AGRICULTURAL INTENSIFICATION IN THE TITICACA BASIN

INTRODUCTION

For the past 100 years, anthropological theories of the evolution of complex society have been intimately linked to agricultural production. From the 19th century evolutionists and Marxists through V. G. Childe, Julian Steward, and contemporary archaeological theory, agricultural production has figured consistently in our idea of what created the conditions for the emergence of sedentary populations, urban environments, and hierarchical political structures.

Contemporary research indicates that the use of domesticated plants in and of itself is insufficient to account for the emergence of complex society. Even hunter-gatherers routinely encourage the growth of semi-domesticated species. Rather, it is the means by which agricultural production is organized that is critical to the development of complex social and political organization. Organization of production is essentially about human labor, and complex agricultural production is properly understood as a kind of labor intensification. The intensification of agricultural labor, or simply "agricultural intensification" is the core process by which humans create the environment for the development of complex societies.

AGRICULTURAL INTENSIFICATION

As a concept, agricultural intensification is an analytical tool for addressing theoretical questions in comparative anthropology. Intensification can be defined in a variety of ways depending upon the problem or problems to be addressed. Definitions can be specific, focusing on technology, types of crops, and/or types of ener-
getic balances depending upon the questions asked. Alternatively, intensification can be broadly defined to address evolutionary patterns of cross-cultural change in a variety of historical contexts.

In this paper, I adopt a traditional definition of agricultural intensification that borrows from Ester Boserup (1965:43). She defines intensification broadly as a shift in land use that allows a greater amount of food production than was previously possible in any given area of land. To this definition I would add a regional component and explicitly note that a “given area of land” includes the entire area where a political unit extracts agricultural resources. By political unit, I mean any group of people bound by at least some rules of cooperation. In short, agricultural intensification is a change in the production of domesticated plants and/or raising of animals in a politically-bounded region that increases the yield of resources. In premodern agriculture, i.e. prior to industrialized economies, agricultural intensification requires higher labor inputs. With industrialization, the use of machines that use fossil fuels substitutes for human energy. These higher labor inputs may be direct, and involve greater labor investment in the cultivation of the land itself. An example here would be an increase in the number of people from any political group working the land or herds, or, conversely, an increase in the total average per capita labor by that group. Alternatively, these greater labor investments can be indirect, invested in technologies that can increase the efficiency of agricultural production. An example here would be labor invested in manufacturing plows, axes, hoes, and so forth that increases the per capita labor efficiency of the farmer or herder. In either case, the intensified production implies either more work for people, or requires a new kind of specialized labor organization that increases economic efficiencies but involves a loss of autonomy over production. Agricultural intensification entails both economic and social benefits and costs to individual farmers. As such, these costs and benefits shift as the social landscape and physical environment change through time.

AGRICULTURAL INTENSIFICATION AND POLITICAL COMPLEXITY

The modern debate on the relationship between intensive agricultural systems and political organization most likely begins with Julian Steward’s publications in 1949 and 1955. In this work, Steward referred to “irrigation civilizations” that depended upon large-scale canal constructions to feed large populations. As is fairly well-known, Steward cited Karl Wittfogel’s work on China, published some twenty years earlier, that explicitly linked irrigation and political centralization. Steward, however, formulated these ideas into anthropological and comparative concepts. Wittfogel’s later publications (1938, 1953, 1957 in particular) owe much to Steward’s theoretical synthesis.

Steward saw the development of irrigation technology as a factor that increased the carrying capacity of the land. Karl Wittfogel was publishing some of his ideas about the same time. Following Wittfogel, some kind of theocratic political organization would have been necessary to manage the complex agricultural systems (Steward 1949:22-23). According to this Malthusian logic and classic cultural ecological theory, populations would continue to increase as an independent variable.
This increase would put pressure on the resource base and therefore force new cultural changes, particularly economic and technological ones.

Karl Wittfogel took this “hydraulic hypothesis” much further, arguing that state bureaucrats were a requisite for the proper functioning of irrigation systems. In his view, household and village level labor organization and technological skill were insufficient to manage irrigation systems. The control of the irrigation technology, or more appropriately, control of the managers as a subordinate class, essentially provided the elite of these civilizations with the ability to control their populations.

