and 90 percent of the control of pest species), secondary pest outbreaks resulted. Indeed, pest problems in highland Guatemala have increased since the 1980s when intensive application of pesticides to NTA crops began. In response, even agriculturists who grew traditional crops had to purchase pesticides to control these threats, particularly if their fields were located close to NTA fields. But costs were high. Another problem was that pests developed resistance to pesticides. As a result, farmers had to purchase new pesticides or in extreme cases surrender their crops.[35]

Rising synthetic fertilizer costs accompanied by decreasing demand and prices for their products reduced Mayan self-sufficiency. Even among those who enjoyed increased agricultural productivity by combining organic and synthetic fertilizers, the skyrocketing cost of synthetic fertilizers forced some to seek outside income to meet these expenses.[36]

Although Kaqchikel raconteurs credit synthetic fertilizers with providing a brief respite from coastal migration in the 1960s and early 1970s, national migration trends were high even before fertilizer costs skyrocketed. In 1970 for example, municipal functionaries estimated that 60 percent of the Mayan population migrated to the coast in search of employment. As the price of basic foodstuffs such as beans and corn

increased in the 1970s, 75 percent of Guatemala's children were undernourished. Since synthetic fertilizer held the promise to combat this crisis, it became "an indispensable technical base" for many farmers. When the 1973 international oil crisis drove up the cost of synthetic fertilizer, many low-income Maya who had become dependent on it had to migrate to the coast to pay for it. In one illustrative example, Poaquil experienced its most intense emigration during the 1970s. Printed in 1980, the Poaquil health center monograph states:

> During the summer due to a lack of [employment] activity approximately forty percent of the manual laborers emigrate seasonally to the coast to take advantage of the cutting of cotton and coffee. It is affirmed that ninety-five percent of the agriculturists that go to cut on the coast work to pay for their fertilizers or money that has been lent to them for the purchase of those goods. The salaries paid the agricultural peon fluctuate between 1.50 and 2.00 quetzals [$1.50–$2.00] daily.

Instead of alleviating the need to work on the coast, synthetic fertilizers perpetuated it. Their dependency on the expensive fertilizer regime led farmers in Tecpán to judge synthetic fertilizer "a mixed blessing at best." Since only Maya with sufficient land and cash resources avoided coastal migration, in effect the Green Revolution separated the poor from the rich in highland Guatemala by compelling resource-poor farmers to migrate while their resource-rich counterparts remained in their communities.[37]

Such forces beyond their control help to explain ambivalent and at times bitter memories associated with synthetic fertilizers in Kaqchikel narratives. Ka'i' Kame, a fifty-year-old facilitator of local development groups, explains:

> As the cost of fertilizer increased more people had to go to the coast to pay for it. The *contratistas* [labor brokers] gave them fertilizer in exchange for work on the coast. They owed between five hundred and two thousand quetzals [$83.34–$333.34]. The chemical fertilizer resolved one problem, but then caused another. Forty years ago fertilizer cost five quetzals [$5.00] per quintal, but now it is one hundred quetzals [$16.67] per quintal. A long time ago the land was stronger. It was not yet ruined, but now the chemicals have burned the land. The animals in the land have died. The land has lost its life.[38]

As a result of the adverse public health effects, spiraling costs, and diminishing returns of synthetic fertilizer, many Kaqchikel farmers are returning to organic fertilizers. Some have given up growing NTA crops and reverted their fields back to milpa for these reasons. Jun Ey, a seventy-four-year-old agriculturist from Aguas Calientes explains:

> I use natural, not chemical fertilizer because there are no costs. It is good for my corn, bean, and tomato harvest. I have not had pests in a while. The chemical fertilizer brought pests so then farmers had to buy poison from the same people who make the chemical fertilizer. It was a way to deceive the people. If you buy chemical fertilizer, you can make big money; but it will catch up with you because each day you have to spray [pesticides].

In a reflection of other Mayan farmers' sentiments, Jun Ey argues that synthetic fertilizers led to a vicious cycle of increased costs from which farmers could not escape. To guide their alternative agricultural methods, many Kaqchikel reflect on a time when agriculturists only employed organic fertilizer from the manure of such domestic animals as goats, sheep, horses, chickens, and cows. A seventy-year-old evangelical barber and farmer details one method of acquiring organic fertilizer: "A long time ago people only used fertilizer from their home. Each home had a hole and you swept everything from the courtyard into it. Then you would gather this compost and bring it to your fields. . . . Organic fertilizer is a tremendous aid, but [most] people no longer have the animals to make it." As his comment implies, Kaqchikel used almost any organic material available to them from kitchen scraps and ashes to plant residues and animal waste for compost. And as one elderly woman from Patzún indicates, the shift from organic to synthetic fertilizer affected gender relations as well as economics and the physical environment: "Before, we, the women, were in charge of the compost, mixing kitchen and crop scraps; but now we are losing the traditions and we have to buy fertilizers and Patzún is covered with garbage."[39]

Because it is better for the land and helps to control pests, the few farmers who have access to manure readily use it arguing that, instead of jeopardizing the land's fecundity and natural pest predators, organic fertilizer replenishes them. Though the literature about the effects of organic fertilizer is inconclusive and scant, one study performed in Patzún found

that corn planted with organic fertilizer had fewer aphids than corn grown with synthetic fertilizers. And by slowly building up the organic content of soil, manure applications can reverse the trend of soil depletion. Some studies have shown that organic fertilizers can match and even outperform synthetic fertilizers. According to Kaqchikel farmers, for some crops, such as potatoes, natural fertilizers yield a better harvest. Informants also insist that crops produced with organic fertilizers provide a healthier diet than those produced with synthetic fertilizers. And for animal owners, manure is free.[40]

Yet for those who do not own livestock, organic fertilizer can be prohibitively expensive and hard to locate. Farmers from Quetzaltenango, for instance, purchase chicken manure from Guatemala City, about one hundred kilometers away. Even for those who have the materials at hand, producing organic fertilizer is labor intensive, though Kaqchikel did not consider this a drawback. More significantly, once soil has become dependent on synthetic fertilizers, it can take two to eight years for it to restore its structure so that organic compost can be effective. For Mayan farmers with limited resources, this waiting period impedes their transition to organic fertilizers. Few can afford to wait out the low yields while soil organisms reestablish themselves. Since access to organic fertilizer is largely dependent upon a farmer's resources, like synthetic fertilizer, its use reveals (and at times exacerbates) class disparities in Mayan communities.[41]

Despite the challenges, more Guatemalan farmers are applying organic fertilizers including leaf litter and water hyacinth composts. To facilitate the shift away from synthetic fertilizers, some Kaqchikel advocate a mixture of organic and synthetic fertilizers. Ix'ajmaq, a thirty-one-year-old teacher and university student elaborates, "Organic fertilizer from compost is not enough so we have to use chemical fertilizer for our corn crops." Like farmers in Brazil, Kaqchikel agriculturists like Ix'ajmaq are using synthetic fertilizers as supplements rather than the principal source of vegetal nutrition.[42]

In an indication of how prevalent and important the debate about fertilizers, agricultural production, and public health has become in Guatemala, these issues permeate curricula. Literacy campaigns that focus on the problems and necessities of the indigenous population identify fertilizers as a central concern. To cite another example, one Kaqchikel school director believes organic practices to be so crucial to her people's

survival that she includes lessons about agriculture, agrochemicals, and organic fertilizers in the curriculum.

