The direct and indirect impacts of population growth and economic development on maize (Zea mays L.) diversity in highland Guatemala

Michael K Steinberg* and Matthew J Taylor**

*New College, University of Alabama, Tuscaloosa, Alabama, USA
Email: mksteinberg@as.ua.edu

**Department of Geography, University of Denver, Denver, CO 80208, USA

Revised manuscript received 25 June 2008

This paper discusses the impacts of population growth and economic development on maize diversity in highland Guatemala. In the context of this discussion, economic development specifically refers to the recent expansion of the non-traditional agricultural exports (NTAEs). Population growth and economic development (i.e., NTAEs) are linked because as land has become scarce in highland Guatemala, due to the poor distribution of land resources and rapid population growth over the past 50 years, many farmers have turned to non-traditional economic strategies such as new crops that produce more income per unit of land. These new crops have improved the economic conditions of many farming families, but it has come at a cost regarding the maintenance of local maize varieties and household food security.

Key words: maize diversity, non-traditional agricultural exports, population growth

Introduction

Guatemala has long been considered an important centre of maize diversity in the Americas. But while Guatemala is recognised as a historically rich agricultural landscape, forming part of the Mesoamerican crop domestication hearth, the landscape is also undergoing widespread agroecological simplification due to various factors, some of which will be discussed in this paper. The erosion of maize diversity in Guatemala represents a case study in the larger global decline of agroecological diversity described in numerous studies from various landscapes (examples include Clawson 1985; Altieri and Merrick 1987; Bellon and Brush 1994; Zimmerer 1991, 1996, 1999; Brush 2000; Abbott 2005). The situation described in this paper is therefore not limited to Guatemala. Population growth, economic and cultural changes among farmers (globalisation), among many issues, threaten crop diversity in many domestication hearth area (Brush 2000; Brookfield 2001). However, one unique aspect of the decline of maize diversity in Guatemala versus the erosion of crop diversity in other landscapes is that maize is the staff of life within the Maya culture. Maize is a sacred plant, whose meaning and value have traditionally gone far beyond a simple commodity. Thus, its decline symbolises important changes within the larger Maya culture.

The authors do not purport that farmers do not have the right to seek more profitable crops and new economic strategies in response to changing conditions such as population growth that lead to the erosion of maize diversity. Instead we point out that along with ‘development’, even development that increases the incomes of farmers and is therefore deemed successful through a capitalist lens, there are many costs such as declining local crop diversity and increased use of petroleum-based fertilisers and pesticides.

This paper is based on fieldwork among indigenous Maya farmers in the western highlands of Guatemala,
primarily in the Cuchumatán Mountains north of Huehuetenango, the department capital (Figure 1). Information for this paper was collected in several Maya villages found in the department during field research trips in 2005, 2007 and 2008, with in-depth interviews being conducted with Maya farmers from Todos Santos Cuchumatanes and Concepción Huista. Dozens of other conversations also took place with farmers in fields and on roadsides that contributed to the information in this paper.

**Guatemalan maize diversity**

Highland Guatemala is an important diversity and domestication hearth of maize and its wild relatives (Mangelsdorf and Cameron 1942; Ilitis et al. 1986; Steinberg and Taylor 2002; Van Etten 2006). Maya people created this crop diversity over thousands of years of agricultural trial and error in the diverse landscapes that make up Guatemala. This diverse landscape spans the cold highlands of the Cuchumatán Mountains to the hot and humid tropical lowlands in the Petén. Guatemala is considered to be the most botanically diverse country in Central America overall (Steyermark 1950), and this botanical diversity also translates into great agricultural diversity. For example, within a relatively small area in the western highlands in the Cuchumatán Mountains in the Department of Huehuetenango, 166 maize varieties have been collected (Stadelman 1940; Wellhausen et al. 1957). In fact, based on a study by Mangelsdorf and Cameron (1942) it was hypothesised that this region of Guatemala may have represented the centre of origin for cultivated maize, although recent studies have suggested that the true centre is found farther north in Mexico (Matsuoka et al. 2002). However, it is clear that Guatemala represents a key region...
harbouring a vast amount of morphological and cytological variation in the crop (FAO 2002). Despite this high diversity, few studies document the details of Guatemala’s crop diversity, especially when we compare research in Guatemala to research in other domestication hearths such as Mexico where literally dozens of agricultural diversity studies have taken place. Guatemala’s long-running civil war, which ended in 1996, created unstable conditions in the highlands, which, in turn, prevented widespread agroecological research (FAO 2002; Steinberg and Taylor 2002; Van Etten 2006). There have also been few studies focused on maize genetic diversity in Guatemala (Bretting et al. 1990).

