Chapter 2

Background and Framework

Archaeological research concerning prehistoric agriculture can be divided into three broad categories:

1. Research concentrated on the origins of agriculture in various parts of the world;
2. Research focused specifically on the intensification of agriculture or the remains of prehistoric agro-engineering technology;

My research addresses the second and third categories. It is geographically centered on a specific study area and agricultural technology; however, it contributes to the larger body of literature concerning agricultural production and demography by offering a case study that details a history of ecological change, risk management and the social dimensions of intensive agriculture. There is a vast body of literature that attends to these two categories, much of which directly influenced the concepts and conceptual background presented here. Most, if not all of this literature, falls under the general heading of *agricultural intensification.*
Agricultural Intensification

Agricultural intensification considered generally, has been a hotly debated topic in economics, anthropology and archaeology for over 100 years. Throughout the history of this research there have been two broad approaches. The first examines the relationship between demography and intensification, spans over two centuries of debate, and draws from a wide body of cross cultural case studies and a variety of disciplines outside of anthropology. The second focuses on the social conditions of intensive production, and is a more recent anthropological development, emphasizing non-demographic parameters such as household labor and consumption. This approach draws on modern ethnographies and is generally considered as moving beyond ‘just demography and intensification’.

Demography and Intensification, General Theory

The relationship between changes in demographic patterns and agricultural intensification has dominated the last two centuries of anthropological, economic and geographic research into prehistoric, historic and modern agriculture. It has also been one of the most hotly debated topics in anthropology, economics and demography (Boserup 1965; Malthus 1878; Netting 1990, 1993; Sanders 1972; Sanders, et al. 1979; Spooner 1972). Three major shifts in scholars’ conceptualization of demography-driven agricultural intensification have occurred during this span. But before I address these
I need to explicitly define just what I mean by *agricultural intensification*.

### What Is Agricultural Intensification?

Agricultural intensification is the substitution of labor or capital for land (Brookfield 1972; Stone 2001). Intensification simply increases (or checks the decline) of agricultural output per unit of land, while demanding higher costs of labor and/or capital (Stone, et al. 1990). Fallow shortening or the construction of agro-engineering facilities such as terraces or irrigation canals are its most familiar forms (Boserup 1965; Netting 1993; Stone, et al. 1990); however, lengthening of the growing season, introduction of new cultigens, or shifting patterns of community labor organization are also considered forms of intensification (Netting 1993; Stone 2001). While much debate has occurred over the *process* of intensification, there has been general acceptance for its aforementioned features for decades. For example, in 1972, H.C. Brookfield (Brookfield 1972: 31) wrote:

> Strictly defined, intensification of production describes the addition of inputs up to the economic margin,…In regard to land, or any natural resource complex, intensification must be measured by inputs only of capital, labour and skills against constant land. The primary purpose of intensification is the substitution of these inputs for land, so as to gain more production from a given area, use it more frequently, and hence make possible a greater concentration of production.

Modern ethnographic studies emphasize the capital improvement of land through the adoption of or investment into new technologies, such as mechanized agriculture or chemical fertilizers (Brookfield 2001). But in most prehistoric societies such capital
investment was not possible. In those circumstances, capital investment was carried out by the investment of more labor into a defined area of land. This labor may have, but did not always, manifest itself in the form of agro-engineering features. The Classic Maya are a perfect example of this because they relied solely on the labor of humans for agricultural and even non-agricultural tasks\textsuperscript{ii}. Thus, agricultural intensification is defined here as \textit{any increase in the labor input per unit of land, which serves to increase output or simply minimize the decline of output per unit of land.}

There is a critical point to be made here, especially when discussing my own case of Classic Maya intensification. Intensification may include innovations and investment of labor capital into works that leave a permanent mark on the archaeological record. Brookfield (1984: 16) writes,

\begin{quote}
Some innovations create \textquote{landesque} capital, which once created persists with the need only of maintenance; other innovations require continued application and leave no lasting mark on the land;
\end{quote}

He continues (Brookfield 1972: 32)

\begin{quote}
Indeed, the physical evidence of major site transformation, which is often all that remains to be seen of former intensive practices, represents only one end of a continuum of former intensification, and the archaeological record therefore constitutes only a partial and biased inventory of past practices.
\end{quote}

Essentially, Brookfield (1972, 1984) is referring to one of the common misperceptions about intensification, i.e., that \textquote{landesque} capital improvements to the landscape are (or were) intensive agriculture. In reality, these improvements are simply the result of a process of intensification. From an archaeological perspective, they are often our only material evidence for intensification that, as Brookfield (1972, 1984) notes, represent the
final stage on a continuum of intensification. Turner and Harrison (Turner and Harrison 1978: 337) emphasized this point for the Maya when making a distinction between the *type* of agriculture and the *intensity* of agriculture. As an example, the terraces on the Cohune Ridge cannot be considered ‘intensification’ through innovation, but landscape improvements resulting from a process of intensification.

‘What agricultural intensification is’, is generally accepted within anthropology. Yet considerable debate still centers on the process of intensification, i.e., why and how it occurs. First I begin, as all do, with Thomas Malthus, a political economist, who authored his theories concerning populations and intensification while witnessing the expansive demographic growth of Continental Europe and North America during the late 18th and early 19th centuries (Malthus 1878).

