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Feeding a Growing Population on an Increasingly Fragile Environment

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Introduction
Geographic research on food production in Latin America is at an interesting and perplexing, if not exciting, crossroads as we enter the third millennium. The 20th century drew to a close with an edited volume (Browder 1989) demonstrating the fragility of Latin American lands and suggesting strategies for sustainable development, and a review article (Clawson 1992) positing future agricultural-environmental concerns, reminding us that Latin America is overwhelmingly, and increasingly, an urban, not a rural, society. This is not to say that the rural population is not growing; it is. Indeed, today there are more rural dwellers in Latin America than there were people living in the entire region just a few decades ago. These people have the daunting task of feeding themselves and the urban masses, generating foreign exchange through exports, and protecting the biophysical environment in the process. Fortunately, scholars from a number of disciplines have spent the 1990s in the proverbial field studying these stalwart farmers and their activities. Anthropologists, economists, political scientists, and others, have written extensively on a multitude of issues such as land tenure disputes, the shift from consumption to market production, and the impacts of free trade, nearly always framing their studies in a larger social context. Geographers, in contrast, have tended to focus on other topics. Those working on agriculture in Latin America come largely from the so-called “Berkeley School” that traditionally emphasizes the study of landscapes and people in relation to their biophysical environments, often with an historical bent and a decided predilection for non-mechanized activities.
This chapter discusses the work of these scholars, emphasizing future prospects.

Discussion is divided into four topical sections. The first section focuses on animal husbandry. If there has been any one issue that has garnered public outcry, it is surely the destruction of the rainforest along the frontier of the expanding cattle industry. As this section illustrates, grazing research by geographers is going well beyond the obvious. It further emphasizes the "missing links" in the literature, identifying topics that might merit further inquiry. The second section focuses on ancient agriculture. Latin America has a rich antiquity and many agricultural and environmental issues of the 21st century are not only not new, but in some cases very old. Geographers have long contributed to archaeology, especially in regard to agro-environmental themes. This section not only highlights recent contributions to this enduring theme, but points to some future topics of study. The third section focuses on those present-day agricultural activities that require low levels of technological and/or financial inputs, and their prospects for the future. Call them what you will, "peasant farmers," "traditional agriculturalists," or something else, most of Latin America's food producers are individuals with small plots of land, limited economic resources, little access to modern technology, and huge obstacles. They certainly warrant attention as the future is clearly in their hands. The fourth section elaborates themes introduced in earlier sections and places them in what might be considered broader conceptual contexts and suggests future challenges for both Latin America and scholars.

Let Them Eat Grass
Domestic livestock is a critical, if sometimes neglected, component of Latin America's agricultural landscapes. Despite the near absence of large, domesticated animals in aboriginal Latin America (Andean camelids being the exception), most communities today thoroughly integrate animals into their household strategies for survival and success. The anthropological and geographical literature of the mid-20th century emphasized the domestic importance of livestock, from Tierra del Fuego to the Sonoran Desert. During the past two decades, however, academics have devoted more attention to the impacts (both possible and actual) of livestock on Latin America's varied environments. Central to the alarmist literature of the 1980s was the role of cattle ranching in changing many of Latin America's largely vacant regions. And, while pictures of flaming Amazonian forests
have lost some of their popularity in today's press, the underlying issues of environmental change associated with livestock ranching remain important. Geography's contributions in the 21st century will no doubt continue this recent research focus on Latin America's animal industry sector.

Geographers have been actively involved in understanding the new dimensions of environmental change associated with ranching. The term "ranching," as opposed to "herding," "grazing," and a host of other terms, is itself confusing. Ranching involves the use of extensive tracts of land, generally in a set pattern, with little movement of animals outside of a property for extended periods of time. Complications in understanding arise from the vast panoply of land tenure situations over time and space in Latin America. Most research on the subject provides a dichotomy of private versus communal land situations; land is either owned by a family or individual, or is managed by some form of corporate institution with many families depending on the grazing resources. There are many arrangements that lie between, but these extremes provide a general scheme for understanding ranching's futures and frontiers throughout the region. Geographic research in the past decade has elucidated many patterns from the historical roots of ranching to future challenges of the industry. The most wide-ranging historical treatment is to be found in a volume addressing North American ranching frontiers (Jordan 1993). It includes Mexico, but nothing further south. A great deal of more localized and regional work has been conducted in Mexico, especially in regard to the supposed environmental impacts of ranching in the central part of that country (Aguilar-Robledo 1998, 1999, Butzer 1992, and Butzer and Butzer 1993, 1995, 1997). These works have provided a needed counterpoint and balance to the widely popular perspective of one environmental historian's (Melville 1990, 1994) polemic against sheep raising in central Mexico.