The region of greatest maize diversity in Guatemala is the Cuchumatán Mountains. This region is also culturally diverse, being home to eight distinct ethnolinguistic indigenous Maya groups (Lovell 1992). This same area experienced the main brunt of government brutality during the civil war, especially from the 1970s to the early 1990s. Indeed, many of the villages in the western highlands identified by Stadelman (1940) as housing the greatest number of maize varieties witnessed massacres and subsequent out-migration (REMHI 1998). For example, between 1981 and 1996, the Guatemalan military destroyed at least 440 villages (mainly in the western highlands) in a scorched-earth military strategy; murdered or ‘disappeared’ 150 000 civilians; and created a million-strong internally displaced population (Jonas 2000; Ball et al. 1999).

Population pressure, economic development and maize diversity

While conflicts over land resources in Guatemala is not a recent development, land disputes are exacerbated by a four-fold increase in population over the last 50 years from 3 to 12 million people. While it is beyond the scope of this paper, one can state that disputes over land resources date back to the initial conquest of Guatemala by Conquistador Pedro de Alvarado in 1524, when large areas of native land were expropriated by the Spanish Crown and Catholic Church. The civil war (1960–1996) was essentially driven by poor distribution of land, and the poverty that accompanies such unequal allocation of key resources in a largely rural and agrarian society. And while peace accords were signed in 1996, little has changed regarding land holdings, land distribution and entrenched poverty in rural Guatemala.

Rural residents account for two-thirds of the almost 12 million people in Guatemala (Naciones Unidas 2000 2001). While national population statistics exist, reliable local data are largely nonexistent, especially in areas such as the Cuchumatán Mountains. However, there is no doubt that the population has exploded simply based on anecdotal observations such as deforestation rates and the fact that marginal land is increasingly placed under production of some kind. At the same time, Guatemala suffers from extremely unequal distribution of land – 2 per cent of the population owns 65 per cent of the land. And among those rural farmers who do own land, many do not own enough land to support themselves. In rural Guatemala, 54 per cent of farms are too small to support subsistence farming (Table 1). Also, average plot size of holdings below 1.4 hectares decreased from 0.7 hectares in 1964 to 0.19 hectares in the 1990s (Annis 1987; Bilsborrow and Delargy 1990; Elias et al. 1997; Brockett 1998). The unequal land distribution in Guatemala is the worst in Central America. The poor distribution of land resources, coupled with population growth, has placed a great burden on rural farmers, especially in a largely agrarian country.

Table 1  Distribution of farmland in Guatemala

<table>
<thead>
<tr>
<th>Below subsistence plots (less than 1.4 ha)</th>
<th>Sufficient for subsistence (1.4–3.5 ha)</th>
<th>Plots that can produce for internal market (3.5–45 ha)</th>
<th>Large, export-oriented farms (above 45 ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per cent of total farms</td>
<td>54</td>
<td>24</td>
<td>19</td>
</tr>
<tr>
<td>Per cent of total farmland</td>
<td>4</td>
<td>7</td>
<td>25</td>
</tr>
</tbody>
</table>