> Here in Patzicía we have plenty of agricultural work, but there are also problems that go along with that. It is important that children know how to farm, that they know what is good for the land and what hurts the land. We have plenty of vegetables here, but we also have much insecticide and chemicals. Some farmers do not know it is a problem, so it is important that students understand it is a problem. Here in our town we have gastritis because there are so many chemicals. They use too many chemicals in agriculture. When you go to the hills and fields you can smell the poison.[43]

Kaqchikel and other small-scale Guatemalan farmers' increasing use of organic fertilizers capitalizes on a number of advantages. Unlike synthetic fertilizers that suffer from low soil retention rates, by releasing nutrients slowly organic fertilizers act as a sponge thereby maintaining higher levels of moisture. By nourishing natural fungi and other nutrients, they correct soil imbalances, whereas synthetic fertilizers' concentration of a few nutrients results in the deficiency of others. Organic fertilizers also stimulate plant growth by producing carbon dioxide. Yet even with these benefits, Kaqchikel farmers are not rejecting synthetic fertilizers or agricultural technology outright. By the very nature of their rural lives and Guatemala's varied ecology, these Mayan farmers recognize the need for solutions that focus on local agronomic, ecological, and socioeconomic conditions. Like other studies, the Kaqchikel case demonstrates the need for integrated, ecologically specific solutions that allow for farmers' expertise and control. In fact, as early as the 1970s, the Instituto de Ciencia y Tecnología Agrícolas in Guatemala experimented with allowing farmers instead of agronomists to evaluate the appropriateness and effectiveness of certain technological innovations. As anthropologist Les Field argues, using farmers to assess innovative techniques and technologies is particularly important when working with indigenous peoples whose identities and livelihoods are tied to the land and agriculture. Most importantly, having indigenous agriculturists guide research models, projects, and goals not only enriches agronomists' understanding of agricultural development but also yields practical applications for indigenous farmers and communities.[44]

Return trips to Guatemala in 2001, 2003, 2005, and 2008 revealed that the ambiguities, tensions, and differences of opinion about synthetic

fertilizer were deepening in Kaqchikel communities. Many complained of synthetic fertilizer's rising cost and some mobilized to amplify their voices. On June 26, 2008 the *alcaldía indígena* (indigenous mayor's office) of Sololá organized a demonstration of over one thousand people to protest the spiraling costs of gasoline and synthetic fertilizer. Since its constituency of rural Maya is comprised mainly of small-scale farmers, the alcaldía indígena is acutely aware of the challenges Kaqchikel farmers face. Yet just a few days before the protests, Kaji' Tz'ikin, a former Sololá alcalde indígena praised synthetic fertilizer for increasing yields and thus alleviating hunger and migrant labor. These contrasting opinions were at once both oppositional and interrelated. The protesters were not denying the importance of synthetic fertilizer; they simply did not want it to impoverish them. In turn, as one of the first Sololatecos to use synthetic fertilizer in 1956, the eighty-one-year-old Kaji' Tz'ikin later helped form and direct a cooperative that provided loans to small-scale farmers to purchase synthetic fertilizer. Perhaps capital more than any other factor explained the differences in experiences and opinions. Kaji' Tz'ikin's nearly one hundred fifty cuerdas upon which he farmed wheat, milpa, potatoes, cabbage, carrots, and other vegetables helped him to weather the increased prices over the years. As in the past, farmers with large landholdings or those who had successfully transitioned to NTAs could afford to pay the rising costs. As one Comalapan who grows blackberries on two cuerdas said: "Sure chemical fertilizer is expensive, but I can earn a good profit exporting blackberries." Not all NTA farmers enjoyed such prosperity, however. One devastated farmer who held a handful of blackberries that had been rejected because they contained high levels of toxins, bemoaned: "I can't make tortillas with these."[45]

As the protesting Sololatecos pointed out, instead of alleviating poverty, agrochemical and NTA strategies ultimately impoverished many small-scale Mayan farmers. Though Kaqchikel (and other Mayan) communities as a whole are increasingly land starved, the differing opinions about and contrasting approaches to this problem expose cracks in the community solidarity image of indigenous life. Cultural legacies aside, this study confirms that the farther away end users are from decisions about the practices and usages of agricultural technologies, the worse the long-term and unintended consequences are for them. Since postwar geopolitics largely dictated the Green Revolution in Guatemala, synthetic

fertilizer generally undermined small-scale farmers' self-sufficiency by creating an agrochemical dependency that constrained their ability to determine their cultivation practices.

The Kaqchikel case demonstrates that synthetic fertilizers are not a long-term solution to small-scale, sustainable agriculture. When rising costs and diminishing returns compelled Kaqchikel to return to the very migration patterns from which they expected synthetic fertilizer to relieve them, its limitations were apparent. In a recent study that underscores the Kaqchikel experience, the chemist Arvin Mosier and his colleagues found that nitrogen fertilizer application does not meet the food needs of a growing population. Ultimately, when indigenous and other small-scale farmers reduce their dependence on synthetic fertilizers (and other agrochemicals), they increase their own autonomy and their farms' sustainability. And as oil prices increase, small farms that use organic fertilizers become more productive than larger agrochemically dependent ones in terms of output per unit of purchased goods. Even though Kaqchikel, Maya, and other indigenous groups have been erroneously labeled as having narrow worldviews, solutions to global food crises can be found in their community-based strategies. This is not to say that Kaqchikel farmers hold the answers to agricultural problems around the world, but rather that their example underscores the importance of allowing local knowledge, experience, and ecology to guide agricultural approaches. For example, that milpa farming cannot be replicated on an industrial scale could be considered one of its strengths. Ethnoecological approaches, which take seriously how indigenous peoples understand, use, and manage their environment, could transform how innovative technologies are created and applied and avoid the pitfalls of simplistic universal solutions.[46]

But as the history of the Green Revolution in Guatemala demonstrates, local agricultural practices do not develop in a vacuum. The interplay of international, national, and local forces determine both the range of innovation available to local farmers and their ability to act on their assessments. For example, even today Ladinos (non-indigenous Guatemalans) and foreign agronomists too often dismiss Mayan practices, knowledges, and epistemologies as "backward" or unscientific. Just as the shift toward the Green Revolution in Guatemala was overdetermined by politics, a significant reduction in the use of synthetic fertilizers

and other agrochemicals is more contingent upon political and economic changes than upon the small-scale farmers who are already "greening" their cultivation practices.[47]

At the same time, Mayan farmers are not powerless. Although their profit margins are smaller, milpa farmers have more control over the use of synthetic fertilizers than their NTA counterparts because milpa farming is more closely related to patterns of local consumption. Dependency theorists such as Alain de Janry have long argued that the dependency of local markets on global ones is related to the disarticulated nature of undeveloped economies where goods are largely produced for export markets and consumption abroad. Save the few who produce for the growing organic market in Europe and the United States, NTA farmers are still largely tied to the agrochemical regime. In contrast, with their considerable local market power and in the face of rising petroleum and thus synthetic fertilizer prices, small-scale farmers who produce for local and even regional consumption have the potential to alter the composition of their agricultural inputs. Indeed, many have already done so. A local consumer base that is increasingly concerned about the public health effects of synthetic fertilizers may be inclined to encourage and even demand this shift.[48]

NOTES

1. I am indebted to John Soluri, Ted Fischer, Travis Wagner, Michael Steinberg, Mark Lapping, Jeffrey Fitts, Hector Sáez-Nuñez, and the three anonymous reviewers for *Agricultural History* for their critiques of earlier drafts of this essay. Audience comments at the Latin American Studies Association International Conference, 2001, Washington, DC, where I first presented this research were also helpful. Crystal Wilder and Cassandra Fitzherbert provided valuable research and technical assistance.