**Malthus**

Malthus viewed human populations as forever caught between demographic pressure and intensity of production (Malthus 1878). He argued that long-term conditions would eventually expand populations beyond the means of production, eventually creating demographic misery, i.e., disease, infant mortality, and shortened life spans (Malthus 1878). Malthus suggested that human populations would consistently increase beyond the means of production, with ‘positive’ checks such as famine, disease and warfare, reducing their members below or equal to a level of equilibrium in the short-term (Malthus 1878). He believed that only two factors could ‘control’ the effects of
population growth on a short-term basis: one, internal preventive mechanisms, such as female infanticide, or two, the adoption of technological innovations, which only offer temporary respite from long-term misery, i.e., eventually populations would expand to meet or exceed the new limits provided by such innovations.

Malthus envisioned a human condition that is consistently poised between prosperity and misery, famine and conscious effort (e.g., late marriage and birth spacing), and disease and preventive social mechanisms. Malthus’ major points can be summarized as follows:

1. Populations will in the long run expand beyond the productive means provided by any given technology.
2. Technological innovations can win temporary respite over this inevitable trend.
3. Positive checks would reign supreme, eventually returning populations below or equal to equilibrium.
4. This long-term trend of misery is primarily a result of population growth occurring at a geometrical rate, with intensification of production occurring at an arithmetical rate. All production would also be constrained by the declining marginal productivity of labor.iii

Malthus’ ideas, while accepted by some social scientists for over 100 years, have been criticized along three general lines: 1) for their overly pessimistic outlook on the relationship between populations and resources, 2) for their overly generalized conclusions, which do not take into account local traditions and history, and 3) for their
failure to anticipate new technological innovations for production and transport. Central to these criticisms is the overly simplistic notion that for Malthus, innovation was an independent variable, leading to population growth, the dependent variable. The primary champion of this critique was Ester Boserup, a Danish economist, who pointedly argued that population growth and ultimately population pressure on resources were the independent variables influencing agricultural intensification.

**Boserup**

Boserup countered Malthus’ ideas in 1965, using observations of swidden farmers in Southeast Asia and Africa. She (Boserup 1965, 1981) challenged Malthus’ theories by arguing that population growth would lead to population pressure on resources and ultimately lead to agricultural intensification (defined by Boserup as an increased labor input per unit of land). Boserup observed increasing populations, and more limited access to lands created by such growth, as the prime movers for the adoption of new agricultural strategies or technologies. In the case of the Philippines, for example, change involved decreasing fallow length and the investment of more labor into each parcel of cultivated land. Boserup protested that she was not introducing another linear model of evolution, despite suggesting that farmers would increasingly shorten their fallow (the amount of time land is removed from cultivation), and maximize their labor/productivity ratio. In severe cases, such intensification might include the construction of terraces, application of double cropping or construction of other intensive agro-engineering facilities. Boserup viewed population growth and, ultimately, population pressure as
driving these changes. Contrary to Malthus, this theory provided a more optimistic picture of the burgeoning populations of the 20th century, i.e., it assumed that the key to economic development was effective use of available labor and technological innovation. Boserup’s scheme can be summarized as follows:

1. Population growth in human populations is an independent variable.

2. Population pressure, resulting from such growth, would lead to intensification, measured as the amount of labor invested into a parcel of land or at least the frequency of cultivation, and innovations that supported such intensification.

Numerous scholars tested Boserup’s theory on the prehistoric landscape, finding great relevancy (to greater or lesser degrees) for her scheme from a variety of contexts. Whether it was Mesopotamia and the rise of urban centers (Adams 1972) or the great diversity of populations and settlements found throughout Mesoamerica (Sanders 1972), her scheme was applied to case study after case study. Some scholars argued that her ideas required clarification, but applauded her attempt at a generalized theory. Sanders, for example, suggested that local environmental variables and subsistence traditions and technology should be considered (Sanders 1972). A handful of scholars such as Lee (Lee 1986) rejected her overly simplified presentation of Malthus and suggested that Malthus’ and Boserup’s schemes actually complemented each other, because both presented population pressure models. Essentially, Lee and others now argue that Malthus plus Boserup provides a richer picture of populations and the intensification of agriculture (Lee 1986; Wood 1998).
**Malthus plus Boserup**

James Wood (Wood 1998) recently refined Lee’s insight and mathematically married the Malthus and Boserup schemes, in order to understand some of the demographic patterns observed in Europe before and after the Black Plague. Basically, Wood (Wood 1998) illustrates that Malthus plus Boserup (*a hybrid model*) provides a clearer picture of pre-industrial demography because it allows for the recognition of the long-term Malthusian patterns of human populations, while being able to explain the population growth and pressure associated with technological change in the short run. Essentially, Wood argues that Boserup’s model is a sub-set of Malthus, with Malthusian processes prevailing in the long run.

In order to link Malthus and Boserup, Wood introduced the theoretical construct of ‘well-being’, which he (Wood 1998: 104) defines as, “...*any aspect of individual health or physical condition that is either positively associated with the probability of childbirth or negatively associated with the risk of death.*” ‘Well-being’ proves to be an extremely valuable concept because it allows for consideration of contextual issues, such as changing resource base and diet, while providing a means to quantitatively characterize pre-industrial population changes. Wood demonstrates that analysis of the mean and the variance of well-being for a given population, given a set of local conditions (land tenure, access to resources, climate, etc.), should illustrate whether a population is experiencing Malthusian stagnation or Boserupian expansion. The real value of Wood’s hybrid scheme is however, that it provides a measure (well-being), which is sensitive to local
considerations (something Boserup’s model lacked), clarified short-term processes (a limitation of the Malthusian scheme) and can also be applied cross culturally. Wood’s hybrid Boserup-Malthus scheme can be summarized as follows:

1. Technological innovation will result in an overall increase in the mean and the variance of well-being through time (positive well-being).
2. A positive (with regards to the mean and variance) well-being will reflect a population experiencing population growth.
3. A negative (with regards to the mean and variance) well-being will reflect a population that has expanded beyond its means (or surpassed demographic saturation).
4. While populations may experience Boserupian expansion in the short term, they will also endure Malthusian stagnation in the long term.