Throughout the 1960s and early 1970s, a host of ethnographic and historical studies demonstrated that the hydraulic hypothesis was wrong. Even Steward ultimately conceded that the control of irrigation agriculture was not the cause of complex societies in arid lands (and see Mitchell 1973). In fact, virtually no theorist today would suggest that the original hydraulic hypothesis, as formulated by Wittfogel, is correct (Stanish 1994).

I have maintained, however, that the rejection of the hydraulic hypothesis went too far (Stanish 1994). The hydraulic hypothesis has several components, and each have separate theoretical implications. Each part has been subject to empirical testing with varying results. One component—that villagers in nonstate societies were not capable of maintaining complex agricultural systems—is clearly incorrect. The idea that repressive states must necessarily develop by controlling irrigation systems fails the empirical test of comparative anthropology as well. However, one component of the hydraulic hypothesis—that there is a link between political complexity and agricultural intensification—cannot be discounted. There is a fairly strong empirical correlation between these two variables that deserves greater investigations by archaeologists and ethnologists.

Steward theorized causal links between polity and agricultural intensification. Agricultural systems do not just include irrigation canals, but a variety of other water management technologies. One of the major empirical tasks that we face, therefore, is to trace the evolution of agricultural intensification and political evolution in areas around the world. Finely-tuned studies of long archaeological sequences permit us to define much more precisely how agricultural production was intensified. If indeed the correlation exists, then we can propose models to define the causal links between political complexity and kinds of agricultural intensification that we see in the archaeological record? I now turn to a case study where we have sufficient data to conduct this empirical task.

THE TITICACA BASIN

The Titicaca Basin proper, as defined by its hydrological boundaries, covers approximately 50,000 km². This vast region was home to millennia of complex cultural developments including one indigenous first-generation state and countless complex chiefdoms and smaller polities (Figure 1).

The geographer Pulgar Vidal (n.d.) divides the Titicaca Basin into two broad agricultural and ecological regions called the suni and puna. The suni is located between 3800 and 4000 m.a.s.l. It is characterized by rolling hills cut by steep gullies
and low, flat plains called pampas. The higher and drier *puna* is located between 4000 and 4800 m.a.s.l. The *suni* represents the upper limit of plant agriculture while the *puna* is a grazing zone for the extensive camelid herds owned by many Titicaca Basin peoples. The traditional altiplano crops, most notably chenopods and tubers, do not grow above the *suni* zone in any meaningful quantity. The *suni* is the richest area and is where most modern and prehispanic settlement is located.

Overall, the most important animal product of the *puna* in the prehistoric past is the camelid, particularly the llama and the alpaca. Camelids provide wool and meat and serve as pack animals. The virtually unique capacity of the Titicaca Basin to support such large camelid herds has contributed to its position as a major center of complex society in the Americas prior to European conquest.

**Lake Titicaca Basin Agricultural Techniques**

There are a number of agricultural practices in the Titicaca basin utilized by people today and in the past. The following list includes all of the major agricultural types that would have been utilized prior to the Spanish conquest. The agricultural techniques, listed from the least intensive to the most intensive include camelid herd-
ing, the cultivation of small lakes called cocha, rain-fed terrace agriculture, irrigated land, and raised field agriculture.

**Prehistoric Agricultural Intensification in the Titicaca Basin**

In the last two decades, we have accumulated survey and excavation data from a number of areas in the Titicaca Basin including Albarracin-Jordan and Mathews (1990), Bandy (1999), Stanish et al. (1997), Stanish and Bauer (2004), and (Plourde 1999). These data permit a reconstruction, albeit subject to future testing and refinement, of the agricultural history of the region.

Systematic data from the Juli-Pomata region allow quantitative data on land use through time. These survey data can be used to define agricultural land use through time with criteria and assumptions as outlined in detail in Stanish (1994).