The empirical data for this study come from a larger project that used both oral and archival sources to explore the history of Guatemala from Mayan perspectives. The majority of informants were male and female elders, although I interviewed some younger farmers. Oral narratives from residents of the Maya-Kaqchikel towns of Comalapa, Poaquil, Tecpán, and Patzicía in the department of Chimaltenango, Aguas Calientes, and Barahona in the department of Sacatepéquez, and Sololá in the department by the same name provided a nuanced understanding of Mayan farmers' uses and perceptions of synthetic fertilizers. I conducted all interviews in informants' first language: Kaqchikel. In turn, the *jefe político* (governor) papers from Chimaltenango at the Archivo General de Centro América and periodical holdings at the Hermeroteca–Biblioteca Nacional in Guatemala City as well as the municipal archives in Comalapa and Patzicía provided information on the introduction, use, and dissemination of synthetic fertilizers. The majority of the interviews took place during my initial fieldwork from June 1997 to Sept. 1998. All interview recordings are in my possession.

Interview with Wuqu' Iq', Dec. 17, 1997, Comalapa. Due to the continued political volatility of Guatemala and recurrent human rights abuses, I have preserved the anonymity of my sources for their safety. For the most part, I have used pseudonyms that derive from the Mayan calendar. Female informants can be recognized by the "Ix" prefix to their one-word names. In contrast, male names have two words.

2. For a pioneering effort, see, Sutti Reissig Ortiz, *Uncertainties in Peasant Farming: A Columbian Case* (New York: Athlone Press, 1973). Ortiz based her analysis of agricultural development on hundreds of interviews with Páez farmers. Yet even in studies that laud indigenous and other farmers' agricultural practices, their voices remain buried. See, for example, Paul Richards, *Indigenous Agricultural Revolution: Ecology and Food Production in West Africa* (London: Hutchinson, 1985); Robert E. Rhoades, *Breaking New Ground: Agricultural Anthropology* (Lima: International Potato Center, 1984); Stephen D. Biggs, *Resource-Poor Farmer Participation in Research: A Synthesis of Experiences from Nine National Agricultural Research Systems* (The Hague: International Service for National Agricultural Research, 1989); Joyce Lewinger Moock and Robert E. Rhoades, eds., *Diversity, Farmer Knowledge, and Sustainability* (Ithaca: Cornell University Press, 1992); Robert Chambers et al., eds., *Farmer First: Farmer Innovation and Agricultural Research* (London: Intermediate Technology Publications, 1989). For a critique of the imperialist history of research in indigenous communities and a framework for participating in decolonized indigenous research, see, Linda Tuhiwai Smith, *Decolonizing Methodologies: Research and Indigenous Peoples* (London: Zed Books, 2006).

3. The date of chemical fertilizers' arrival in Kaqchikel oral histories ranged from 1937 (Interview with Oxi' Kawoq, Oct. 31, 1997, Comalapa) to 1968 (Interviews with Jun Iq', Apr. 18, 1998; Oxlajuj Ajpu', Jan. 19, 1998, Comalapa). Although synthetic fertilizer was promoted in Guatemala by the turn of the century, most Mayan farmers did not experiment with it until the 1950s. As reflected in archival data, large-scale agrobusinesses were beginning to use synthetic fertilizers in the 1920s (along with a few pioneering small-scale farmers). Yet most of these enterprises did not routinely use fertilizers until the 1940s and 1950s. In this sense, both oral and archival sources accurately reflect how the introduction of synthetic fertilizer varied across time and place in Guatemala.

4. Sonia I. Arbona, "Commercial Agriculture and Agrochemicals in Almolonga, Guatemala," *Geographical Review* 88 (Jan. 1998): 47, 53, 55, 56, 58, 61, 62; David Pimentel, "Green Revolution Agriculture and Chemical Hazards," *Science of the Total Environment* 188 Supp. 1 (Sept. 1996): S87, S92–94; David Pimentel et al., "Environmental and Economic Costs of Pesticide Use," *BioScience* 42 (Nov. 1992): 750–51; Polly Hoppin, "Pesticide Use on Four Non-Traditional Crops in Guatemala: Policy and Program Implications" (PhD diss., Johns Hopkins University, 1991); AVANSCO, *Impacto Ecológico de los Cultivos Hortícolas No-Tradicionales en el Altiplano de Guatemala: Efecto sobre Plagas, Organismos Benéficos y Suelo* (Guatemala: Instituto AVANSCO, 1994), 1; Lori Ann Thrupp et al., *Bittersweet Harvests for Global Supermarkets: Challenges in Latin America's Agricultural Export Boom* (Washington, DC: World Resources Institute, 1995), 7; Martin G. Khublarian, "Chemical Substance Transport in Soils and Its Effect on Groundwater Quality," *Environmental Health Perspectives* 83 (Nov. 1989): 31–32; David Pimentel, "Impacts of Pesticides and Fertilizers on the Environment and Public Health," *Toxic Substances in Agricultural Water Supply and Drainage,* ed. Joseph Summers and Susan S. Anderson (Denver: US Committee on Irrigation and Drainage, 1989), 102–103; A. M. Fan and V. E. Steinberg, "Health Implications of Nitrate and Nitrite in Drinking Water: An Update on Methemoglobinemia

Occurrence and Reproductive and Developmental Toxicity," *Regulatory Toxicology and Pharmacology* 23 (Feb. 1996): 41–42; Dennis D. Weisenberger, "Human Health Effects of Agrichemical Use," *Human Pathology* 24 (June 1993): 574; Lester R. Brown and Gail W. Finsterbusch, *Man and His Environment: Food* (New York: Harper & Row, 1972), 173; Gordon Conway, *The Doubly Green Revolution: Food for All in the 21st Century* (Ithaca: Cornell University Press, 1998), 91–92. Of course other factors contribute to high rates of cancer in developing countries. Studies of industrialized nations have shown no link between nitrate levels and gastric cancer, for example, see, Conway, *Doubly Green Revolution,* 92.

5. Mark Dowie, *American Foundations: An Investigative History* (Cambridge: MIT Press, 2001), 113; Angus Wright, *The Death of Ramón González: The Modern Agricultural Dilemma* (Austin: University of Texas Press, 2005), 184; David McCreery, *Rural Guatemala, 1760–1940* (Stanford: Stanford University Press, 1994), 181–94; René Reeves, *Ladinos with Ladinos, Indians with Indians: Land, Labor, and Regional Ethnic Conflict in the Making of Guatemala* (Stanford: Stanford University Press, 2006); Stephen Schlesinger and Stephen Kinzer, *Bitter Fruit: The Untold Story of the American Coup in Guatemala* (New York: Doubleday and Anchor Books, 1983); Charles Brockett, *Land, Power, and Poverty: Agrarian Transformations and Political Conflict in Central America* (Boston: Unwin Hyman, 1988), 28–35; James Dunkerley, *Power in the Isthmus: A Political History of Modern Central America* (London: Verso, 1988), 464; Eric B. Ross, *The Malthus Factor: Population, Poverty, and Politics in Capitalist Development* (London: Zed Books, 1998), 125–26; Robert G. Williams, *Export Agriculture and the Crisis in Central America* (Chapel Hill: University of North Carolina Press, 1986); William C. Thiesenhusen, *Broken Promises: Agrarian Reform and the Latin American Campesino* (Boulder: Westview Press, 1995), 69–74.

6. Edward F. Fischer and Peter Benson, *Broccoli and Desire: Global Connections and Maya Struggles in Postwar Guatemala* (Stanford: Stanford University Press, 2006), 145; Ross, *Malthus Factor,* 126; Brockett, *Land, Power, and Poverty,* 72–74.