While Wood’s scheme holds great value for intensification studies, it is a generalized and demography-based model. Like Boserup’s and Malthus’ ideas, explicitly demographic models of intensification have been challenged in recent years on the basis that specific case studies illustrate that intensification may be highly contextual and influenced by a variety factors beyond demography, including, political economy, social organization, market access and access to capital investment. For example, Cowgill criticized Wood’s hybrid model for the lack of a political economic component (Cowgill 1998: 122). He writes,

…Wood regards the political economies of societies as complicating variables that can eventually be incorporated in his model but for the present are best set aside in favor of a simpler model that focuses on supposedly more basic variables. For me, nothing is more basic than
political-economic aspects of societies, and models that neglect them are as fatally flawed as would be models of climate that left out precipitation (Cowgill 1998: 122).

Such criticisms will be lumped together here under the heading of the social conditions of intensification for simplicity. They range from wholehearted rejections of Malthus and Boserup, to those that move ‘beyond-Malthus’ or ‘beyond-Boserup’ (Stone 2001).

At the forefront of some of these critiques has been interpretations from archaeological research (Leach 1999; Morrison 1994, 1996). Many of the critiques align with the quote from Cowgill, suggesting that the demography centered models deny the influence of other ‘socially’ based variables. Others have been more critical of the evolutionary character of the models (particularly, Boserup’s), and have completely rejected their use in archaeology. For example, Morrison (Morrison 1996: 583), writes,

I draw attention to the structural similarities between Boserup’s work on intensification and other typological schemes of progressive cultural evolution, arguing that her work is…one more example of a progressive, stepwise classification of cultural types based on the substitution of space for time. Our contemporary ancestors are now swidden farmers. To put it more bluntly, I would suggest that Boserup has created a pseudo-historical sequence by (I argue, falsely) generalizing modal economies and placing them into stages of her own devising. The structure of this worldview compares closely with other such attempts – savagery to civilization, primitive modes of production to socialist, bands to states…Without this sequence, there is no model.

Leach (Leach 1999: 311) reaffirmed such criticisms, stating that,

Archaeologists have taken these assumptions as dogma because all-embracing developmental or evolutionary scheme’s such as Boserup’s provide useful frameworks for integrating uneven evidence drawn from various periods and diverse regions.
My dissertation relies on models, but at the same time, I recognize their limitations. I simply believe that any reasonable approach to the subject of intensification must begin with the critical application of models in order to explore the diversity of real world examples. One group of scholars who advocate a similar approach have made great strides in contemporary understandings of the process of intensification (Netting 1968, 1990; Stone 1996, 2001; Stone, et al. 1990). They clearly illustrate that there are other variables influencing the intensification process, but at the same time they do not deny the role of demography in intensification. This group is centered on the concept of *smallholders*, the primary producing unit in most non-industrial societies.

**Beyond Demography, The Smallholder Approach**

*Smallholders and Intensification*

The smallholder approach, championed by Robert Netting, recognizes the limitations of demography-focused schemes, (Boserup specifically) and attempts to build upon such limitations (Netting 1993). Netting and others argue that Boserup’s scheme, while simplified, provides a critical framework for isolating many of the *other* variables involved in agricultural intensification (Netting 1993; Stone 2001; Stone, et al. 1990). They confirm that population pressure does initiate intensification in many circumstances, but hope to add other variables. For Netting and others, these variables are the *family household* and *household labor*. Netting (Netting 1993: 13) writes,
My own variation on the Boserup theme was to emphasize the role of the small, nuclear or polygynous family household as the social unit that typically mobilized labor, pooled consumption, and exercised tenure over the intensively tilled farm. I saw household size and composition as correlated with and responsive to farm area, cultivation techniques, and especially the labor needs of the agricultural operation.

In many respects, the smallholder approach adds ‘culture’ to studies of agriculture (Stone 2001), or Chayanov to Boserup (Netting 1993). The smallholder approach, while more complex than any demographic model of agricultural change, is also a generalized model. It too obscures some of the diversity of influences and responses to agricultural change. It does, however, provide a valuable framework not only to better understand the process of intensification, but also to identify other influential variables. The only drawback to archaeological applications of the smallholder approach is the fact that it was derived from modern ethnographies of communities engaged in cash market (usually capitalist) activity. Consequently, some of its assumptions and generalizations clearly cannot be transferred to the prehistoric landscape; however, I believe a modified form can be employed for better understanding the archaeological remains of intensification at least in the Maya region.

What is a Smallholder?