*Early Formative*

The establishment of the first permanent settlements defines the Early Formative period and date to circa 2000-1300 BC (Figure 2). These settlements were small, undifferentiated hamlets located near optimal resource zones. Settlement data from the Island of the Sun located in the far southern Lake Titicaca indicate that Early Formative sites were located near springs or naturally inundated areas near the lake edge. There is no evidence for raised field agriculture or canals or terraces during this period. Likewise, in the Juli-Pomata, Early Formative period sites cluster near the richest low, swampy areas near the lake. The settlement pattern represents a resource catchment-optimization strategy of mixed farming, herding, and wild resource exploitation. We also see that the transition to settled societies in this region was very gradual in the Juli-Pomata region as well.

From the settlement and excavation data in the region, we can characterize the Early Formative period lifeway as simply an extension of the earlier Late Archaic one with the addition of pottery within a context of very modest population growth. Data from other work in the Huancané-Putina area likewise indicate that a nonintensive, rain-fed agriculture near the rivers was a component of the subsistence during this period, but that lake exploitation, herding, and wild plant collecting were part of a broad subsistence strategy mix.

*Middle Formative*

Around 1300 BC in some areas of the Titicaca Basin, people created tribal or simple chiefly societies. These societies were characterized by a two-tiered settlement system. The major sites had small but complex architectural constructions. The smaller sites were modest hamlets and small villages usually less than 1.0 hectare. The period from 1300 to 500 BC is referred to as the Middle Formative and is defined as the time when simply chiefly societies were the dominant political organization in the region. Political organization varied over the landscape of course. In some areas agriculture was not as significant as the reliance on wild foods. Economic surpluses were small, and there was a corresponding lack of complex political
In the north and south however, the regions of Qaluyu and Chiripa development respectively, chiefdoms developed as the dominant political organizational type.

Data from the Island of Sun strongly suggest that terraces were first utilized during the Middle Formative, probably around or slightly after 800 BC. There was a substantial shift in the settlement location from springs near the lake to areas that today can only be exploited by agricultural terraces. The population of the island increased dramatically from the earlier period. The settlement shift is not explainable by a rise in the lake level since even the Early Formative sites were well above the lake shore. Most shore areas where the sites were found were cliffs very high above the water level. It is possible that there were some Early Formative sites near the lake edge that were inundated, and this could partially explain the apparent rapid rise in population. However, the shift from springs above the lake to higher land that is terraced today indicates a shift to terrace agriculture.

In the Juli-Pomata region, the vast majority of the Middle Formative sites were in the lower suni in rain-fed terrace areas. The data also suggest the use of raised field agriculture at this time. Research reported in Stanish (1994, 1997) indicate that the percentage of the population located in the raised field areas increased relative to higher pasture sites and nonraised field terraces in the suni. While low relative to later periods, there was a most likely some raised field land use in the region at this time. Likewise, Erickson (1988) has documented extensive use of raised fields in
this period in the north, as has Graffam (1992) and Janusek and Kolata (2004) in the south Titicaca Basin. Raised fields were used on a modest level in the Juli-Pomata region.

In the Putina region, Aimée Plourde (1999) mapped and excavated a site called Cachichupa. This site has a substantial Middle Formative occupation. There is massive nonagricultural terracing at the site that dates to the very beginning of the Middle Formative period (Plourde, personal communication 2002). While not designed as agricultural features, the existence of these terraces clearly indicates that terrace construction was part of the Middle Formative period technological repertoire.

**Upper Formative**

By 500 BC, some areas developed complex chiefly societies characterized by multiple site size hierarchies, regional polities, complex architecture, fancy pottery production, and the importation of preciosities. This Upper Formative dates from 500 BC to AD 400. Around 200 BC, two major polities emerged in the region and represented the culmination of the late Upper Formative period complex chiefly development: Pucara in the north and Tiwanaku in the south. These primate centers pulled in populations from surrounding areas and created settlements an order of magnitude larger than any other settlement in the region. At its height, Pucara covered at least 100 hectares, and probably reached 150 or more. Tiwanaku during the late Upper Formative, known locally as the Qeya period, was probably equivalent in size and complexity to Pucara. Since Pucara collapsed and was essentially abandoned at the end of this period, we have a good understanding from the surface of the architecture, size, and complexity of this site. Late Upper Formative Tiwanaku, in contrast, was subsequently covered by later massive urban constructions and we cannot easily identify the size and complexity of the settlement during this period.