Through careful archival reconstruction, analysis, and interpretation, these geographical contributions have demonstrated convincingly that the environmental impacts of grazing activities during the Viceregal Period of New Spain (colonial Mexico) were much less severe than commonly argued by historians. The adaptation of the lay Spaniards to central Mexico’s environmental mosaic involved the continued use of transhumance—the regional and seasonal migration of livestock over large areas—so common in Spain. In addition, with the inappropriate use of an "irruptive ecology" model, environmental historians (Melville 1994) ignored the extant vegetation conditions of the region at the time of Spanish contact (Butzer...

The “ecological invasion” by cattle in the lowlands of Latin America is articulated most clearly in the recent work conducted in eastern Mexico (Sluyter 1995, 1996, 1997). The decline of the resident native population of Veracruz created a land use vacuum, into which Spanish shepherds and cattle herders pushed their animals and established ranches. The permanent territorial loss of cultivated areas by natives, to cattle, ensured that no indigenous population rebound would be experienced in this lowland region. As opposed to Melville’s perspectives on livestock impacts, this argument does not focus on the direct devastation of animals on Latin American landscapes, but rather on the impossibility of population recovery given that ranching quickly occupied areas of cultivation previously used by native populations. Cattle and sheep ranching in Latin America has certainly followed global trends in the industry, modernizing and reshaping itself from a provincial activity to a globally important commercial industry. Geographers working in a number of Latin American contexts have explained the unfolding of these 20th century processes. Recent research (Bell 1998) on the ranching frontiers of Rio Grande do Sul, Brazil, illustrates several important structural obstacles. National political support for reforming legal aspects of property rights in the peripheral regions of Brazil was weak; linkages between domestic elites and foreign merchants were insubstantial and slowed development; and Rio Grande do Sul’s infrastructure and attraction of foreign capital remained limited. To be sure, cattle were already an important source of livelihood in most of Colonial Brazil before the 20th century (Dean 1995). National policies in Brazil continue to encourage ranching in the central regions of the country, especially the cerrado, where rolling open grasslands are common. Transnational comparisons, however, remain unelucidated: how do different state policies shape trends in the animal industries of Latin America?

The introduction of fencing and exotic grasses helped to modernize ranching as an industry, and led to the expansion of the cattle industry into areas previously unoccupied or cultivated with crops (Wilcox 1999). This process of industrial globalization is widespread in Latin America. Indeed, regions long occupied by cattle ranchers underwent the same process of technological innovation and subsequent environmental problems, even if the changes were not so readily apparent. Northern Mexico was one of the earliest “modernizing frontiers” for cattle ranching in Latin America, due to its proximity to the United States and its long-standing tradition of large
cattle ranches. Here too, seemingly innocuous changes led to a current landscape that is far different from the one existing only 50 years ago. Easily available government loans, cattle buyers from the United States, and ranching associations were all active agents of change in this newly emergent industrial landscape of cattle ranching (Perramond 1996, 1999). As opposed to the Brazilian example, Sonoran ranchers were in a better place for early industrialization with more state support of the livestock sector.

The ecological changes wrought from this recent industrial livestock revolution are unclear, although visible signs are certainly suggestive. One important aspect has been the spread and supposed impact of exotic plants, especially grasses, introduced to supplement indigenous grass pastures in many regions of Latin America. An intertwined, but under-appreciated, aspect of this is that of soil erosion. Many of the exotic grasses require areas to be cleared of native vegetation, especially woody scrub species, prior to sowing. Exposed soils are subject to increased erosion immediately following clearance, but the long-term impact must be analyzed in terms of the relative amount of erosion mitigated by the dense new grass cover (Perramond 2000). An emerging research trend for the 21st century will be to understand the impact of these non-native grasses on regional and local biodiversity. This line of inquiry would provide insight on the landscape dynamics of native versus exotic species changes. Given the difficulty of tracking and monitoring wildlife, and determining habitat use or preference, it is also likely to encourage joint research between geographers, biologists, and wildlife ecologists.