7. Lowell Gudmundson and Hector Lindo-Fuentes, *Central America, 1821–1871: Liberalism before Liberal Reform* (Tuscaloosa: University of Alabama Press, 1995); Reeves, *Ladinos with Ladinos*; David McCreery, "State Power, Indigenous Communities, and Land in Nineteenth-Century Guatemala, 1820–1920," in *The Indian in Latin American History: Resistance, Resilience, and Acculturation,* ed. John E. Kicza (Wilmington, Del.: Scholarly Resources, 2000), 191–212; McCreery, *Rural Guatemala,* 148, 294, 308, 337; Chester Lloyd Jones, "Indian Labor in Guatemala," in *Hispanic American Essays,* ed. A. Curtis Wilgus (Freeport, NY: Books for Libraries Press, 1970), 311–12; Carol A. Smith, ed., *Guatemalan Indians and the State: 1540–1988* (Austin: University of Texas Press, 1990), 68–70, 83; L. Arriola, *Riesgos y Oportunidades en la Producción de Cultivos No-Tradicionales de Exportación: Una Evaluación de Impacto Socio-Ambiental en Patzún, Chimaltenango, Textos para Debate* (Guatemala City: AVANSCO, 1994); M. Vargas Ortíz, "Situación Penosa," *El Impulso* (Guatemala), Feb. 28, 1915, 2; Jefe Político to Alcalde de San Martín Jilotepeque, Legajo (Leg.) 76, 1933; Jefe Político to Alcalde de San Martín Jilotepeque, 1937, Jefatura Política, Chimaltenango (hereafter JP-C), Archivo General de Centro América (hereafter AGCA); *Memoria de la Secretaria de Gobernación y Justicia Presentada a la Asamblea Nacional Legislativa en sus Sesiones Ordinarias* (Guatemala: Tipografía Nacional, 1915), 3, 214; *Diario de Centro América* (Guatemala), Mar. 22, 1933.

8. For an example of a sister and brother coming to blows over how their father allotted family land, see, Juana Miculax Mutzutz to Patzicía *juez* [judge], Apr. 26, 1948, Paquete

(Paq.) 45; *Juana Miculax Mutzutz v. Pascual Miculax,* May 20, 1949, Paq. 150, *denuncias,* Archivo Municipal de Patzicía, Patzicía, Guatemala (hereafter AMP); Interview with Waqxaqi' Ajmaq, July 7, 2001, Comalapa.

9. Workers at Finca Luarca Zumbador to Ministro de Economia y Trabajo de Guatemala, Oct. 27, 1947, Leg. 48762 (actual no. 69); Inspección General de Trabajo: Guatemala, Zona Número Tres, Mar. 22, 1948; Inspección Departamental de Trabajo, Zona Número Tres, San Marcos, Dec. 16, 1947; Clemente Laynes y compañeros de Finca Australia to Presidente de la República de Guatemala, Oct. 24, 1947, Leg. 48762, Instituto General de Trabajo, Correspondencia, AGCA; Ramo Civíl II, Leona Itzol contra Cruz Yancoba Sitán, July 1, 1939, Paq. 45, AMP; David Carey Jr., "Empowered through Labor and Buttressing Their Communities: Mayan Women and Coastal Migration, 1875–1965," *Hispanic American Historical Review* 86 (Aug. 2006): 501–34; Richard Adams, *Crucifixion by Power: Essays on Guatemalan National Social Structure, 1944–1966* (Austin: University of Texas Press, 1970), 170, 392–93; McCreery, *Rural Guatemala,* 1–3, 148, 294, 308, 326–33, 341–42; Oliver La Farge, "Maya Ethnology: The Sequence of Cultures," in *The Maya and Their Neighbors,* ed. C. L. Hay (New York: Appleton-Century, 1940); McCreery, "State Power," 192, 207–208; Guillermo Náñez Falcón, "Erwin Paul Dieseldorff, German Entrepreneur in the Alta Verapaz of Guatemala, 1889–1937" (PhD diss., Tulane University, 1970), 323; Richard Adams, "La Población Indígena en el Estado Liberal," *Historia General de Guatemala,* Vol. 5, ed. Jorge Luján Muñoz (Guatemala City: Asociación de Amigos del País, Fundación para la Cultura y Desarrollo, 1995), 176; John Early, "Population Increase and Family Planning in Guatemala," *Human Organization* 34 (Fall 1975): 276; David McCreery, "Debt Servitude in Rural Guatemala, 1876–1936," *Hispanic American Historical Review* 63 (Nov. 1983): 758; Valentín Solórzano, *Evolución Económica de Guatemala* (1947, repr., Guatemala: Editorial José de Pineda Ibarra, Ministerio de Educación, 1977), 319–20, 343; David C. Johnson, "Internationalization and the Guatemalan Coffee Economy, 1890–1910," *SECOLAS Annals* 34 (Oct. 2002): 73; McCreery, "Wage Labor," 217–19; Marilyn M. Moors, "Indian Labor and the Guatemalan Crisis: Evidence from History and Anthropology," in *Central America: Historical Perspectives on the Contemporary Crises,* ed. Ralph Lee Woodward Jr. (New York: Greenwood Press, 1988), 71.

10. Gudmunson and Lindo-Fuentes, *Central America, 1821–1871*; Reeves, *Ladinos with Ladinos*; *Diario de Centro América,* Sept. 3, 4, 7, 9, 1936; Sheldon Annis, *God and Production in a Guatemalan Town* (Austin: University of Texas Press, 1987), 44; Wright, *Death of Ramón González,* 186.

11. Carlos Rafael Cabarrús Pellecer, *En la Conquista del Ser: Un Estudio de Identidad Étnica* (Guatemala City: CEDIM-FAFO, 1998), 93; Robert Wasserstrom, "Revolution in Guatemala: Peasants and Politics under the Arbenz Government," *Comparative Studies in Society and History* 17 (Oct. 1975): 443–78; Piero Gleijeses, "The Agrarian Reform of Arbenz," *Journal of Latin American Studies* 21 (Oct. 1989): 472–73; Nathan L. Whetten, *Guatemala: The Land and the People* (New Haven: Yale University Press, 1961), 158; Brockett, *Land, Power, and Poverty,* 100–105, 196, 201n3; John Gillin, "San Luis Jilotepeque: 1942–55," in *Community Culture and National Change,* ed. Richard Adams (New Orleans: Middle American Research Institute, Tulane University, Publication No. 24, 1972), 26; Jim Handy, "National Policy, Agrarian Reform, and the Corporate Community during the Guatemalan Revolution, 1944–54," *Comparative Studies in Society and History* 30 (Oct. 1988): 698–724; Jim Handy, "The Corporate Community, *Campesino* Organizations, and Agrarian Reform: 1950–1954," in *Guatemalan Indians and the State*; Jim Handy, *Revolution in the*

Countryside: Rural Conflict and Agrarian Reform in Guatemala, 1944–1954 (Chapel Hill: University of North Carolina Press, 1994), 87–89; Dunkerley, *Power in the Isthmus,* 144–50, 434; Theisenhusen, *Broken Promises,* 74–84; Ross, *Malthus Factor,* 121–22. The UFCO perceived need for fallow land stemmed as much from the threat of hurricanes as the company's still less-than-intensive production practices. A number of links connected the Rockefeller Foundation, UFCO, and the Eisenhower administration. As one example, the chairman of the Rockefeller Foundation, John Foster Dulles, drafted the 1936 contract with Ubico that gave UFCO "a ninety-nine year lease with exceptional tax benefits" and served as the Secretary of State. His brother, Allen Dulles, was director of the CIA from 1953–1961 and a member of the UFCO board. See, Gerard Colby with Charlotte Dennett, *Thy Will Be Done: The Conquest of the Amazon: Nelson Rockefeller and Evangelism in the Age of Oil* (New York: HarperCollins, 1995), 233, 241–44, 264; Dowie, *American Foundations,* 109–14.

12. Dowie, *American Foundations,* 109–12; Brent E. Metz, *Ch'orti'-Maya Survival in Eastern Guatemala: Indigeneity in Transition* (Albuquerque: University of New Mexico Press, 2006), 66.