In the Juli-Pomata region, there was a significant shift to the raised field areas during this period. The most intensive use of raised fields occurred during this period. Three sites with complex corporate architectural constructions were built in the area. Two of these were architecturally associated with a formal complex of agricultural features, including the construction of aqueducts that fed the raised fields, a canalization of the river, and a formal raised field layout with satellite settlements. By architectural association, I mean that the habitation and agricultural features were integrated. The canal at one site was placed precisely between the fields and the edge of the habitation area. Likewise, the river was canalized away from its original discharge area to make room for the field systems. Later occupations built tombs and settlements on top of the fields indicating that they were not in use at that time.

A similar pattern was seen on the Island of the Sun. Aqueducts and a formalized field system were constructed in Challa including reservoirs and causeways between Upper Formative sites. This was partially confirmed by excavations in one of the aqueducts that had all Upper and Middle Formative period pottery. This indicates that the aqueduct had to have been constructed in the Upper Formative period or later.

In the northern Titicaca region, settlement data from the Huancané region indicate a correspondingly complex agricultural system with canalized rivers, raised
fields, aqueducts, and other canals all architecturally associated with a settlement with a Middle and Upper Formative period site with elaborate corporate constructions. Similarly complex agricultural systems are found at the site of Maravillas in the north and other settlements in the northern Titicaca Basin.

Around AD 300-400, the site of Pucara collapsed as a major regional center, while the site of Tiwanaku continued to grow. Systematic survey data in the Pucara valley (Cohen n.d.) indicates a dispersal of the population into small hamlets. Raised fields continued to be used near the lake during this time by local polities that I have called Early Huaña (Stanish 2003), but there was a clear shift to extensive agricultural systems in the immediate Pucara area.

**Tiwanaku Period**

Around AD 600, the Tiwanaku peoples expanded out of their capital in the southern Titicaca Basin. The nature of Tiwanaku political economy remains poorly-known, but we know that they at least gained control of a number of colonies and territories outside of their heartland. Tiwanaku was the first indigenous state in the Andes south of Cusco. It was contemporary with the Wari state and it flourished two or three centuries later than the Moche culture on the coast, the first state in South America. Tiwanaku collapsed around AD 1100. The collapse of this state correlates with a major drought in the region although there had been earlier droughts during Tiwanaku expansion.

In the Juli-Pomata, the total percentage of the population in the raised field areas decreases from the previous period, although total population living near raised fields increased 50% from the Upper Formative. I interpret this to indicate that raised field agriculture had reached a maximum capacity, at least in this study area. A subjective review of the topography of the area supports the hypothesis that there was no more room for raised field construction. In this context, Tiwanaku peoples expanded the next most intensive techniques available to them, irrigated and rain fed terrace agriculture. A mere 4% of the population lived in the pasture lands.