Geographers working on modern conservation issues have also tackled the problems of ranching and coexistence with conservation projects. Research on conservation in the Maya Biosphere Reserve (Carr 2000) illustrates that farmers with cattle in the Sierra de Lacandón were often the most antagonistic to conservation efforts promoted by non-governmental organizations (NGOs). Even in regions where cattle ranching is an economically negligible activity, the ecological impacts are significant, in terms of conservation geographies. Where do future trails lead for research on Latin America’s livestock frontiers? The merits of intensive, regional work examining the historical roots of ranching are clear. Modernization and industrial change in cattle ranching has been nearly ubiquitous, but what of the other animal industries in Latin America? During the past two decades, a clear trend towards pork and poultry production has expressed
itself, as the urbanizing continent demands more intensive uses of land. The unpleasant consequences of this new facet of animal agriculture (e.g., pollution of drinking water) are readily apparent in suburban areas of Latin America. Yet this latest phase of industrial agricultural development remains unexamined by geographers. Clearly, this is a fruitful avenue for geographers interested in the increasingly urban aspects of the animal industries. It is an agricultural and environmental transformation that will affect many Latin Americans for decades to come.

**Agro-Eco Antiquity**

Prehistoric peoples in the New World were responsible for domesticating some of the world’s most important crops. In order to cultivate them, often far beyond the natural ranges of their ancestors and in different environments, and frequently to feed locally dense populations, farmers developed complex agricultural systems that were not only successful, but transformed the landscape in the process. As in previous decades, many geographers continued to study these systems and their components throughout the 1990s. Their efforts were primarily in the form of fine resolution analyses—studies that yielded insights that both expand understanding and challenge several commonly accepted interpretations of native farming. Among these are major revisions concerning Andean, Amazonian, and Mesoamerican shifting cultivation and short-fallow systems, terracing, irrigation, and wetland fields.

Andean terraces have long been regarded as primary and remarkable evidence of dense pre-Hispanic population, engineering prowess, cultural achievement, and state level administration. Two studies in separate communities in southern Peru’s Colca Valley present valuable insights. One (Treacy 1994) reveals that the initial conversion of ancient irrigated hillside fields into irrigated bench terraces was carefully planned and executed, involving the excavation of new canals and reservoirs in a relatively brief period of time. The other (Brooks 1998) found that a centuries-long construction process involved cross channel terraces being modified into sloping field terraces, which were converted into linear bench terraces. Both studies remind us that interpretations of ancient agricultural landscapes require great care, suspension of a tendency to regard vestigial agriscapes as the product of a single cultural phase or construction episode, and close attention to local and regional processes. They also agree that a change in environmental conditions precipitated major agricultural change, and that
the same factors affecting agriculture in times past occur today. The prospect of renovating ancient terraces is limited, however, by land tenure related problems of access to dependable water for irrigation.

Collaborative studies by geographers, sometimes with archaeologists, have provided a great deal of knowledge on the nature and efficacy of Classic Maya terracing in the southern Petén lowlands of Guatemala. There, conserving soil on steep slopes in a tropical climate was of the essence. Several different types of terraces and check dams were found. Some evolved incrementally while others were constructed quickly but with deliberation, skill, and coordination (Beach and Dunning 1995). Variations in form and distribution were probably the result of topographic, environmental, and demographic differences (Dunning and Beach 1994). Soils were found to vary considerably over the region (Dunning 1996), as did rainfall. Indeed, one location was so dry that a dam and a reservoir were needed for irrigation (Beach and Dunning 1997). Not only did the ancient Maya adapt to a mosaic of environmental conditions (Dunning, Beach, et al. 1998), but a sediment core extracted from a lake revealed a 10,000 year history of environmental change, some of which was natural and some human-induced (Dunning, Rue, et al. 1998). Most of the human-induced change involved deforestation as lands were cleared of natural vegetation for farming, and the construction of terraces which impeded soil erosion and sedimentation (Dunning, Beach, and Rue 1997).

Remains of ancient terraces were also found on the east coast of Mexico (Sluyter and Siemens 1992) where none were thought to exist. Also, some studies (e.g., O‘Hara, Street-Perrott, and Burt 1993) suggest that those who romanticize native agriculture as ecologically sound are naïve, and that more effort needs to be placed on understanding processes of landscape transformation than making overly simplistic correlations between technologies, cultures, and environmental changes. Studies such as these argue that despite their efforts and wisdom, pre-Hispanic farmers were not always successful at limiting environmental impacts.

In addition to research on slope lands, several geographers have contributed knowledge of prehistoric farming in wet and dry environments. One assessed canal systems in northern Chihuahua and hypothesized that irrigation began in the American Southwest as early as it did in Mesoamerica (Doolittle 1993). Later work resulted in the discovery of canals dating to ca. 1100 BC in southern Arizona (Ezzo and Deaver 1998; Muro 1998). Similar canals dating to approximately the same time were found in Peru.
In concert, these studies move back considerably the antiquity of canal irrigation in the New World, and to at least three very distant locales.