According to Netting,

Smallholders are rural cultivators practicing intensive, permanent, diversified agriculture on relatively small farms in areas of dense population. The family household is the major corporate social unit for mobilizing agricultural labor, managing productive resources, and organizing consumption (Netting 1993: 2).
The key features of ‘what a smallholder is?’ have been recently summarized by Stone (Stone 2001). He (Stone 2001: 165-166) writes:

- **Smallholders live under conditions of scarcity…**
- **Smallholders are not economically isolated…**
- **The smallholder economy is not devoted to subsistence production and use-value or to profit maximization and exchange-value…** Smallholders may sell their goods and/or labor, but are never wholly dependent on the market economy; they always provide for a substantial portion of their own subsistence.
- **Smallholder agriculture is ‘sustainable’ as defined in energy terms: production is predictable and sufficient to feed the producers, and stable over the long run…**
- **Smallholders exhibit a wide range of agricultural technology.**
- **Smallholders farm intensively: they tend to have high rates of production concentration at the expense of low output per worker and per unit of input. They do, as Boserup has maintained, work harder.**
- **…Smallholder agriculture demands individual discipline, social coordination, physical skill, and expert knowledge to carry out such tasks as hand-weeding, transplanting and fertilizing, and the making and maintaining of dykes, terraces, ridged fields and irrigation canals.**
- **Smallholders have great incentive for tenure security on their intensively used land…**
- **…Smallholder agriculture is run by households. There is wide cross-cultural variation in form and function of the household (Wilk and Netting 1984), but several pivotal features of smallholder farming ‘increase the number and importance of economic activities carried on in a household, and hence the centrality of the household as a social institution’ (Netting 1993: 61). These features include the need for high levels of skilled and coordinated labour, sustained use and improvement of resources, establishment and transmission of property rights, and multiyear storage and management of resources to minimize risk.**
There are two other features that I believe should be added to Stone’s summary, primarily because they provide a great deal of analytical utility to the smallholder approach. The first is the relationship between household size and farm size. Netting (Netting 1993: 85-86) writes,

If a smallholding is to produce optimally, it requires certain amounts and types of labor, and if the smallholder household is to survive and prosper, it needs employment for its members. The dynamic process of continual adjustment between the numbers and skills of household members and the agrarian resources to which they have access is particularly important among intensive cultivators. It is apparent that smallholders everywhere strike some kind of economic balance between household numbers and land size.

Through an analysis of several smallholding communities, Netting illustrates a positive correlation between household size and farm size within communities despite the fact that the absolute size of farms among different communities varies considerably (Netting 1993). This relationship has been quantitatively evaluated in many parts of the world, including Hayden and Cannon’s (Hayden and Cannon 1984) analysis of Highland Maya communities in Guatemala, even though their study did not explicitly employ a smallholder approach.

The relationship between household size and farm size is quite a logical notion when one considers the second feature of the smallholder approach I would like to emphasize: household labor. Netting’s work refocused the Boserupian scheme from solely regional analysis, to micro-level processes occurring inside household. This Chayanovian notion illustrates that the demographic conditions of a household are directly related to
production and consumption demands and hence, labor demands and utilization. Netting (1993: 306) writes,

The causal arrow that determines amount of labor per worker in the Chayanovian peasant household comes from the consumer/worker ratio—that is, from the demand generated by family size and composition. This is a demographic parameter and has some resemblance to the population pressure that provides the motive power for agricultural intensification in Ester Boserup’s (1965) model of change.

Essentially, Netting adds a different scale to analyze agricultural intensification in process.

Like the Boserupian, Malthusian or hybrid models, Netting’s smallholder approach has been criticized for reducing societies to a scheme that does not recognize the great diversity of local traditions and history. But I believe that it is in this generalized scheme that the framework for identifying other critical variables in the social conditions of intensification may be found. As Stone (Stone 2001: 164) writes, in response to harsh criticisms of Netting’s approach,

I applaud it. To attempt an unlimited view this book (Netting 1993) would have paid a heavy price in clarity and coherence. As it is, it sets the stage nicely for subsequent investigation of smallholder political economy.

To reiterate, I believe that the only drawback to the smallholder approach within archaeological research is the fact that it depends on ethnographies of modern communities emeshed in the market economy and commodity labor. Despite this shortcoming, I will argue that the smallholder approach holds great value when considering Classic Maya intensification and agriculture. The Maya certainly did not have to deal with confounding variables of the labor market or cash cropping, but the
smallholder approach provides us with insights that enable us to evaluate Maya agriculture generally and to compare the Maya to other modern, historic, and prehistoric case studies.

**Summary of Intensification**

Our perceptions of populations and technological and social innovation with regard to agriculture have changed remarkably in over 100 years of research. Basically, Malthus and Boserup, while seemingly opposed, in fact complement each other (Wood 1998). Populations do introduce new agricultural technologies or strategies to ameliorate problems associated with population growth and pressure. But these technologies are also employed in relation to social and economic pressures or incentives, such as taxes, tribute and access to market. From all of the broad approaches and results discussed above, there are several features that I would like to emphasize:

1. Population growth and pressure often results in increased labor input per unit of land, i.e., intensification.
2. Such intensification may temporarily ameliorate conditions of pressure or misery, but these systems will ultimately return to long-term Malthusian processes.
3. A diachronic analysis of populations and production can illustrate whether a population is experiencing either Malthusian decline or Boserupian expansion.
4. Increased labor input into agriculture may result in landesque capital improvements to the landscape, such as terraces.
5. Once these improvements are in place, there is a direct effect on household organization of labor and land tenure or use rights. Essentially, *intensification* is translated through the demands and available labor of households.

6. These permanent investments of labor often result in a high correlation between household size and farm size.

7. The archaeological record is biased in its treatment of agricultural intensification, because it emphasizes event over process. For example, terracing is a process that reflects upon the end results of possibly hundreds of years of intensification that could leave no other permanent mark on the landscape.

We now know intensification not only affects the demographic patterns of populations, but also has a measurable effect on household and community organization, land use and tenure, ideology and politics. That these social and economic aspects of intensification are highly contextual does not preclude cross-cultural comparisons of some of these trends through the use of a smallholder approach.