In the southern Basin in the Tiwanaku heartland, Tiwanaku raised field agriculture dramatically expanded. The work of Juan Albarracin-Jordan, Gray Graffam, John Janusek, Alan Kolata, James Mathews, Charles Ortloff, and Matthew Seddon (Graffam 1992; Janusek and Kolata 2000; Mathews 1992, Ortloff and Kolata 1993; Seddon 1994; Seddon and Janusek 1994, and others) indicate an expansion of fields into the Tiwanaku and adjacent valleys to the north and south. Kolata (1993:201) estimates that at its height, the Tiwanaku state was cultivating 19,000 hectares of fields. While his population estimates of between 285,000-1,485,000 are based upon questionable assumptions (most notably his short to non-existent fallow time and assumed contemporaneity of all fields), his data still point out that a huge population could have been fed in the southern three valleys of the Titicaca Basin at the time of Tiwanaku ascendancy. Even if we allow for more reasonable fallow periods and land use and abandonment over time, we still have conservative population estimates of over 100,000 people in the Tiwanaku core area alone. In the entire Titicaca Basin, we can conservatively estimate populations of at least one half million during Tiwanaku times.
Data from the north Titicaca Basin near Huancané provide a fascinating insight into Tiwanaku period political strategies for agricultural intensification. A few kilometers north of a large non-Tiwanaku size, Hu-03, is a small valley with a series of agricultural constructions including canals, fields, and reservoir. There is a major Tiwanaku settlement system in this valley. It is almost certain that the population at Hu-03 continued to work the complex field system around their site while the Tiwanaku state established an enclave a few kilometers away. There is no evidence of Tiwanaku influence at Hu-03, but the surface evidence at least suggests a Tiwanaku-contemporary occupation that I have called Late Huaña (Stanish 2003). Certainly, the agricultural resources at Hu-03 are substantially better than in the Tiwanaku enclave. At the present time without excavation data, the best interpretation of these settlement patterns is that Tiwanaku was permitted or forced their way into an adjacent valley near Hu-03 and exploited an independent water resource. This small enclave maximized the resources in the area with a sophisticated agricultural complex while the local population along the Huancané river continued to intensify their resources independently.

Tiwanaku ceased to be a regional political force by the 12th century AD, possibly earlier. According to Ortloff and Kolata (1993), the proximate cause of Tiwanaku collapse was a drought that began around the middle of the 11th century and lasted for two centuries or so to around AD 1300. This interpretation has been challenged by Erickson (1999). However, it would appear that this drought did indeed have severe consequences for the continued utilization of raised field agriculture. Throughout the southern Titicaca basin, there are numerous abandoned canals and aqueducts that run from now-dry quebradas and springs to fossil raised fields. They are rare in the north Basin where the topography precludes their efficient use. These can only be interpreted as a response to the drought, bringing fresh water to the raised fields from increasingly more distant and less productive rivers and springs.

Altiplano or Late Intermediate Period

The collapse of Tiwanaku political organization and the prolonged drought of the 12th century provided the context for the emergence of numerous smaller polities in the Late Intermediate or Altiplano period. These Aymara “señoríos”, as they were referred to by the Spanish chroniclers, were characterized by internecine warfare, a dispersed settlement system, the collapse of regional exchange, and a general collapse of centralized political structures (see Frye 1997).

These small polities relied extensively upon camelid herds as well as rain-fed terrace agriculture. While earlier cultures most certainly were pastoral as well, the Altiplano period people's intensified the use of the puna grazing lands, and created a much more dispersed settlement system to maintain the herds. The quantitative data from the Juli-Pomata area illustrate the dramatic shift in land use. Population in the puna grazing areas increased three-fold as a percentage, and increased by a factor of seven in the total number of sites. Even though there were modest population increases in this period, settlement in the raised field areas dropped almost in half, both in percentage and absolute terms. Furthermore, numerous canals and raised fields were used as architectural platforms for cemeteries and habitation sites suggesting
that the drop in raised field use was even greater. That is, it is most likely that people moved into previous raised field areas as the water resources contracted, and used the area like they do today for grazing. While raised field use in the post-Tiwanaku times is documented in other areas of the basin as well, it was most likely on a household or at best village level of organization, not a state or regional level as in the previous period (but see Graffam 1992 for an alternative view). In short, raised fields increasingly became less viable in the drier environment of the post-Tiwanaku periods. Populations dispersed throughout region and refocused agricultural activities toward the pasturing of animals and terrace agriculture.

Inca Period

The Inca occupation of the Titicaca Basin represents the first nonindigenous conquest of the region in its history. The Collasuyu region was one of the most important territories in the Inca state. It was perhaps one of the richest set of provinces in the empire. More than any period, the Inca occupation represents a strong political control in the region with a state capable of moving populations, imposing peace, facilitating exchange, and organizing production.