As for wetlands, an archaeologist and a geographer working together in a former Xaltocan lakebed found the earliest evidence of raised fields in the Basin of Mexico (Nichols and Frederick 1993). These fields were considerably narrower than their present-day counterparts, further confirming that wetland fields also undergo evolution and refinement. The reason for field narrowing is not known, but should be made clear through future study.

Working in the area best known for chinampas, Xochimilco, another geographer (Crossley 1999) tested two fundamental concepts long postulated but never examined. His analysis of soil texture, organic matter, and moisture content from chinampa profiles throughout the chinampa zone indicate that sub-irrigation was probably less important than previously asserted. More important than sub-irrigation was the very high organic matter content that helped perpetuate moisture availability. Following up on the hypothesis proffered by others (Whitmore and Turner 1992) that frost reduction might be important, this study replicated in Mexico experimental microclimatic investigations similar to those carried out earlier in the Andes (Knapp 1988). It found that air temperature minima above chinampas remained significantly higher than above a dry-ground control site, and that the number, duration, and severity of late fall and early spring frosts were greatly reduced by the water in the canals between chinampas.

Further south, in the Andes, a pair of geographers (Knapp and Mothes 1999) discovered previously unknown fields under what is now downtown Quito, Ecuador. Construction excavations revealed a series of broad ridges and swales buried by volcanic ash. Preliminary analyses indicate that these wetland fields were in use after AD 600. They were abandoned rapidly with the eruption of Quilotoa ca. AD 1200, and for reasons other than conquest by either Inca or Spanish invaders.

Not all ancient raised fields were associated with wetlands. Construction projects in the late 1980s near Cuscatán, El Salvador revealed profiles of narrow parallel ridges and furrows beneath a layer of tephra. Investigated by geographers (Amaroli and Dull 1999), these fields are among the oldest known vestiges of milpa agriculture in Mesoamerica, dating ca. 820 BC. Ridging is labor intensive and not associated with long-fallow shifting cultivation. This, and the proximity of studied fields to one another are
indicators of short-fallow cultivation. Together with the work done in Ecuador, this study shows the great potential for making important discoveries in volcanic landscapes, environments created by events that can preserve as well as destroy.

In yet another major contribution to the archaeology of agriculture, a geographer (Denevan 1996) argued that pre-European people living in the Amazon did not farm the floodplains because of flood risks, preferring instead to cultivate the tops of adjacent bluffs. Doing so required a great deal of labor to clear the forests with stone axes (Denevan 1992c), and, accordingly, fields were farmed under either short fallow shifting, or permanent, cultivation systems (Denevan 1998). These assertions are supported by subsequent soil analyses of terra preta, or Amazon dark earths. Previously thought to be the product of household refuse, these dark soils were actually produced by long-term, regenerative biochemical processes triggered by accumulations of charcoal and ash following frequent field-clearing fires. They were not produced by infrequently occurring natural fires, or those associated with long fallow cultivation (McCann, Woods, and Meyer 2001, Woods and McCann 1999, and Woods, McCann, and Meyer 2000).

In sum, Latin American geographers interested in agriculture have made major contributions to archaeology, particularly in regard to understanding how ancient peoples fed themselves and modified their biophysical habitats in the processes. Lessons learned from the past should help alleviate problems in the future.

**Productive, but Still Not Prosperous**

One of the most important issues explored by geographers conducting research on agricultural landscapes in Latin America is the change in systems concomitant with changes from consumption to commercial production. Throughout Latin America subsistence farmers are facing such diverse issues as the modification of their traditional agroecosystems, increased regional population pressure, persistent social and economic marginality, unfair land tenure systems, lack of capital, economic uncertainty, and land degradation (Arbona 1998, Farrell, et al. 1996, Sambrook, et al. 1999, Zimmerer 1999). In many regions commercial production may proceed at the expense of basic foodstuff production. Indeed, the negative impacts of commercialization are already well documented by many authors (e.g., Blaikie and Brookfield 1987).
On the other hand, many farmers in Latin America may eventually benefit from this evolution as some of them have augmented their household incomes through greater access to regional or international markets (e.g., Grossman 1993). Furthermore, no one can deny that they have also received increased assistance from scholars, governmental agencies, and development institutions in the past several decades (e.g., Grossman 1994).