13. Russell King, *Land Reform: A World Survey* (Boulder: Westview Press, 1977); William Paddock and Paul Paddock, *Famine 1975!* (London: Weidenfeld and Nicolson, 1967), 46; Ross, *Malthus Factor,* 126–27; Keith Griffin, *Alternative Strategies for Economic Development* (Basingstoke, UK: Macmillan, 1989), 147; Adolf Berle, "The Cuban Crisis: Failure of American Foreign Policy," *Foreign Affairs* 39 (Oct. 1960): 40–55; John P. Gillin, "Some Signposts for Policy," in *Social Change in Latin America Today: Its Implications for United States Policy,* ed. Philip E. Mosely (New York: Vintage Books, 1960), 14–62.

14. Interviews with Junlajuj K'at, July 9, 1998; Ix'aq'om, Nov. 5, 1997; Oxi' Kawoq, Oct. 31, 1997; Jun Imox, Dec. 9, 1997; Oxlajuj Ajpu', Jan. 19, 1998; Lajuj Kan, Oct. 16, 1997, Dec. 20, 1997; Ixk'aj, Dec. 17, 1997; Ixchiköp, Dec. 17, 1997; Wo'o' No'j, Apr. 22, 1998; Ixkame, Aug. 17, 1998; Wuqu' B'atz', Feb. 10, 1998; Waqi' Iq', Apr. 22, 1998, Comalapa; B'eleje' Ey, Nov. 23, 1997; Ix'aq'ab'al, Mar. 17, 1998; Ixmanik, Nov. 17, 1997, Poaquil; Waqi' Imox, May 3, 1998; Kab'lajuj Aq'ab'al, Nov. 19, 1997, Tecpán; Adams, "La Población Indígena," 177; John Watanabe, "Enduring Yet Ineffable Community in the Western Periphery of Guatemala," in *Guatemalan Indians and the State,* 188; Ricardo Falla, *Quiché Rebelde: Estudio de un Movimiento de Conversión Religiosa Rebelde a las Creencias Tradicionales en San Antonio Ilotenango, Quiché, 1948–70* (Guatemala: Editorial Universitaria, 1978), 82; Fischer and Benson, *Broccoli and Desire,* 39–40. Almost invariably, Kaqchikel informants used the term *abono cémico,* which I translate as chemical fertilizer. I leave it as such in their accounts because it highlights the presence and use of chemicals, which the term synthetic fertilizer obscures. Depending on the region and local custom in Guatemala, the measurement of a cuerda ranges from six to twenty-five cuerdas to a *manzana* (6,999 square meters). In the department of Chimaltenango the measurement is six cuerdas to a manzana among Mayan farmers. In many Kaqchikel communities such as Patzicía and Comalapa there are forty varas in a cuerda, but this measurement is not standardized either; some Mayan farmers measure twenty varas in a cuerda. I thank Alberto Esquit Choy for clarifying these measurements for me.

15. Interviews with B'eleje' K'at, Nov. 5, 1997; Wuqu' K'at, Apr. 5, 1998; Kab'lajuj Tijax, Apr. 7, 1998; Waqi' Kame, May 17, 1998; Wo'o' Ey and Kab'lajuj B'atz', Mar. 28, 1998; Kab'lajuj Ajpu', May 5, 1998; Ixwatzik', Nov. 12, 1998; Oxi' Kawoq, Oct. 31, 1997, Comalapa; Kaji' No'j, Waqxaqi' B'atz', Lajuj Q'anil, Mar. 25, 1998, Poaquil; Ka'i' Kan, Nov. 24, 1997;

B'eleje' Iq', June 4, 1998, Tecpán. For similar evidence of increased harvests from synthetic fertilizer application, see, John Watanabe, *Maya Saints and Souls in a Changing World* (Austin: University of Texas Press, 1992), 135–36.

16. Interview with Junlajuj Tz'i', Oct. 24, 1997, Comalapa. Some Kaqchikel farmers, such as broccoli growers from Tecpán, accept the risks inherent in both the application of agrochemicals and their dealings with the international economy because they maintain that the opportunity to trade NTAs has improved their lives, see, Fischer and Benson, *Broccoli and Desire,* 39, 48; Sarah Hamilton and Edward Fischer, "Non-Traditional Agricultural Exports in Highland Guatemala," *Latin American Research Review* 38 (Oct. 2003): 82–110.

17. "La Doctrina de los Abonos Químicos," *Boletín de Agricultura, Revista Mensual* (Apr. 1903): 246; *Memoria del Ministerio de Agricultura 1922* (Guatemala: Tipografía Nacional, 1922), 10–11; Annis, *God and Production,* 44; "Municipalidad de San Juan Comalapa Libro para Actas de Sesiones Ordinarias y Extraordinarias Comenzado el 23 de Julio de 1928 Terminado 1 de Enero de 1930," Dec. 19, 1929, Archivo Municipal de Comalapa; *Diario de Centro América,* Sept. 3, 4, 7, 9, 1936; *La Gaceta de Policía* (Guatemala), June 13, 1943, 1079; Arriola, *Riesgos y Oportunidades en la Producción*; Metz, *Ch'orti'-Maya Survival,* 66.

18. Interview with Kaji' Tz'ikin, June 24, 2008, Sololá; Falla, *Quiché Rebelde,* 82–83; Carol A. Smith, *Indian Class and Class Consciousness in Prerevolutionary Guatemala* (Washington, DC: Latin American Program, Wilson Center, 1984), 32; Ricardo Falla, "Hacia la Revolución Verde: Adopción y Dependencia del Fertilizante Químico en un Municipio del Quiché, Guatemala," *Estudios Sociales,* Vol. 6 (Guatemala: Universidad Rafael Landívar, 1972), 16–51. In another comparative case, it was not until the 1960s that Mayan residents of Aguacatán began using synthetic fertilizer, see, Douglas E. Brintnall, *Revolt Against the Dead: The Modernization of a Mayan Community in the Highlands of Guatemala* (New York: Gordon and Breach, 1979), 176.

19. Adams, "La Población Indígena," 177; Watanabe, *Maya Saints and Souls,* 134; Helda Eleonora Morales, "Pest Control and Soil Management in the Guatemalan Highlands: Understanding Traditional Agricultural Practices" (PhD diss., University of Michigan, 1998), 4, 51; Arriola, *Riesgos y Oportunidades en la Producción*; Watanabe, "Enduring Yet Ineffable Community," 188; Falla, *Quiché Rebelde,* 82. For evidence of Mayan milpa farmers' yields increasing in Mexico after synthetic fertilizer application, see, Ute Schüren, "Milpa in Crisis?: Changing Agricultural Practices Among Rural Producers in Campeche," in *Maya Survivalism,* ed. Ueli Hostettler and Matthew Restall (Markt Schwaben, Ger.: Verlag Anton Saurwein, 2001), 272.

20. Morales, "Pest Control and Soil Management," 62; Wuqu' K'at, "Libreta de Apuntes," nd, MS, in Wuqu' K'at's possession; Miguel Angel Sotz O., "Monografía de Comalapa, Diagnóstico Comunitario 1994," nd, typed MS, Proyecto 2439 Chuwi Tinamit, Chuwi Tinamit Archive, Comalapa, Guatemala, p. 9; Santiago Xet, "Campos de Ensayos y de Demostraciones, Prácticas del Programa de Fertilización de 'FAO-SFEI' en San Juan Comalapa, Chimaltenango," and "Técnica sobre la Agricultura: Servicio de Fomento de Economía Indígena cuenta con Programas de Ensayo sobre Fertilización," *Comalapan* (Comalapa), (Sept. 1966): 6, 7.

21. Victor Bulmer-Thomas, *The Political Economy of Central America since 1920* (Cambridge: Cambridge University Press, 1987), 114–16, 206; Edward F. Fischer, "Late Capitalism and Maya Resurgence in Guatemala," in *Maya Survivalism,* 207; Edward Fischer and

Carol Hendrickson, *Tecpán Guatemala: A Modern Maya Town in Global and Local Context* (Boulder: Westview Press, 2003), 137; Williams, *Export Agriculture,* 40, 43.