Analysis of the Late Horizon or Inca period settlement data demonstrates several patterns: First, raised field agriculture virtually disappeared during the Late Horizon. Settlement data indicate a shift away from the raised field zones in the survey area to locations in the rain-fed terrace areas. Second, there was a substantial shift to the puna pasture lands from earlier levels. The shift to the puna lands was significant, particularly when compared with earlier figures. By the Late Horizon, this figure had increased to almost 20%. In fact, about 1/5 of the population lived in the pasture grazing lands, a pattern that emphasizes the importance of camelid wool and meat in the Inca economy. Third, the Late Horizon settlement pattern is heavily weighted to terrace agricultural and lakeside urbanized areas, suggesting a maximization strategy in the region designed to produce and move commodities and to locate populations in optimal agricultural land.

These data support both Graffam (1990:248-249) and Ortloff and Kolata's (1993) arguments that the fields were economically unfeasible by the time of the Inca conquest. The Juli-Pomata settlement data reflect this changed ecological situation. Less than 15% of the population lived in the raised field areas during this period, and most of that population can be accounted for by the presence of a major Inca road that runs through the pampas in areas of former raised fields.

In short, the Inca empire moved into an environment in which raised field agriculture was impossible, except in a very few restricted spots. They intensified the Altiplano period agricultural strategies focusing on rain fed agriculture, some irrigated terraces, and pastoralism. The Inca also dramatically increased exchange with regions outside of the region, particularly to the east and west where agricultural production was optimal (Wachtel 1982).

The Island of the Sun has a small area of raised fields that was one of the exceptions that proves the rule (Bauer and Stanish 2001; Stanish and Bauer 2004). These intensive raised fields were most likely utilized by the Inca. In the southern Kona Bay a small complex of canals, fields and reservoirs were used. The Island of the
Sun is warmer than the mainland areas due to the higher ambient temperatures provided by the lake. Where raised fields were indeed possible, the Inca utilized them as best as they could.

The Inca settlement pattern was one of a high quantity of dispersed, small sites plus the establishment of large urban settlements on the road system. This strongly bimodal settlement distribution indicates an imperial system of rural agricultural development combined with urban centers where craft production was intensified. The earlier Tiwanaku state had housed craft specialists (Janusek 1999). But the Inca strategy was to disperse these urban centers around the region. These centers were much smaller than Tiwanaku, with the largest being around 80 hectares in size and some as small as 5 hectares. However, we have identified scores of Inca urban settlements in the Titicaca region during their occupation indicating a conscious effort to disperse these productive centers (Stanish 1997, 2003).

DISCUSSION

The data from the Titicaca Basin permit us to trace the evolution of agricultural land use and intensification over more than two millennia. These data unequivocally indicate a correlation between political complexity and agricultural intensification. However, that pattern was not one of a slow, progressive increase in technology and labor investment through time. Rather, the pattern was one in which preexisting technologies were differentially utilized to optimize the political and ecological environment of any given period. All of the agricultural techniques were developed by as early as 800 BC, probably before. As political organizations became more complex from the Middle Formative to the Tiwanaku period, farmers would adopt the more labor intensive strategies at the expense of less intensive ones within the limits of the physical environment. When less complex societies followed more complex ones, agricultural strategies shifted to earlier patterns. It is not surprising that the Middle Formative and Altiplano period agricultural strategies are strikingly similar, even though they were employed in different cultural, ecological, and demographic contexts. In each period, chiefly societies relied heavily on the pasturing of animals and a strong focus on terrace agriculture. Raised fields were used, but most likely by household or village level farmers and not in any formal way.

During the Tiwanaku and Inca periods, the time of maximum political complexity in the region, agriculture was the most intense in the historical sequence. The drought of AD 1100-1200 most likely contributed to the collapse of Tiwanaku. However, and this is extremely important, the survey data strongly indicate that there was no demographic collapse that accompanied the Tiwanaku state collapse. In fact, there was a slight population increase in the Juli-Pomata region, and probably a leveling or slight increase in the Tiwanaku valley itself (Albarracin-Jordan and Mathews 1990, Stanish et al. 1997). What did collapse was the political structure that was able to provision the capital city. The post-Tiwanaku settlement landscape was one in which populations did not decline, but merely dispersed, relying a much more extensive economic system. Therefore, the drought did not lower the carrying capacity of the land. Rather, it slowly destroyed the viability of one kind of land
use—raised field agriculture—as an intensification option. In the Altiplano period the populations once again adopted more extensive, risk-averse, systems of agricultural production and were able to maintain the Tiwanaku period population levels.