Note: Data are derived from the latest agricultural census in 1979 (Naciones Unidas 2000). Even though these data are old, they clearly illustrate the problems of land fragmentation among smallholders, who increasingly do not have enough land upon which to survive.
Population growth has both directly and indirectly impacted maize diversity in Guatemala. Diversity is impacted directly because Maya farmers grow maize on plots of land that decrease in size with every generation because land is subdivided among offspring (Davis 1997). Reliance on smaller and smaller plots does not allow farmers to experiment and maintain enough geographic distance between maize varieties to prevent varietal mixing. In past times, farmers would plant different varieties of maize in different fields to ‘fit’ perceived micro-environmental adaptations – elevation, slope, soil type, etc. However, farmers repeatedly informed us that today they rarely enjoy the luxury of access to multiple plots of land. Of 35 structured interviews conducted, 28 farmers claimed to have less land today compared with their parents’ generation. Among these 28 farmers, mean size of land holdings was 1.1 hectares, which is larger than holdings reported in other areas (Bilsborrow and DeLargy 1990; Elías et al. 1997; Brockett 1998). Within these 1.1 hectares, farmers claimed to have access to an average of two different micro-environmental zones, zones usually being associated with soil types, elevation or precipitation. All 28 claimed this was fewer zones than their parents’ generation. This perception is of course highly subjective. But, in speaking with informants, all believed that their father’s generation had access to more micro-environments and ultimately more land, which in turn led to a more diverse assemblage of maize plantings. Environmental perception (positive or negative perceptions of types of land and opportunities presented by the land in this case) does have an impact on decisionmaking. Many farmers relayed stories about the great number of varieties grown by older family members, some for special occasions. We were told of varieties grown specifically in high, cold areas, wet, bogy areas and sunny drier areas. Over many generations, farmers developed intimate ethnobotanical information about specific maize varieties and where they grew best. All farmers interviewed claimed that having access to multiple plots in different micro-environmental settings is diminishing due to inheritances and gifts to grown children who desperately need plots of land for their own families or a shift in production to NTAEs (Plate 1).

Among the seven that did have more land today compared with their parents’ generation, most claimed out-migration among siblings or success in off-farm economic activities or increased NTAE production was the most significant factor that had allowed them to expand holdings. Even those with expanding holdings acknowledge pressure that arises as children grow and need at least subsistence farmland. Farmers do rent plots of land from absentee or non-farming
owners, thus providing some new farming opportunities in new areas, but these are often short-term agreements or are dedicated to non-traditional agricultural exports (NTAEs), not maize (Plate 2).

Our 35 informants planted an average of 2.6 maize varieties in 2006–2007. This is not a static number/activity however, and should thus be treated as a snapshot in time. We were told in some years they planted more, some less. But almost all agreed that the typical farmer today plants fewer varieties than their parents. Three farmers claimed they plant more maize varieties than their parents. But even they agreed that in general maize diversity was declining as its economic importance was usurped by NTAEs or off-farm activities.

Our research in the Cuchumatán Mountains concerning multiple plots, maize diversity and NTAEs is reinforced by studies in other regions of Guatemala. In a recent case study of two Maya communities in the highland department of Chimaltenango, Hamilton et al. (2002) reported that in one community, one-fifth of all households own no land and another three-fifths own less than one hectare. In this community the median plot size is just less than 0.5 hectare. Dwindling plot size is extremely problematic for farmers who plant multiple varieties. Farmers who do plant several varieties of maize must often do so in the same fields. Farmers told us they have little choice given limited access to geographically isolated fields. The result is greater crossing of varieties, which dilutes the uniqueness of the individual variety. One of the considerations of maize quality by farmers is colour and colour consistency. Farmers told us that they value the most pure-coloured kernels for seed stock. All 35 informants claimed that maize quality today is lower than in the past, with most citing the mixing of colours as a factor that reduces perceived quality. Again, this is a highly subjective perception. But farmers recognize that maize farming is changing and in some cases under stress in part due to land shortages. As one travels through highland Guatemala during harvest season, the results of this mixing are clear – speckled maize abounds – which indicates crossing with other varieties. Farmers are well aware that as different maize varieties are planted within close proximity to one another, certain unique traits are being lost. This crossing makes it harder to find pure-coloured kernels to save for the next planting season. All 35 informants agreed there is a positive correlation between land holdings and crop diversity. In fact, many respondents seemed impatient with us, saying ‘Of course the shortage of land impacts maize farming and diversity. You need land to plant maize!’
Indirectly, but equally important, population pressure has eroded maize diversity because reliance on smaller and smaller plots of land has forced farmers to seek out crops that produce the greatest amount of income per unit of land. Smallholders have sought a new economic life in the returns promised by modernising traditional milpa agriculture into vegetable crops for export, or in some cases illicit crops such as opium poppies that are grown in the highlands (Logan 2006; Steinberg and Taylor 2007). Here population pressure comes head to head with globalisation. Over the last 25 years smallholders have dedicated increasing portions of their small plots to grow high-value vegetables or NTAEs for internal and international markets. Unlike other traditional and non-traditional export sectors in Guatemala, the cultivation of vegetables and fruits for export is dominated by smallholders (Hamilton et al. 2002). Broccoli, cabbage and snow pea production have become quite popular among Maya farmers in the highlands during the past decade (Dugger 2004; Hamilton et al. 2002) (Plate 3). In fact, having visited various villages in the Cuchumatanes since 1995, the rapid transformation of the agricultural landscape from one that was dominated by maize in the early 1990s to one that is rapidly transitioning to export crops has been astounding. This agricultural transitioning is one of the clearest signals of the influence of globalisation in even the most remote areas in highland Guatemala. It is important to note that not all vegetable cultivation is for the international market. Increasingly, smallholders cultivate vegetables for supermarkets in Central America as well (Dugger 2004).