22. Interviews with Jun Kame, May 1, 1998; Jun Tz'i', July 11, 1998; Jun Iq', Apr. 18, 1998; Jun Kan, Aug. 19, 1998; Waqi' K'at, May 3, 1998, Comalapa; Rigoberta Menchú, *Crossing Borders* (London: Verso, 1998), 219; Watanabe, "Enduring Yet Ineffable Community," 188; Falla, *Quiché Rebelde,* 82.

23. Interview with Oxi' Kame, Mar. 4, 1998, Comalapa; Oficina de Derechos Humanos del Arzobispado de Guatemala—Proyecto Interdiocesano de Recuperación de la Memoria Histórica, *Guatemala, Nunca Más: Impactos de la Violencia* (Guatemala City: ODHAG, 1998), 4 Vols.; UN Human Rights Report, *Guatemala: Memoria del Silencio,* http://shr.aaas.org/guatemala/ceh/mds/spanish/toc.html, 1999 (accessed Aug. 12, 2008). Oral accounts regarding agronomists did not associate them with any group affiliation. The implication is that these foreigners acted of their own accord, not on behalf of an organization. Similarly, Kaqchikel also accused 1976 earthquake relief workers of disseminating Marxist ideology that attracted the Guatemalan military and heightened violence in Kaqchikel communities, see, David Carey Jr., *Our Elders Teach Us: Maya-Kaqchikel Historical Perspectives. Xkib'ij kan qate' qatata'* (Tuscaloosa: University of Alabama Press, 2001), 144–47.

24. Interviews with Wuqu' Imox, Nov. 12, 1997; Lajuj Aq'ab'al, Nov. 14, 1997, Aguas Calientes; Ka'i' B'atz', Nov. 26, 1997; Ixsu'm, June 1, 1998, Tecpán; Waqi' K'at, May 3, 1998; Wo'o' Kan, Apr. 27, 1998; Oxlajuj Kan, Mar. 8, 1998; Oxlajuj Iq', Apr. 17, 1998; Wuqu' Iq', Dec. 17, 1997; Ixchel, Feb. 12, 1998; Ixsamaj, Sept. 6, 1998; Wo'o' Ajpu', Nov. 11, 1997, Comalapa; Ixxeq, July 1, 2001, Poaquil; Ross, *Malthus Factor,* 126–27; Dowie, *American Foundations,* 109–14; Cabarrús Pellecer, *En la Conquista del Ser,* 93. In stark contrast to Kaqchikel knowledge, scholars who conducted a study in the eastern Guatemalan towns of Jalapa and Chiquimula found that farmers and community members had little awareness of the health problems caused by pesticides. See, Roger Popper et al., "Knowledge and Beliefs Regarding Agricultural Pesticides in Rural Guatemala," *Environmental Management* 20 (Mar. 1996): 241–48.

25. AVANSCO, *Impacto Ecológico,* 42; Weisenberger, "Human Health Effects of Agrichemical Use," 571, 573; Pimentel et al., "Environmental and Economic Costs," 751, 758; Douglas L. Murray, *Cultivating Crisis: The Human Cost of Pesticides in Latin America* (Austin: University of Texas Press, 1994), 69–71; Elizabeth Guillette et al., "An Anthropological Approach to the Evaluation of Preschool Children Exposed to Pesticides in Mexico," *Environmental Health Perspectives* 106 (June 1998): 347–53; Wright, *Death of Ramón González,* 317–20, 339–40; Luiz A. Martinelli et al., "Sources of Reactive Nitrogen Affecting Ecosystems in Latin America and the Caribbean: Current Trends and Future Perspectives," *Biogeochemistry* 79 (May 2006): 3–24; J. N. Galloway et al., "Nitrogen Cycles: Past, Present and Future Perspectives," *Biogeochemistry* 70 (Sept. 2004): 153–226; Conway, *Doubly Green Revolution,* 34, 86, 91–93; Edmund K. Oasa, "The Political Economy of International Agricultural Research: A Review of the CGIAR's Response to Criticisms of the 'Green Revolution,'" in *The Green Revolution Revisited: Critiques and Alternatives,* ed. Bernhard Glaeser (London: Allen & Unwin, 1987), 23; Brown and Finsterbusch, *Man and His Environment,* 173; Michael Perelman, *Farming for Profit in a Hungry World: Capital and the Crisis in Agriculture* (Montclair, NJ: Allanheld, Osmun, 1977), 179.

26. Helda Morales et al., *Impacto Ambiental de los Cultivos no Tradicionales en el Altiplano de Guatemala* (Guatemala City: AVANSCO, 1994), Textos para Debate, no. 5;

Hoppin, "Pesticide Use"; Morales, "Pest Control and Soil Management," 44; Joachim von Braun et al., "Nontraditional Export Crops in Guatemala: Effects on Production, Income, and Nutrition," *International Food Policy Research Institute Report No. 73* (Washington, DC: International Food Policy Research Institute, 1989); Michael J. Watts, "Living Under Contract: Work, Production, Politics, and the Manufacture of Discontent in a Peasant Society," in *Reworking Modernity: Capitalism and Symbolic Discontent,* ed. Allan Pred and Michael J. Watts (New Brunswick: Rutgers University Press, 1992), 65–105; Mary McKay, Ecumenical Project for International Cooperation, Inc., personal communication, Sept. 8, 2001.

27. Interviews with Wuqu' Umül, June 24, 2001; Oxi' Imox, July 3, 2001; Oxi' Masat, June 26, 2001; Ka'i' Imox, June 29, 2001; Ixqïtz', July 6, 2001; Ixq'a'n, July 3, 2001, Comalapa; Ixxeq, July 7, 2001; Kab'lajuj Kawoq, July 1, 2001, Poaquil; Jun Masat, July 1, 2001, Tecpán; Pimentel, "Green Revolution," S87; Prabhu L. Pingali and Cynthia Marquez, "Health Costs of Long Term Pesticide Exposure in the Philippines: A Medical and Economic Analysis," *International Rice Research Institute Social Science Division Papers, No. 90-04* (Aug. 1990): 1–2.

28. Interviews with Ixkotz'i'j, July 3, 6, 2001; Ixpajb'äl, July 4, 2001; Waqxaqi' Ajmaq, July 7, 2001; Oxi' Masat, June 26, 2001; B'eleje' Imox, June 25, 2001; Ixqo'ch, June 28, 2001, Comalapa; Ka'i' Masat, July 1, 2001; Kab'lajuj Kawoq, July 1, 2001, Poaquil; Jun Masat, July 1, 2001, Tecpán; Fischer and Hendrickson, *Tecpán Guatemala,* 142.

29. J. Jeyaratnam, "Acute Pesticide Poisoning: A Major Global Health Problem," *World Health Statistics Quarterly* 43 (1990): 139–44; Pimentel, "Green Revolution," S96; Agencia Española de Cooperación Internacional, *Medio Ambiente y Salud* (Madrid: Ministerio de Salud Pública y Asistencia Social, 1995), 3; Robert Repetto and Sanjay S. Baliga, *Pesticides and the Immune System: The Public Health Risks* (Washington, DC: World Resources Institute, 1996), 55; Weisenburger, "Human Health Effects," 575; Fischer and Hendrickson, *Tecpán Guatemala,* 142.