At the forefront of these changes is the incorporation of local—essentially subsistence systems—into regional or global economic structures. The shift from primarily subsistence to commercial agriculture usually involves the utilization of new or modified production strategies. This change can be implemented by forces exerted from outside the cultivation system itself, such as government offices, development programs orchestrated by planning agencies, or investment from profit-oriented companies (Revels 2000, Rice 1999). In many cases, it is a combination of two or more of these agents that facilitate agricultural change. The process of agroecosystem commercialization can also be initiated by the farmers themselves, in what is essentially a process of autochthonous or indigenous development (e.g., Zimmerer 1991). Although little discussed, researchers are becoming more aware of this form of development as relatively isolated regions of the world are being more effectively integrated into regional, national, and global economies. Traditional or small-scale farmers may contribute labor, land, and available capital towards their goal of increased revenue from cash crops or livestock raising. At its most basic level, this commercialization involves attempts by subsistence farmers to increase the efficiency of their own land-labor system.

Importantly, the specific nature of the existing production system, in large part, determines which changes in production strategies can be made, and in turn, the impacts of those modifications. It is well recognized that the nature of these impacts is frequently double-edged, with negative and positive effects developing in sequence or simultaneously. Augmented revenue, increased social and geographic mobility, and improved political standing may stem from the expansion of commercial agriculture in a formerly subsistence community. At the same time, however, severe detrimental effects may occur as well, including increased social turmoil associated with inequities in land tenure and access to employment, problems of developing and maintaining reliable markets, the inability of small-scale farmers to adequately invest in their own production, the reduction of local crop diversity, and increased environmental degradation. All of these, of
course, were hot topics in the 1980s (e.g., Bromley and Bromley 1988).

It is increasingly obvious that national governmental policy plays a key role in the processes of agricultural change at the local level (e.g., Lawson 1988). Few scholars disagree that the options available to farmers are also influenced by regional, national, and in many instances, global economic and political patterns. However, in regions peripheral to direct governmental intervention (e.g., those regions not benefiting from administered development schemes, technical assistance, loans, or price controls), farmers may be left to adjust their production strategies with little guidance from outside sources. With little or no direct aid from planners outside the region, these farmers are incrementally adjusting their production strategies to fit anticipated changes in economic opportunity in their own region. In this regard, they operate on the periphery of national development policy.

Development processes in the Dominican Republic (Zweifer et al. 1994), southwestern Mexico (Lambert 1992, 1996), and the central Andes (Zimmerer 1991, 1999, 2000) also appear to support the argument that "grassroots" initiatives of economic development are often more flexible with regard to emerging economic opportunities than exclusively "top down" development schemes. These processes also suggest an important role for local environmental diversity in shaping the options and impacts of agricultural change. Indeed, environmentally diverse regions may provide greater opportunities for the "fine tuning" of emerging small-scale commercial activities.

The agroenvironmental complexity of Latin America also makes it imperative to ground our understandings of agrarian change in field-based investigations. Thankfully, this approach continues to be an important component of most research in Latin America. Given the large number of active scholars working in Latin America, the character of agriculture research in the future will undoubtedly be broad, and at the same time, deep.

Hundreds of scholars advance our knowledge of contemporary agriculture with their studies of past and extant agroecosystems. Emphases on landscape evolution, political processes, and the processes of globalization have helped place these systems into a global context. Several geographers have demonstrated the value of looking at prehistoric or pre-European agricultural production systems as a method for understanding contemporary patterns. A similar approach has been applied to the evolving
agrarian landscapes during the colonial period, with special emphases on the impacts associated with the introduction of livestock. The real value of these investigations is the temporal context they provide to contemporary systems, and a diachronic perspective to landscape change in general.

However, most research on agriculture in Latin America continues to be focused on studies of contemporary production systems. Geographers are currently studying in almost every environmental setting of Latin America, and their studies range from analyses of specific cultivation strategies (e.g., McGlade 1994, Coomes 1998, Coomes, Grimard, and Burt 2000) to analyses focused on regional-scale studies of political ecology (Grossman 1998, Knapp 1991, Mutersbaugh 1997, Zimmerer 1996). The issues of economic peripherality and social justice continue to be important as scholars attempt to place local changes into larger national or global contexts (Zimmerer 2000). Other geographers are continuing to advance our understanding of the role that women play in traditional agriculture (Hays-Mitchell 1997, Keys 1999). Furthermore, adding to the already large body of research on environmental degradation, geographers are placing new emphasis on the issues of pesticide usage, health, and nutrition (e.g., Arbona 1998, Grossman 1992).