These smallholder highland farmers are the same individuals who are (or were) the creators, managers and preservers of maize diversity in Guatemala. In recent years, with the aid of national and international subsidies from development agencies such as USAID, the NTAE economy has boomed (Hamilton et al. 2002). For example, in 1989, Guatemala exported 34,824 metric tons of vegetables (all producers), while in 2003, the amount jumped to 59,777 tons (USDC 2004). At the same time, overall maize production has declined from 27,885 metric tons in 1990 to 22,065 metric tons in 1998 (Naciones Unidas 1999). As a result, Guatemala now imports increasingly greater quantities of maize. For example, the amount of maize imported increased from 2,963 metric tons in 1961 to 54,230 metric tons in 2001 (FAO 2004). It is ironic that an important hearth and domestication area of maize such as Guatemala must now import the same crop. While various factors contributed to declining maize production, such as out-migration of farmers to the United States and decreasing plot size, expanding vegetable production clearly competes with maize for cropland in

Plate 3 Cabbage field
Guatemala because available cropland is so limited to begin with (Taylor et al. 2006).

All farmers we spoke with in Concepción Huista (a centre for NTAE production) said they grow NTAEs on land previously occupied by maize. This is not surprising after all because maize is the primary staple in the region and has been so for thousands of years, thereby dominating agricultural lands. And all farmers interviewed grow some NTAEs, a radical departure from farming a generation ago. We suspected that most would grow some NTAEs, but the fact that every informant we spoke with planted new crops was surprising. Among our informants, 67 per cent of their land holdings were dedicated to NTAE production. This strategy has undoubtedly benefited some farmers economically (see Hamilton et al. 2002). In fact, snow peas in Guatemala produce 15 times more income than traditional crops such as maize on the same unit of land (Krznaric 2006). These new crops are viewed and described in positive terms by informants, indicating the belief on the part of farmers about their ability to produce more income and lift individuals out of poverty. All 35 of our informants agreed that head to head, NTAEs produce more income than maize. One farmer who was especially aggressive in his conversion to NTAEs claimed there was ‘no future’ in maize farming given land limitations and prices paid for the new crops. Thus, it is not surprising in a landscape where farmers depend on diminishing plots of land that they have turned in large numbers to new crops. Maize diversity, the general agroecological landscape and even ritualistic landscape surrounding maize are further diminished as more non-traditional crops are planted.

There is not a simple linear relationship between NTAE production and maize abandonment. Hamilton et al. (2002) note that among the Maya farmers they studied who grow vegetables for export, all continue to plant maize. Farmers continue to plant maize to ensure against the risks of vegetable production (price fluctuations and disease) and because, if possible, farmers prefer to supply household needs for basic grains with their own production (Hamilton et al. 2002). Farmers also dedicate different amounts of farmland to maize or NTAEs in any given year based on prices, start up costs, time availability, etc. So it is not a static relationship. However, farmers informed us that as NTAE production spreads, maize is confined to smaller and smaller plots. There is often no land available into which farmers can expand in order to make up for the loss of maize production. Our informants also all agreed that the trend towards dedicating more space to NTAEs will be likely to continue. Moreover, these farmers stated that they are well aware that they are increasing their risk by planting fewer staple crops, but few see alternatives in an economically global village. Smallholders who do not grow NTAEs cannot survive economically and are often bought out by growers of NTAEs. This concentrates the land in the hands of NTAE growers, increases the amount of land in NTAE production, increases economic inequality and further erodes maize diversity by displacing more maize farmers, ultimately undermining the rich cultural landscape associated with maize (Goldin and Saenz 1993; Goldin 1996; Krznaric 2006). In one field exercise, we asked 15 farmers who were growing NTAEs to map their current land holdings and the crops they contain. We then asked the same group to sketch their farm as they want it to appear in the future. All sketches contain more NTAEs at the expense of maize. Nine of the future maps contained only NTAE crops. This simple exercise indicates a great desire to further expand participation in the NTAE economy. Farmers we spoke with were all in agreement that NTAEs were economically beneficial; however, they also recognised that they now had to spend more of their cash income on food items that they previously grew themselves. So household food security, and likely household nutrition, has declined. Some lamented (especially older farmers) the growing need for cash incomes in an increasingly cash-based society, where family and village bartering arrangements are quickly becoming a thing of the past, but none stated the desire to return to subsistence times either.