**Can the Maya be Viewed As Smallholders?**

The simple answer is yes and this can be illustrated by reviewing the features of a smallholder, as summarized by Stone (Stone 2001), while pointing to current archaeological research in the Maya region for applicable evidence.

*Scarcity*

According to Stone, “Smallholders live under conditions of scarcity…” (Stone 2001). Based upon recent population estimates for many lowland
Maya sites (Culbert and Rice 1990), Maya farmers can be viewed as producing under conditions of scarcity, especially during the Late Classic and especially concerning access to agricultural land. Some sites, such as Copan (Wingard 1992), have been the subject of research on this topic, which demonstrates that while there existed adequate resources for much of the Classic Period, towards the termination of the Classic these resources were, in a word, scarce. Additionally, many ‘landesque’ capital improvements, such as the terraces on the Vaca Plateau, also illustrate intensive use of the landscape and likely population pressure on resources. Basically, despite the many varying opinions of researchers studying Maya agriculture, few would challenge the notion that the Maya produced under conditions of land scarcity, at least during the Late to Terminal Classic. I discuss this assumption thoroughly in chapters six and seven as it applies to Caracol and the Cohune Ridge.

Isolation

Stone’s (Stone 2001) second point emphasizes that smallholders are not economically isolated. He (Stone 2001) states that while households do consume the majority of agricultural resources they produce, they do participate in other economic activities. Recent research into Maya household economies clearly illustrates that Maya households were socially, politically and economically integrated. At some Maya sites, such as Caracol (Chase and Chase 2001), there are demonstrable remains
of integration, such as causeways. At other sites, evidence for economic integration is not as obtrusive, but certainly as valid. At Ceren, for example, archaeologists have clearly illustrated that the 100 or so families in the community were economically tied to each other (Sheets 2000). It is important to note here that the scale of household integration at Maya sites is hotly debated and may have varied from site to site.

Subsistence Production vs. Exchange Value

Stone (Stone 2001) states that the smallholder economy provides for a substantial portion of their own subsistence. He adds that while smallholders may participate in a market or other exchange activities, the household remains as the primary organizational unit for production, distribution and consumption of basic resources. While it is unclear if there is a genuine ‘market’ economy operating at lowland Maya sites during the Classic, it is widely agreed that most households produced the majority of their subsistence requirements for consumption at the household level (Webster 1985). There is for now no evidence that suggests a large portion of staple goods moved beyond the boundaries of most Maya households. Again, I turn to recent research at Ceren, which demonstrates that all of the households in the village participated in subsistence production and some craft activity (Sheets 2000). In order to address this issue specifically, I examine the agricultural labor economy of households on the Cohune Ridge in chapter seven.
Sustainable Agriculture

Stone (Stone 2001) emphasizes that smallholder agriculture is generally sustainable. And while most Maya sites exhibit clear evidence of the collapse of elite culture in the ninth and tenth centuries, Maya farmers produced intensively for many centuries prior to the declines observed in the Terminal Classic. No research program illustrates this point better than the diachronic settlement and resource research program carried out at Copan (Abrams 1995; Webster 1985; Webster and Freter 1990; Webster, et al. 2000; Webster and Gonlin 1988; Webster, et al. 1992; Wingard 1992). While the Copan polity experienced severe declines in the latter part of the ninth and tenth centuries, the inhabitants of Copan were able to produce sufficient resources for over five centuries, even while population pressed on resources. Ultimately this seems to be a question of scale, relating back to Wood’s hybrid model.

Diversity of Technologies

Stone (Stone 2001) states, “Smallholders exhibit a wide range of agricultural technology”. Clearly this is the case for the Classic Maya despite their reliance on basic tools, such as digging sticks, hoes and axes. Wingard (Wingard 1992), through simulation investigated the demographic consequences of the application of different agricultural strategies on the variable Copan Valley environment, even without the widespread presence of ‘landesque’ capital improvements, such as
terraces. Fedick and Dunning (Dunning 1996; Fedick 1996), for example, also illustrate a diversity of techniques, some of which are associated with landscape improvements, such as wetland fields or terraces (Fedick 1996).

**Intensive Farming**

Stone (Stone 2001: 166) writes, “Smallholders farm intensively: they tend to have high rates of production concentration at the expense of low output per worker and unit of land.” While no quantitative analysis of prehistoric labor input into agricultural tasks in relation to output has of yet been presented, many researchers believe this to be the case for many Maya sites, especially during the Late Classic (Webster 1985). In part, this assumption is driven by Boserupian notions of population pressure on resources. Based upon recent population estimates (Culbert and Rice 1990), it is clear that land was at a premium for many Maya sites. Additionally, the presence of ‘landesque’ capital improvements, such as terraces or raised fields suggests a high level of labor input on small parcels of land. I quantify this notion in chapter seven.

**Expert Knowledge**

Stone (Stone 2001: 166) stresses the ‘quality’ work carried out by smallholders. By ‘quality’, Stone is referring to each farmer’s knowledge and skill level, associated with agricultural production. He (Stone 2001: 166) refers specifically to, “hand-weeding, transplanting, and fertilizing, and the making and maintaining of dykes, terraces, ridged fields and
irrigation canals.” While no ‘traditional irrigation features’ are known for the Maya region, many researchers have identified dykes, terraces and drained fields (Fedick 1996). Additionally, Fedick and others have clearly illustrated that agriculture in the lowlands required such expertise knowledge. Ethnographic studies of agriculture in highland Guatemala also illustrate some of the complexities associated with agriculture in a nearby region (Matthewson 1984).