Although an enormous amount of research has already been conducted, much remains to be done in the coming decades. Additional emphasis needs to be placed on the long-term environmental impacts of agricultural change. For a few years now, geographers have played a major role in a field of study called ethnopedology, the knowledge of soils held by local people (Hecht 1990, Rider 1994, WinklerPrins 1997, and Zimmerer 1994). Further study should be focused on soil loss in response to specific changes in production systems (e.g., Grossman 1997, Zimmerer 1993). The deleterious impacts of soil erosion and soil loss on agricultural and water resources are universally recognized. It is also apparent that as farmers and cattle raisers in Latin America intensify their production activities the extent of soil loss will increase in many regions. However, despite the fact that soil loss is recognized as a problem of global concern, its regional patterns are less adequately understood. Careful analysis of the soil erosion literature reveals the fact that there is little agreement about what can be classified as slight, moderate, or even severe soil erosion, in both absolute or relative terms. There is disagreement about what constitutes significant rates of loss or what kinds of changes in horizon thickness are acceptable. However, most scholars recognize that the depletion of soil resources in
developing regions of Latin America will become one of the most important problems to plague these regions in the coming decades. Advances in both field-based research and synthesis of these field studies is crucial for understanding the role of soil loss in evolving agricultural systems.

Another challenge is to link the high quality field research with the mechanisms responsible for economic development in each region in Latin America. All too often, unfortunately, the institutions responsible for designing and implementing economic change in rural regions do not consult with, or in many cases, are even unfamiliar with the extensive fieldwork conducted by geographers and other scholars. It is important for geographers to make their field results available to these agencies, and to actually seek a collaborative approach to regional development.

In sum, most agricultural production systems in Latin America are in a state of flux. Some farmers have been able to take advantage of emerging market opportunities because they have access to an environmentally diverse agricultural landscape, or have a relatively flexible labor system, or because they are willing to adopt new strategies that they deem necessary. The degree to which they are skilled at prioritizing their land-use activities to mesh with their predictions about future market patterns is unclear, but such ability will be crucial for the establishment or maintenance of sustainable development in rural areas of Latin America. Although the long-term impacts of these changes on the physical environment and regional social and economic stability are not yet fully understood, it is evident that the cultivation landscapes of the region are being rapidly modified. All across Latin America farmers are venturing, in various forms and degrees, into volatile national and global markets over which they have no control. Latin Americanist geographers will undoubtedly continue to play an important role in understanding this process. With their help it may be possible for the entities responsible for economic change in Latin America to encourage sustainable development strategies that are grounded on significant scientific inquiry.

Looking Forward
Since the United Nations “Earth Summit” in Rio de Janeiro a decade ago, the belief that the agroecological practices and knowledges of native peoples might contribute to environmental conservation and sustainable development efforts has become thoroughly institutionalized (Carruthers 1997, Porter and Sheppard 1998, UN 1992, 1993, UNEP-Secretariat of the CBD
1992). Yet, despite what seems superficially to be a radical departure from the disregard for environmental limits and non-Western cultures so characteristic of orthodox development, the widespread zeal for sustainable development is founded in diverse reactions to the failures of orthodox development rather than in consensus (Sluyter 2001b). Negative consequences of orthodox development's foundational strategy of diffusing knowledge, technology, and institutions from the West to the non-West has eroded faith in the superiority of transcontextual, universal scientific knowledge and increased interest in native alternatives, but not yet resulted in a coherent, thoroughly conceptualized alternative model.

Geographers continue contributing to the effort by elaborating a sound empirical and theoretical basis for defining the relationship between native agroecologies and sustainable development, but the sheer number of academic disciplines and diverse applications fragments the necessary research and resulting literature, thus rendering synthesis far from imminent (Sluyter 2001b). The epistemological division between contemporary and historical approaches remains one of the most profound sources of such fragmentation within and across geography and related disciplines. Contemporary approaches seem to have much more direct relevance to contemporary challenges than do historical approaches, almost by definition. Geographers and scholars from allied disciplines have, therefore, catalogued development's social and environmental impacts and produced understandings of contemporary native ecologies in great enough detail to understand how they function and provide concrete alternatives to orthodox development (Denevan, et al. 1984, Knapp 1991, Wilken 1987, Zimmerer 1996). Historical approaches offer a different but no less essential basis for understanding and application, despite having been somewhat subordinated to contemporary approaches, and geographers have contributed most consistently to research on long-term landscape transformations and precocolonial native ecologies.