Some agricultural associations in Guatemala like AGEXPRONT (Association of Exporters of Non Traditional Products) encourage smallholders to grow crops for export in an attempt to lift rural families out of poverty with the increased earnings from export agriculture (Plate 4). While some do encourage farmers to continue in the cultivation of traditional crops, they suggest that farmers plant their best land in export crops (Hamilton et al. 2002). We also noted the usurpation of previous ‘desirable’ maize land by export crops in the Cuchumatán Mountains, especially around Concepción Huista. According to conversations with farmers, this shuffling of land use has several potential implications for maize diversity. First, the maize types that once performed well in better soils and slopes are now abandoned. Second, as maize farmers expand into undesirable land, only...
the most marketable varieties are planted (at the expense of more ceremonial varieties). Finally, where spare land is available (this is rare in Guatemala except on the distant frontiers), farmers often put previously untilled land to the hoe in an attempt to maintain some maize production. This expansion of agricultural lands reduces natural biodiversity via deforestation, and has significant geomorphological ramifications such as increased soil erosion and even landslides in especially steep areas.

The expansion of NTAEs also erodes agroecological knowledge concerning traditional crops such as maize. With very limited land available per individual, farmers who spend time and energy planting and tending broccoli, for example, spend less time tending maize. As more farmers, especially younger ones, continue to participate and expand further away from maize farming, the intimate knowledge concerning individual varieties and the micro-adaptations decreases, further reducing diversity and general agroecological knowledge. All of our informants acknowledged a general declining level of knowledge concerning maize farming. This was made clear during one specific interview with a young farmer. While discussing his current crops, mainly NTAEs, his father suddenly appeared from inside their home and began to scold him for his disinterest in maize.

Conclusions

Based on our research, as well as reports by researchers in other parts of Guatemala (e.g. Goldin and Saenz 1993; Lee 1993; Carletto 1996; Hamilton et al. 2002), it appears that both the direct and indirect influence of population pressure and globalisation (NTAEs) are negatively affecting maize diversity in the Cuchumatán Mountain region. Population pressure has both limited the amount of land available to farmers and motivated them to find new crops that produce more income per unit of land. Every farmer interviewed claimed that land limitations play a role in the number of maize varieties planted, again, both directly and indirectly. Farmers also described their village economies as becoming more cash-based in recent years, thereby also driving the process whereby more subsistence crops are abandoned in favour of export crops.

The intention is not to oversimplify the political ecological factors impacting maize diversity in Guatemala, but farmers obviously need a certain minimum amount of space to grow a diverse number of varieties. Farmers we spoke with had a clear understanding of the relationship between geographic isolation and the integrity of an individual maize variety. They also recognised that, indeed, given land shortages, they must find crops that provide...
higher returns to survive in an increasingly cash-dependent society. Thus farmers have turned in large numbers and are dedicating more land to non-traditional agricultural exports. The explosion of the NTAE economy in highland Guatemala has in many cases resulted in increased incomes among smallholder farmers. So it is economic development in a very literal sense. But there are larger and long-term costs associated with this development.

In the Cuchumatán Mountain region, it has taken farmers literally thousands of years of trial and error to develop the hundreds of maize varieties catalogued by past studies. Yet it appears that it is taking a relatively short amount of time to abandon traditional practices and knowledge systems used to maintain diversity. Declining maize diversity, household food insecurity and the loss of agroecological knowledge is a heavy price to pay in exchange for inexpensive vegetables for consumers.

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