**Land Tenure Security**

Stone (Stone 2001) writes, “Smallholders have great incentive for tenure security on their intensively used land...”. McAnany (McAnany 1995), when reviewing the mortuary practices of the Maya, suggests a functional relationship between ancestor veneration and land holdings. Nowhere are such relationships between households and land tenure security more clearly evident, than when observing ‘landesque’ capital improvements (Stone 1994). Stone illustrates this point for terracing among the Kofyar in Africa, commenting that not only do terraces provide for their natural and economic function, but also divide the landscape into socially meaningful plots. This is not to say that the Maya held deeds or titles of property on the lands surrounding their households, even at Caracol, but simply that the terraces imply at least somewhat permanent land use rights, if not outright ownership.

**Household Focus**
Here, Stone emphasizes the role of the household in the organization and deployment of labor in consideration of agricultural activity. Ethnographic studies of modern Maya communities clearly establish the function of the household in such activity (Hayden and Cannon 1984; Wilk 1991). Some household and settlement studies have emphasized the role of the lineage or a centralized authority in decisions, such as terrace construction (Chase and Chase 1996b; Fox, et al. 1996); however, I believe an emphasis on the household clarifies many misunderstandings of Maya agriculture. Part of the misunderstanding derives from evidence for ‘landesque’ capital improvement, which is easy to misinterpret as an event over process. This issue is more fully addressed in chapter six.

In short, the ancient Maya exhibit many of the same characteristics of smallholders. Although they were not influenced by modern market economies, the smallholder scheme can be generalized and applied to the Maya region. I am also certain that a smallholder approach is appropriate for developing an understanding of the construction and use of prehistoric terracing on the Cohune Ridge, at Caracol and on the Vaca Plateau. But before I discuss my specific case study, I will review our present general understandings of Classic Maya intensive agriculture.
Classic Maya Agriculture

Archaeologists’ perception of Classic Maya agriculture has changed considerably in the past century. Early on, researchers, such as Lundell (Lundell 1937) and Thompson (Thompson 1931) recognized evidence for intensive agriculture, but spent no time systematically evaluating them. Early ecological studies, along with ethnohistoric and ethnographic research, all indicated that the more recent Maya carried out some form of swidden agriculture. In the 1960’s and 1970’s, this picture of Maya agriculture was challenged mainly because of new insights concerning settlement data, which resulted in high population estimates for many Maya sites.

Impressed by high population estimates, scholars introduced every possible alternative to milpa agriculture to increase the carrying capacity of the lowlands. For example, Turner and Harrison (1983: 338) write,

A critical point of disagreement concerns the significance of any one type of agriculture in time and space. We believe that those methods required to sustain crop production were pursued whenever and wherever the need arose, and for the most part lowland agriculture was not impeded by so called marginal environments or by limited Maya agricultural expertise.

During this revisionist period there was a firm belief that the Maya could have overcome many of the well documented environmental constraints to long-term sustainable agriculture by any means necessary. But as more data surfaced on these perceived alternatives, it became increasingly clear that no agricultural system or technique was universal throughout the entire Maya lowlands and that most of the ‘alternatives’ were not employed by the Maya during the Classic Period (see Puleston’s Ramon Hypothesis,
Bronson’s sweet potato, or Wilken’s artificial rainforest). But it is also clear that even within regions, a number of agricultural techniques could have been employed to meet the subsistence demands of their inhabitants.

Despite these early revisions, one fact remains. Maya farmers were potentially constrained by several ecological factors associated with regards to long-term sustainable agriculture as well as short-term productive capacity (after Donkin 1972),

1. Sufficient and dependable rain and water.
2. Soil and water erosion in rugged areas. Soil erosion is potentially very damaging to the thin tropical upland soils of the lowlands (see chapter six).
3. Declining yields due to a loss of soil nutrients.
4. Declining yields due to pest and weed infestation.

Also, the Maya were potentially constrained by cultural factors, such as stone tools, human labor, and small household labor pools. In some regions archaeologists recovered evidence for ‘landesque’ capital improvements, such as drained fields and terracing, which putatively served to minimize the impact some or all of those four ecological factors. But these ‘landesque’ features are not as ubiquitous as was previously projected. Additionally, it is unclear if some of these features are purely the result of human action as opposed to natural processes (Pope, et al. 1996). What we know is that the Maya probably intensified their agriculture by some means throughout the entire lowlands during the Classic Period. What we do not know is exactly how intensification developed from site to site. What follows is a brief overview of our current conceptions
concerning Maya agriculture specifically focused on sites with evidence for ‘landesque’
capital improvements. I will review the two primary agro-engineering features found in
the lowlands, wetland agriculture and terracing.

**Wetland Agriculture**

Since Siemens and Puleston (Siemens and Puleston 1972) published their paper
documenting the possible existence of drained fields in the lowlands, a sometimes vicious
debate has raged among Mayanists over these features. One debate has centered on
whether natural or purely anthropogenic process led to their formation (Pohl, et al. 1996;
Pope, et al. 1996). Another involves the costs associated with the construction of the
fields, while a third centers on the dating of the fields and the placement of wetland
cultivation in the evolution of cultivation practices. One factor that may have contributed
to these debates is the fact that no real diachronic and quantitative assessments of
increased productivity were ever established.