30. Interviews with Ixche', Nov. 22, 1997; Junlajuj Kej, Mar. 22, 1998; Wuqu' Ey, Mar. 26, 1998; Ixtz'ib', Mar. 27, 1998, Poaquil; Lajuj Kame, Feb. 14, 1998; Junlajuj Kame, Apr. 12, 1998; Jun Q'anil, Feb. 9, 1998; Jun Imox, Dec. 9, 1997; Oxi' Kej, June 14, 1998, Comalapa; Waqxaqi' Kej, Feb. 7, 1998, Barahona; Ixmukane', Nov. 30, 1997; Ka'i' Tz'i', May 26, 1998, Tecpán; Fischer and Hendrickson, *Tecpán Guatemala,* 142; Conway, *Doubly Green Revolution,* 33; Pierre Spitz, "The Green Revolution Reexamined in India," in *Green Revolution Revisited,* 73–74n12; Leon Fink, *The Maya of Morganton: Work and Community in the Nuevo New South* (Chapel Hill: University of North Carolina Press, 2003), 63; Morales, "Pest Control and Soil Management," 49.

31. Interviews with Wuqu' Kej, May 31, 1998; Kab'lajuj Iq', May 31, 1998, Tecpán; Oxi' Tojil, Mar. 21, 1998, Poaquil; Waqi' K'at, Sept. 6, 1998; Wuqu' K'at, Apr. 5, 1998; Ixnum, Apr. 29, 1998; Waqi' Kame, May 17, 1998, Comalapa; Pimentel et al., "Environmental and Economic Costs," 755; Pimentel, "Green Revolution," S86, S91, S95; Conway, *Doubly Green Revolution,* 60–61 (fig. 4.9), 238; Ademar Ribeiro Romeiro, "Alternative Developments in Brazil," *Green Revolution Revisited,* 98–99; Perelman, *Farming for Profit,* 214–15; Kenneth A. Dahlberg, *Beyond the Green Revolution: The Ecology and Politics of Global Agricultural Development* (New York: Plenum Press, 1979), 82.

32. Interview with Oxi' Kame, Mar. 4, 1998, Comalapa; Morales, "Pest Control and Soil Management," 51; Michael Conroy et al., *A Cautionary Tale: Failed US Development Policy in Central America* (Boulder: Lynne Rienner Publishers, 1996).

33. Interviews with Wuqu' Kawoq, Apr. 7, 1998; Junlajuj Imox and Wo'o' Imox, May 23, 1998; Jun Iq', Apr. 18, 1998; Jun Kame, May 1, 1998; Kaji' Aj, Mar. 8, 1998; Wuqu' Iq', Dec. 17, 1997, Comalapa; B'eleje' Kan, Nov. 9, 1997; Kaji' Kej, Nov. 12, 1997, Aguas Calientes; Oxi' Tz'i', May 29, 1998, Tecpán; Waqi' No'j, Mar. 16, 1998, Poaquil; Williams, *Export Agriculture,* 162, 207; Jack Doyle, *Altered Harvests: Agriculture, Genetics, and the Fate of the World's Food Supply* (New York: Viking, 1985), 262–63; Perelman, *Farming for Profit,* 173–76. Precedents inform Wuqu' Iq''s call for government intervention. The price supports for basic grains established during the democratic governments (1944–1954) survived the overthrow of Arbenz through the Instituto de Fomento de Producción. Even the military governments of the 1970s placed price ceilings on basic foodstuffs in an effort to quell unrest. See, Bulmer-Thomas, *Political Economy,* 114; Williams, *Export Agriculture,* 175–76.

34. Lowell Gudmundson, "Peasant, Farmer, Proletarian: Class Formation in a Smallholder Coffee Economy, 1850–1950," in *Coffee, Society, and Power in Latin America,* ed. William Roseberry et al. (Baltimore: Johns Hopkins University Press, 1995), 136–37.

35. Interviews with Jun Ey, Nov. 12, 1997, Aguas Calientes; Oxlajuj Imox, Jan. 13, 1998; Kab'lajuj Ajpu', Nov. 14, 1997, Comalapa; B'eleje' Iq', June 4, 1998, Tecpán. For similar observations from Maya-Tz'utujil farmers, see, Bill Gray Douglas, "Illness and Curing in Santiago Atitlán, a Tzutujil-Maya Community in the Southwestern Highlands of Guatemala" (PhD diss., Stanford University, 1969), 32. Helda Morales and Ivette Perfecto, "Traditional Knowledge and Pest Management in the Guatemalan Highlands," *Agriculture and Human Values* 17 (Mar. 2000): 50; Morales, "Pest Control and Soil Management," 46, 48; Murray, *Cultivating Crisis,* 36–37; Pimentel, "Green Revolution," S89–90; Pimentel et al., "Environmental and Economic Costs," 752–54; Pimentel, "Impacts of Pesticides," 95, 99.

36. Arturo Arias, "Changing Indian Identity: Guatemala's Violent Transition to Modernity," in *Guatemalan Indians and the State,* 235, 238, 240; Morales, "Pest Control and Soil Management," 52.

37. Interview with Ka'i' Kame, Apr. 29, 1998, Poaquil; "Diagnóstico de Salud, Districto San José Poaquil Chimaltenango," 1980, typed MS, San José Poaquil Archive, Guatemala, p. 16; Luisa Frank and Philip Wheaton, *Indian Guatemala: The Path to Liberation* (Washington, DC: EPICA Task Force, 1984), 39; Jim Handy, *Gift of the Devil: A History of Guatemala* (Boston: South End Press, 1984), 221–24; Moors, "Indian Labor and the Guatemalan Crisis," 75–76; Adams, "La Población Indígena," 176; Ja C'Amabal I'b, "La Primera Gran Confrontación: El Movimiento Campesino Indígena del Altiplano Guatemalteca," presented to the United Nations Subcommission on Ethnic Minorities, Geneva, 1984; Arias, "Changing Indian Identity," 235; Smith, *Indian Class and Class Consciousness,* 2; Carol A. Smith, *Labor and International Capital in the Making of a Peripheral Social Formation: Economic Transformations of Guatemala, 1850–1980* (Washington, DC: Latin American Program, Wilson Center, 1984), 12; Carol A. Smith, "Beyond Dependency Theory: National and Regional Patterns of Underdevelopment in Guatemala," *American Ethnologist* 5 (Aug. 1978): 605–606; Watanabe, *Maya Saints and Souls,* 37–38, 135, 138, 144–48; Fischer and Hendrickson, *Tecpán Guatemala,* 127; Clayton P. Maxwell, "Selective Hybridity and Development in San José Poaquil, Guatemala" (master's thesis, University of Texas, 1998), 49. Similarly, Mayan farmers in Mexico became dependent on synthetic fertilizer and other "modern" means of production, see, Schüren, "Milpa in Crisis?" 271. Estimates that as much as 60 percent of Poaquil's population (generally the poor and landless) migrated to the coast in the 1990s reflect a recurring problem. In a compelling contrast, among Ch'orti'

migrants from Eastern Guatemala, few work on the coast to pay for synthetic fertilizers, Metz, *Ch'orti'-Maya Survival,* 253n3.

38. Interview with Ka'i' Kame, Apr. 29, 1998, Poaquil.

39. Interviews with Jun Ey, Nov. 12, 1997, Aguas Calientes; Oxi' Imox, July 3, 2001, Comalapa; Morales and Perfecto, "Traditional Knowledge and Pest Management," 57; Fischer and Hendrickson, *Tecpán Guatemala,* 142. A few studies in Guatemala have compared the effects of organic versus synthetic fertilizer, see, Danilo O. Palma Ramos, *Así Somos y así Vivimos: Los Ch'orti'* (Guatemala: Universidad Rafael Landivar, 2001), 34; Claudia Dary et al., *Estrategias de Sobrevivencia Campesina en Ecosistemas Frágiles* (Guatemala: FLACSO, 1998), 160. Helda Morales and others have studied the impact of fertilizers by comparing pest damage on Kaqchikel farms that used organic fertilizer to farms that used synthetic fertilizers, see, Morales, "Pest Control and Soil Management," 62, 65–84; Helda Morales et al., "Traditional Fertilization and Its Effect on Corn Insect Populations in the Guatemalan Highlands," *Agriculture, Ecosystems & Environment* 84 (Feb. 2001): 145–55. One nongovernmental organization, Alertec, has been established in Guatemala to promote organic fertilizers and agricultural practices.