The Inca and Altiplano periods were characterized by very similar physical environments. However, the economic strategies of the latter represented a low risk strategy of a wide mix of land use and economic behaviors. The Inca, in contrast, faced with a very similar ecological environment, intensified commodity production and agricultural terrace production to their maximum. It also intensified camelid production to its highest level in the history of the basin to that point in time. While the physical environment was indeed a major factor in land use, the intensity of that land use depended upon the political structure that was, or was not, capable of amassing labor. The Inca empire took the same environment and overcame the obstacles through their ability to mobilize labor. They intensively produced food through a more complex system of camelid pastoralism and rain-fed terrace farming.

In short, we see a shift in agricultural strategies over time depending upon the political organization of the region. I conclude that pattern of land use in the Titicaca region demonstrates that intensification involved changes in the labor organization of existing technologies that were all in place quite early, and not the introduction of new technologies. This observation even holds for the Inca empire where the major changes were in labor organization (commodity specialization, economies of scale, divisions of labor etc.) and not the introduction of new technologies.

Agricultural intensification in the Titicaca Basin is best understood as a form of elite political strategies to maximize production. Population pressure was not a factor, however minimum population densities were most likely a necessary cause in the development of the various agricultural technologies by at least 800 BC, if not earlier. Agricultural deintensification, in contrast, was a result of altered physical environments and the breakdown of complex political organizations. In the absence strong political organization, households and villages opted for strategies that were optimal in the particular physical and social environment in which they existed. The shifts from raised fields to pastoralism, after Pucara collapse in the Early Huaña period in the north and in the Late Intermediate period in the south basin, illustrate these strategies in different cultures and at different times.

Earle (1987, 1997:86-87) argues that this kind of agricultural intensification was part of the political economy, the dynamic component of wealth production in complex societies that provides elite the material means to maintain their positions. The data here support his observation that agricultural intensification is a strategy to increase surplus production, and not a direct response to population pressure. Likewise, Spencer, Redmond and Rinaldi (1994:139) specifically see agricultural intensification as an elite strategy to solidify chiefly power and not as a response to demographic pressure. The data from the Titicaca Basin support this general theoretical position that agricultural intensification is a strategy used by populations to increase production under certain circumstances, both ecological and political. Political elites that can mobilize labor will adopt higher risk strategies when possible. When political organization is strong, agriculture is intensified. When political organization is weak, less riskier, more extensive strategies are utilized.
The causal link between political organization and agricultural intensification is complex. In the Titicaca region, the Inca were able to intensify agricultural and other economic productive activities to their highest level. In contrast, the immediate pre-Inca peoples who lacked a complex political organization maintained a very low risk, extensive agricultural system even though the environment was essentially the same. There is an undeniable link between political organization and agricultural intensification. Defining the precise causal relationships between these two variables will require more fine-grained chronologies and creative methodologies that can help define this classic question in anthropological archaeology.

1 A modified and expanded version of this paper appears in Marcus and Stanish (2006).
2 A broad summary of the ecology and paleoecology of the region can be found in Stanish (2003).
3 These figures are consistent with 19th and early 20th century population estimates. David Forbes (1870:200-202) lists a figure of between 750,000 and 870,000 Aymara for Peru and Bolivia, a figure that Tschopik considered to be too high (H. Tschopik 1947:504). Later, Marroquin (1944:1) noted that the Peruvian Department of Puno had 600,000 people in the 1940's. Likewise, Tschopik suggested figures of approximately 500,000 to 750,000 Aymara speakers between the mid-19th century to 1935 (Tschopik 1947:504, 506), basing this in part on a manuscript by La Barre who reported a figure of around 600,000 in 1935 (Stanish 2003).

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