In Mesoamerica and elsewhere, wetland fields take two main forms: drained fields or
raised fields. Drained fields are built by channeling or canalizing existing wetlands, i.e.,
*draining* water-logged soils. Raised fields, on the other hand, are traditionally considered
artificial fields that are constructed from fill material transported from nearby hillsides,
i.e., the fields are *raised* in areas previously not suitable for cultivation. The principle
form of the fields found in the Maya region is *drained fields*. They occur in both riverine
and swamp environments (bajos), with the majority found in the latter. The construction of such fields serves several purposes, including:

1. Transforming previously unusable landscapes into cropping surfaces that are well-drained but also sufficiently moist to counteract risks of poor rainfall.
2. Periodic flooding and field maintenance, which includes the dumping of organically rich soils to increase nutrients, thus concentrating the organic matter (Sluyter 1994).
3. Periodic flooding also serves to neutralize the pH of fields, which in turn allows the more efficient release of critical nutrients.

Table 2.1. Some sites and regions of the Maya lowlands, with verified wetland fields.

<table>
<thead>
<tr>
<th>Region</th>
<th>Nearby Major Site</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulltrowser Swamp</td>
<td>Kokeal</td>
<td>(Turner and Harrison 1983a)</td>
</tr>
<tr>
<td>Rio Hondo</td>
<td>San Antonio</td>
<td>(Pohl 1990)</td>
</tr>
<tr>
<td>Edzna</td>
<td>Edzna</td>
<td>(Matheny 1978)</td>
</tr>
<tr>
<td>Nohmul</td>
<td>Nohmul</td>
<td>(Hammond 1985)</td>
</tr>
<tr>
<td>Cerros</td>
<td>Cerros</td>
<td>(Scarborough 1983)</td>
</tr>
<tr>
<td>Bajo Morocoy</td>
<td>Tzibanche</td>
<td>(Pope and Dahlin 1989, 1993)</td>
</tr>
<tr>
<td>New River Lagoon</td>
<td>Lamanai</td>
<td>(Pendergast 1990)</td>
</tr>
<tr>
<td>Yalahau</td>
<td>Naranjal and El Eden</td>
<td>(Anderson 2001)</td>
</tr>
</tbody>
</table>
Figure 2.1: Maya lowlands with sites labeled and regions shaded where wetlands have been identified.
While there is general agreement about what the fields are or even how they function, there still remains a great debate over their productive capacity and the *social conditions of their construction*. Some scholars argue that abundant staple crops could have been produced at or near wetland sites for transportation to other more populous centers, while the majority argue that wetland fields likely provided an advantageous local adaptation for agricultural production (Fedick 1996). With regards to their construction, Turner and Harrison (Turner and Harrison 1983a) stressed the intensive labor requirements for the construction of these fields and compared them to the Aztec chinampa system, writing,

> The cropping systems emphasized in both broad environmental zones differed technologically only in respect to environmental circumstances and it is doubtful that they differed considerably in labor or organizational requirements (Turner and Harrison 1983: 362)

While both the highland system and the lowland systems are complex, recent experimental studies have shown that 100 square meters of chinampas (the highland system) could be constructed in roughly 300 human hours (Gomez-Pompa, et al. 1990), hardly an excessive input of labor. Additionally, Siemens (Siemens 1996), once a strong proponent for comparing Maya wetland agriculture to the Aztec chinampa system, recently suggested that the chinampa model of highland Mexico was not an appropriate analogy for wetland cultivation in the lowlands. The chinampa system required the centralized construction of drainages and dykes during the 15th century in order to bring large tracts of land into cultivation. This is not the case for any system of wetland fields identified in the Maya lowlands. Many discussions of wetland agriculture have been conflated with discussions of state development, complexity and urbanization before a coherent picture of the actual features has been put forward. Even today there still is no
agreement with regards to the significance of drained fields between regions or even
within regions (Pohl, et al. 1996; Pope, et al. 1996), but some generalizations can be
summarized.

Dunning (1996) concludes that despite the hundreds of thousands of natural wetlands in
the Maya lowlands, only a small subset may have been suitable for cultivation based
upon hydrology, soil and vegetation, conditions and that many of those originally
identified do not exist. Additionally, wetland fields are typically located in what can be
considered marginal environments and away from the large population centers of the
Peten. Thus, it is not likely that many of these features had a significant impact on the
year to year subsistence beyond the immediate region of the wetlands. Shafer (Shafer
1983) suggests that the wetland fields at Pulltrowser swamp could have provided staple
financing for the Colha chert production, and from a regional perspective this is quite
reasonable. But in all likelihood, the majority of the produce from wetland agriculture
did not move beyond the immediate region of production (primarily due to the
transportation costs associated with staple crops), especially if such features did not
greatly increase per-capita production of food surpluses.

Despite the lack of clear agreement concerning drained fields, let us consider them in
light of the four ecological factors constraining Maya farmers. Wetland fields would
have countered two of the four primary constraints listed previously:
1) The fields provide more predictable soil moisture, allowing farmers to adapt to the risks of severe differences in rainfall from year to year.

2) The application of organic ‘muck’ to the field surface would have counteracted the loss of soil nutrients.

Generally, the fields would have produced an adaptive advantage for farmers in the immediate region of suitable wetlands. But the fact remains that there are only a handful of arguably marginal sites where such features are found. Most of the natural wetlands in the lowlands show no sign of human modification and use. Where such use has been documented, a subset of the systems are Preclassic in date and not relevant to the burgeoning populations at sites during the Classic period.