Geographers have shown how the scope and degree of colonial landscape transformations have ensured their continuing consequences for achieving types of agriculture that sustain social and environmental well-being. Native depopulation due to epidemics and the introduction of exotic biota, technologies, institutions, and ideas transformed landscapes on a scale and to a degree unprecedented since the retreat of continental ice sheets. With powerful inertia, material landscape transformation has continued to affect postcolonial land use. In the Basin of Mexico, to take one
striking case, colonial drainage of the lakes and modern pumping of the aquifer have had dire continuing consequences, not the least being destruction and reshaping of much of the highly productive chinampa agroecosystem (Aguilar, et al. 1995, Ezcurra 1990). Conceptual landscape transformation ("ideological," "discursive," "symbolic") equally continues to affect postcolonial land use. Planners now categorize regions or even entire types of landscape that had dense precolonial populations as having a naturally impoverished resource base that limits agricultural productivity. Thus, natives from Mexico to Bolivia long favored wetlands as foci for systems of highly productive agriculture and dense settlement, but Westerners now think of the same environments as "nasty tropical swamps" that are undeveloped and that require drainage to become productive (Denevan 1992a, Siemens 1998).

Only relatively recently have conventional thinkers begun to appreciate the magnitude of such colonial landscape transformations, the inertia of the transformative processes involved, and therefore their continuing consequences and the relevance of understanding them for achieving sustainable agroecologies. Several generations of geographers and allied scholars have integrated diverse types of field and archival analysis to dispel the representation of much of precolonial Latin America as wilderness/untrammeled resources, as sparsely inhabited and little altered by native peoples, thereby inferring the productivity and sustainability of native agroecologies (Denevan 1992a, and b, McCann 1999a, and b, Sluyter 1999, Turner and Butzer 1992). Now a broad-based, self-critical Western intellectual movement has begun to investigate the indivisibility of knowledge/power, decode (post)colonial scientific and other discourses, and thereby reveal taken-for-granted epistemological assumptions and categories that emerged during the colonial period and have persisted into the postcolonial present to misinform policy, promote teleological thinking and orthodox development, and perpetuate colonial social and human-environment relations (Blaut 1993, Escobar 1995, Hecht and Cockburn 1989, Said 1979, Sluyter 1999).

Drawing on that emerging theoretical convergence, studies of human-environment interactions are beginning to demonstrate how interwoven material/conceptual processes have simultaneously transformed landscape and obscured its transformation (Sluyter 2001b). A study of human-environment interactions in the tropical lowlands of Veracruz, Mexico, has revealed how disease introductions at the beginning of the colonial period, during the 16th century, resulted in native depopulation and old-field suc-
cession of former agricultural lands (Sluyter 1999). Recategorization of agricultural fields as wasteland facilitated Spanish space accumulation and conversion to pasture, preempting native population recovery. Further vegetation succession incrementally obscured the native cultural landscape and visually validated categorization as a wilderness dominated by extensive grazing that required intensification to become productive. That material/conceptual process has thus made possible the persistent belief in a teleological development progression from precolonial wilderness through colonial cattle pasture to postcolonial canal irrigation of sugar cane. Yet, given that native peoples had densely settled and productively cultivated the precolonial landscape, the actual narrative should be one of recovery at best and declension at worst—hardly one of heroic progress through Westernization.

In parallel, geographers and allied scientists have worked to recover knowledge of, and sometimes redeploy, defunct native agroecologies (Browder 1989, Denevan 1995, Smith 1995). Efforts have focused on intensive agriculture because the dramatic landscape modifications involved seem to offer the best hope for understanding and because viable alternatives to orthodox development must be able to produce enough food to sustain dense populations. That research has demonstrated widespread systems of precolonial canal irrigation, terracing, and intensive wetland agriculture (Denevan 2001, Doolittle 2000, Whitmore and Turner 2002). Many such systems became defunct with European colonization, introduction of epidemic diseases, and native demographic collapse. Some became defunct earlier, during the precolonial period. And others have persisted, albeit much contracted and altered, into the postcolonial period. Extensive land uses have also elicited interest, not so much because of food production potential but because of persistent and widespread effects on vegetation. For example, regular burning of vegetation by native peoples throughout Latin America to clear agricultural fields and more generally manage flora and fauna, probably expanded savannas, the persistence of which has implications for biodiversity conservation (Sauer 1969).