40. J. I. Rodale, *Pay Dirt: Farming & Gardening with Composts* (Emmaus, Penn.: Rodale Press, 1945); H. Hoitink and H. Keener, eds., *Science and Engineering of Composting: Designing, Environmental, Microbiological, and Utilization Aspects* (Wooster: Ohio State University Press, 1993); S. Okumoto et al., "Efecto de Enmiendas Folieares de Productos Naturales y Abono Orgánico Sobre la Supresión de Enfermedades en el Cultivo del Tomate," en V Congreso Internacional de Manejo Integrado de Plagas, Resúmenes, San José, Costa Rica, 1994; K. Andrews and H. Howell, "Utilización de Controles Culturales," in *Manejo Integrado de Plagas Insectiles en la Agricultura,* ed. K. Andrews and R. Quezada (El Zamorano, Honduras: Escuela Agrícola Panamericana, 1989): 243–53; M. Altieri, ed., *Crop Protection Strategies for Subsistence Farmers* (Boulder: Westview Press, 1993); J. Listinger, "A Farming Systems Approach to Insect Pest Management for Upland and Lowland Rice Farmers in Tropical Asia," 45–103; J. Scriber, "Nitrogen Nutrition of Plants and Insect Invasion," *Nitrogen in Crop Production,* ed. R. Hauck (Madison: American Society of Agronomy, 1984); R. Rodríguez-Káabana, "Organic and Inorganic Nitrogen Amendments to Soil as Nematode Suppressants," *Journal of Nematology* 18 (Apr. 1986): 129–35; P. Phelan et al., "Soil-Fertility Management and Host Preference by European Corn Borer, *Ostrinia nubilalis* (Hubner), on *Zea Mays*: A Comparison of Organic and Conventional Chemical Farming," *Agriculture, Ecosystems & Environment* 56 (Aug. 1995): 1–8; D. K. Letournea et al., "Effects of Soil Management on Crop Nitrogen and Insect Damage in Organic vs. Conventional Tomato Fields," *Agriculture, Ecosystems & Environment* 57 (Nov. 1996): 179–87; S. Eigenbrode and D. Pimentel, "Effects of Manure and Chemical Fertilizers on Insect Pest Populations on Collards," *Agriculture, Ecosystems & Environment* 20 (Jan. 1988): 109–25; T. Culliney and D. Pimentel, "Ecological Effects of Organic Agricultural Practices on Insect Populations," *Agriculture, Ecosystems & Environment* 15 (Apr. 1986): 253–66; Morales, "Pest Control and Soil Management," 65–84; Conway, *Doubly Green Revolution,* 237; Perelman, *Farming for Profit,* 49, 89, 182.

41. Interviews with Waqxaqi' Kej, Feb. 7, 1998, Barahona; Waqi' No'j, Mar. 16, 1998; Waqxaqi' Q'anil, Mar. 21, 1998, Poaquil; Wuqu' Kej, May 31, 1998; Kaji' Aq'ab'al, June 8, 1998, Tecpán; Kab'lajuj K'at, June 27, 1998; Kaji' Tojil, Mar. 2, 1998; Jun Imox, Ka'i' Ajpu', and Oxi' Ajpu', Dec. 2, 1998; Wuqu' Kawoq, Jan. 29, 1998; Ixk'echelaj, Jan. 19, 1998, Comalapa; G. C. Wilken, *Good Farmers: Traditional Agricultural Resource Management in*

Mexico and Central America (Berkeley: University of California Press, 1987); Conway, *Doubly Green Revolution,* 236–37; Metz, *Ch'orti'-Maya Survival,* 166; K. Scow et al., "Transition from Conventional to Low-Input Agriculture Changes Soil Fertility and Biology," *California Agriculture* 48 (Sept.–Oct. 1994): 21–27; M. Culik, "The Conversion Experiment: Reducing Farm Costs," *Journal of Soil and Water Conservation* 38 (July–Aug. 1983): 333–35.

42. Interviews with Waqxaqi' Kej, Feb. 7, 1998, Barahona; Waqi' No'j, Mar. 16, 1998; Waqxaqi' Q'anil, Mar. 21, 1998; Ix'ajmaq, July 1, 2001, Poaquil; Wuqu' Kej, May 31, 1998; Kaji' Aq'ab'al, June 8, 1998, Tecpán; Kab'lajuj K'at, June 27, 1998; Kaji' Tojil, Mar. 2, 1998; Jun Imox, Ka'i' Ajpu', and Oxi' Ajpu', Dec. 2, 1998; Wuqu' Kawoq, Jan. 29, 1998; Ixk'echelaj, Jan. 19, 1998, Comalapa; Fischer, "Late Capitalism and Maya Resurgence," 210; Wilken, *Good Farmers*; Douglas, "Illness and Curing," 32; Romeiro, "Alternative Developments in Brazil," 101.

43. Interview with Ixsya', July 2, 2001, Patzicía; Arias, "Changing Indian Identity," 238, 240.

44. Livestock in Development, "The Integration of Livestock Interventions into a Sustainable Rural Livelihoods Approach," in *Sustainable Rural Livelihoods: Entry Point Papers,* ed. Diana Carney (London: Department of International Development, 1998), 93; Perelman, *Farming for Profit,* 182–83; Spitz, "Green Revolution Reexamined in India," 73–73n12; Conway, *Doubly Green Revolution,* 238; Peggy Bartlett, "Introduction: Development Issues and Economic Anthropology" and Hugh Gladwin and Michael Murtaugh, "The Attentive-Preattentive Distinction in Agricultural Decision Making," in *Agricultural Decision Making: Anthropological Contributions to Rural Development,* ed. Peggy F. Barlett (New York: Academic Press, 1980), 6, 8, 11–13, 115–36; Richards, *Indigenous Agricultural Revolution,* 12; Les Field, "Tools for Indigenous Agricultural Development in Latin America: An Anthropologist's Perspective," *Agriculture and Human Values* 8 (Winter/Spring 1991): 85–92.

45. Interviews with Ixq'anil, June 21, 2008; Jun Kame, May 1, 1998; Oxlajuj Kej, June 21, 2008, Comalapa; Kaji' Tz'ikin, June 24, 2008, Sololá. Fischer and Benson similarly observed that farmers who grew such NTAs as broccoli, snow peas, and French beans did not like to eat them, let alone could they survive on them. See, Fischer and Benson, *Broccoli and Desire,* 29–30.

46. Arvin Mosier et al., "Nitrogen Fertilizer: An Essential Component of Increased Food, Feed, and Fiber Production," in *Agriculture and the Nitrogen Cycle: Assessing the Impacts of Fertilizer Use on Food Production and the Environment,* ed. Arvin Mosier et al. (Washington, DC: Island Press, 2004), 3–15; Perelman, *Farming for Profit,* 158; Narciso Barrera-Bassols and Victor M. Toledo, "Ethnoecology of the Yucatec Maya: Symbolism, Knowledge and Management of Natural Resources," *Journal of Latin American Geography* 4 (Mar. 2005): 9–41; Field, "Tools for Indigenous Agricultural Development," 92; Bartlett, "Introduction," 8, 11–13.

47. Fink, *Maya of Morganton,* 216n39; Schüren, "Milpa in Crisis?" 271. For examples of Ladino perceptions of Kaqchikel, see, Carey, *Our Elders Teach Us,* chpt. 9 and David Carey Jr., *Engendering Mayan History: Kaqchikel Women as Agents and Conduits of the Past, 1875–1970* (New York: Routledge, 2006), chpts. 1 and 4.

48. Alain de Janvry, *The Agrarian Question and Reformism in Latin America* (Baltimore: Johns Hopkins University Press, 1981).