**Terraces**

Of the two technologies discussed here, terracing is more prevalent in the lowlands. Terrace systems were identified early on in Maya archaeology, but they have only recently become the focus of intensive research (Dunning 1996; Dunning and Beach 1994; Fedick 1989, 1996; Fedick and Ford 1990). As with wetland fields, we now know that the form and distribution of terracing varies greatly from site to site and region to region (Fedick 1996). We also know that they are not as ubiquitous as has been previously suggested (Turner and Harrison 1983a). Despite this variation in form and distribution, terrace technology of two primary types has been documented in many parts of the lowlands, i.e., *contour terracing* and *weir, or cross channel, terracing*. Regardless
of type, most terraces are constructed with roughly shaped stone front and supporting walls. *Figure 2.2* illustrates the components of typical terraces found in the lowlands.

*Contour Terraces*

Contour terracing (also referred to as *sloping linear terraces, foot slope terraces* and *linear terraces*) is defined by Donkin (Donkin 1972: 32) as,

> The lateral or contour terrace has many variations. At one extreme, the natural slope is but little modified; at the other, substantial walls support perfectly level benches that may be irrigated. Wherever surfaces are level, the height of the wall (up to 9 meters) is related to the steepness of the natural slope and to the width of the bench; similarly the thickness of the wall, to the volume of the fill.

Contour terracing is by far the most prevalent form of terracing found in the lowlands. It is associated with rainfall agriculture throughout the world and is also found throughout highland Mexico (Smith and Price 1994). Contour terraces typically serve to retain soil and soil moisture on hillsides with moderate to severe slopes.

*Weir Terraces*

Weir terracing (also referred to as *cross channel or check dam*) is defined by Donkin (Donkin 1972: 32) as,
Figure 2.2: Terrace construction components.
Figure 2.3: The Maya lowlands, with terraced sites labeled or regions of terracing shaded.
One comprises fields supported by walls built across an embayment or a narrow valley that was originally occupied by an intermittent stream. The cropping surfaces are characteristically level, and water drains into the fill from surrounding slopes. The catchment is usually many times larger than the area cultivated, which is an important advantage. Such cross-channel terracing represents a use of annual, but largely uncontrolled, accumulations of alluvium. The combination of effectiveness and essential simplicity of construction has prompted the suggestion that this is the earliest form of true terracing (Spencer and Hale 1961).

In a general sense, the distribution of weir terraces is dependent on a narrower array of natural conditions than contour terracing, so their distribution is more limited. Weir terraces are typically constructed not only to catch and trap water and soil, but also to provide deep soils in otherwise unproductive areas. New sediments deposited each year on the bench of weir terraces increase soil nutrients, counteracting one of the primary constraints to long-term sustainable agriculture in the lowlands.

Terracing of either kind, i.e., dry field terracing, serves several purposes,

1. It creates level growing surfaces, which in some parts of the world are associated with irrigation (Treacy 1989).
2. It impedes soil erosion.
3. It facilitates soil regeneration and soil moisture maintenance, Weir terracing evidently took advantage of normal and deliberately accelerated soil erosion.
4. It creates plots of deeper soil than normally found on hillsides.

Terraces are widely distributed throughout much of the Maya lowlands. Recent research clearly illustrates that their forms and distribution vary from site to site and from region to region. Terraces have been found in the Rio Bec region, the Belize River Valley,
Petexbatun Region and the Vaca Plateau. These sites are listed in table 2.2 and illustrated in figure 2.3.

One common misperception about terraces is that they actually increase productivity or are a part of a designed strategy to increase overall site productivity. In my dissertation, I argue strongly against such notions, maintaining instead that terracing by itself does not increase productivity. Terraces, not associated with irrigation, only increase sustainability, i.e., they minimize the impacts of two of the four ecological constraining factors listed previously. Furthermore, terrace construction relies upon certain natural conditions and transformations. Fertilizers of varying kinds added to the bench of the terrace can increase the productivity of soils in the short-term, but those actions or techniques are independent of terrace construction. Another common misperception concerning terraces concerns the labor investment involved in their construction. As in the case of wetland fields, it is commonly assumed that terrace construction required great amounts and organization of labor. For example, Chase and Chase (1998: 69) write,

> The large-scale organized as opposed to discrete ‘hodge-podge’ nature of the terrace systems indicates to us that they were likely not merely the accreditive result of individual family efforts.

And

> The Caracol terrace systems represent massive landscape modifications and required substantial investments of time, labor and upkeep…The scale and organization of these terrace systems, especially when placed within Caracol’s dated settlement history, suggests that some level of administrative control or, minimally, intervention existed with regard to the creation and management of the combined settlement and agricultural systems.
While I address these topics more fully in chapter seven, I again argue strongly against such notions. Most terraces in the lowlands appear to be household-level adaptive responses regardless of their scale and size. Labor estimates should not be assumed but calculated. Similar to the wetland fields, I believe that we must fully evaluate these agricultural features before they are conflated with discussions of labor organization and state formation. But before I discuss the specific features documented for my dissertation, I need to not only establish their cultural context, but also introduce the larger theoretical issues that have been associated with intensification at the site of Caracol.

Table 2.2. Sites and regions with verified agricultural terracing.

<table>
<thead>
<tr>
<th>Region</th>
<th>Nearby Major Site</th>
<th>References</th>
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<tbody>
<tr>
<td>Rio Bec Region</td>
<td>Becan</td>
<td>(Turner 1983)</td>
</tr>
<tr>
<td>Belize River Valley</td>
<td>Xunantunich</td>
<td>(Fedick 1989, 1994; Fedick and Ford 1990)</td>
</tr>
<tr>
<td>Petexbatun Region</td>
<td>Aguateca</td>
<td>(Dunning and Beach 1994)</td>
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<tr>
<td>Usumacinta</td>
<td>Yaxchilan</td>
<td>(Lobato 1988)</td>
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