The case of wetland agriculture in the Neotropics provides a compelling example of research on intensive agroecologies (Denevan 1970). Variously termed raised fields, ridged fields, ditched fields, chinampas, and drained fields, intensive wetland agriculture occurred along streams, around lake and swamp margins, and at springs in both tropical highlands and lowlands. Through various combinations of excavating ditches into, and
building planting platforms above the surface, farmers regulated soil moisture in the root zone. Beyond that basic function, maintenance of a nutrient sump in the ditches, frost mitigation, and pest control were also important in varying degrees and in different contexts (Sluyter 1994). The chinampas of the southern Basin of Mexico comprise the only major extant occurrence, but from Bolivia to Mexico, hundreds of thousands of hectares of such field vestiges occur. The constructions, functions, productivities, periods of usage, and relations to social and environmental changes remain under active investigation.

The high productivity of the chinampas, and the long tenure of wetland fields in some contexts, have spurred efforts to redeploy such systems as sustainable alternatives to orthodox development. These efforts have enjoyed only mixed success for numerous reasons. On the one hand, the revamping of long abandoned, high elevation fields at Lake Titicaca has successfully accomplished both of its goals: an experimental test of construction and cultivation techniques hypothesized on the basis of excavations, and the production of bumper potato crops on more than a hundred hectares of fields reconstructed by Quechua and Aymara farmers (Erickson 1992). On the other hand, the attempt to create chinampas in the tropical lowlands near the Mexican Gulf Coast required considerable modifications of the planner's goals, and high inputs of fertilizers and insecticides to achieve even acceptable yields (Gómez-Pompa 1978, Gómez-Pompa, et al. 1982). In the former case, relic precolonial fields were revived by local farmers using the advice of a scientist. In the latter case, a model of wetland agriculture derived from a tropical highland lake was imposed on a lowland swamp by politically motivated, ill-informed, centrally directed planners who did not consult local farmers about their preferred farming strategies and relied on heavy earth-moving equipment (Chapin 1988, Doolittle 1989). Clearly, native "agricultural methods are not necessarily transferable to different times, environments, and cultures," but then again "the same is true, of course, of modern [Western] methods" (Denevan 1995:37). The key lesson seems to be that management based on long and intimate familiarity with a place—in other words, on local knowledge—that can respond incrementally and dynamically to quickly changing, local opportunities and challenges is central to achieving sustainable agroecosystems (Doolittle 1984, 1989, Hecht and Cockburn 1989, Jackson 1994). Much work remains to be done in order to ascertain the specific factors that make redeployment or transfer of ancient
agroecosystems successful rather than short-lived.

**Concluding Thoughts**

Geographical research on agriculture in Latin America during the late 20th century has focused on rather small-scale activities, often in prehistoric or historic contexts, and always well-grounded in a concern for the biophysical environment. Perhaps more than practitioners from any other discipline, geographers are equally as concerned with the environment as they are with the people attempting to feed themselves, and others, from it. Doubtless this will not change much in the new millennium, and, perhaps it shouldn’t. The contributions of geographers have been both unique and significant, qualities that are probably a function of each other.

Increasingly, however, it seems that geographers are moving away from the specific concern for individual farmers or agricultural communities and their immediate environments, and toward a concern for the larger political and economic milieux in which these farmers exist. This is certainly the case as consumption production gives way to commercial production. And, of course, it is imperative given that Latin America has far more urban dwellers than rural dwellers. People living in cities cannot grow their own food. The burden of production, therefore, falls on the shoulders of the rural folk, or farmers in other parts of the world, such as the wheat and corn belts of the United States.

One solution to this problem of course is to expand mechanized and chemical-dependent agriculture in Latin America. Geographers working in the region during the 1990s have not focused much attention on such practices or their prospects. In no small way, this is because they have accepted modernization, understood as Westernization, to be as much a part of the problem as it is the solution. The question is: How can the West and the rest create social and environmental well-being together? If there is a line of research to which geographers can contribute in the opening decade of the third millennium, this is surely it.

This is not, however, the only area into which geographers could and should venture. Many of the issues being addressed by scholars from other disciplines (e.g., anthropologists working on land tenure and economists working on trade) have spatial dimensions that fall directly under the rubric of geography. To date, geographic research conducted on agriculture in Latin America has not addressed such topics. Doubtless it is time to shift at least *some* of the focus toward such important matters. To be sure, there is
much work to be done and a growing number of scholars to do it. Those who have conducted the research outlined above probably will not participate in any change of direction, continuing instead to work on topics they long found fascinating. This group will, however, gladly welcome the participation and the work of a new generation of scholars embarking on research in exciting new directions.

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