Part I

Introductory Concepts

Cambridge University Press
978-1-107-03341-2 — The Biodemography of Subsistence Farming
James W. Wood
Excerpt
More Information

1 Thinking about Population and Traditional Farmers

> Food and [millet] beer are without doubt the most exciting and interesting topics of native conversation [among the Bemba of Northern Rhodesia]. . . Any one who can follow the ordinary gossip of a Bemba village will be struck at once by the endless talk shouted from hut to hut as to what is about to be eaten, what has already been eaten, and what lies in store for the future, and this with an animation and a wealth of detail which would be thought quite unusual in this country [Great Britain]. It is, of course, natural in an area where the supply is never constant from day to day that the daily meal should be a subject of vivid interest. For those who are accustomed to buy food ready prepared, it is difficult to realize the emotional attitudes to foodstuffs among peoples who are directly dependent on their environment for their diet. Most of their food the Bemba grow, and hence they view their fields and gardens concretely in terms of their future prospects of food and drink. These they constantly discuss. I timed two old women talking over an hour on the single topic of the probable order of ripening of the pumpkins in three gardens, and the way in which they were likely to be distributed. The question evidently dominated their imagination. . .
>
> These casual observations of native life are significant. For us it requires a real effort of imagination to visualize a state of society in which food matters so much and from so many points of view, but this effort is necessary if we are to understand the emotional background of Bemba ideas as to diet. – A. I. Richards (1939: 44–6)

Traditional farming – farming in the absence of fossil fuels, electricity, commercial seed, tractors and combines and other industrial inputs such as inorganic fertilizers, pesticides and herbicides – has sustained much of the human species for ten millennia. And not just sustained: the global emergence of farming led to a thousand-fold increase in the size of the human population by the beginning of the Industrial Revolution in the late eighteenth century (Cohen, 1995: 96). Traditional farming provided the foundation for early civilizations, cities and states, all of which evolved along with it. By some estimates, traditional farming or something very like it was still feeding a third of the world's people in the second half of the twentieth century (Haswell, 1973).

In preindustrial societies, even those with towns and cities, almost everyone belonged to a farming household. In sixteenth-century England, for example, when London and several other urban areas were already flourishing, an estimated 80 percent of households were rural and more or less directly involved in farming (Wrigley, 1988: 12–13). No matter how surviving written records may distort the reality, human history since the origins of agriculture has, until quite recently, been predominantly the history of traditional farmers and the food they produced, and only secondarily the nonfarming people who ate some of it. Elizabeth I, Cardinal Richelieu, Moctezuma and the Mughal Emperors could only ever have been two or three degrees of separation from a poor dirt farmer, and a few weeks away from starvation.

Throughout most of its history, traditional farming has yielded what present-day agricultural scientists would regard as pitifully small quantities of food each year.[1] Most of that food was eaten locally – indeed most of it was eaten by the family that produced it. In other words, traditional farming has often operated near the margin of subsistence. This has been true even where farmers were able, in a good year, to set aside some produce for sale at the local market. The fact that past agrarian societies were made up overwhelmingly of farming families is an indication of the inability of traditional farming to generate a sufficiently large and reliable surplus of food to support a substantial nonagricultural population. Life near the margin meant that even small changes in the food supply could translate into comparatively large changes in health, survival, productive capacity and the ability to raise a family. Thus, the demographic fate of our farming ancestors was hostage to food systems that many people today would consider obsolete and worthy only of "development." That is no reason to fault traditional farmers – they did what they could, with very limited resources at their disposal, against an environment that could be by turns both obdurate and capricious. Their efforts might even be viewed as heroic.

This book is about the manifold linkages between farming and human population in the preindustrial world. It draws upon evidence, recent and historical, from all parts of the world where traditional agriculture has existed in recent centuries – and in some places still exists, if only in modified form. It continues and enlarges a debate (discussed in the next section) originally framed by Thomas Robert Malthus more than two centuries ago, at about the time that modern farming was taking its first fumbling steps. Malthus bequeathed the debate to classical economics, where it played a central role until it was pushed aside by the rise of new economic doctrines late in the nineteenth century. Malthus also injected the debate into the new field of population science, although it remained a secondary concern at a time when purely methodological advances necessarily dominated the discipline. (But recall that one important population scientist, Charles Darwin, was by his own account deeply swayed by Malthus's theoretical arguments.) In the mid-twentieth century the debate caught fire again, largely under the influence of the economist Ester Boserup, who aimed to stand Malthus on his head. Boserup's ideas provided the basis for innumerable writings in anthropology, especially archaeology, placing the interaction of

[1] In traditional European cereal cultivation, only three or four grains of wheat, rye, barley or oats (all C_3 plants) were harvested for each seed sown (Slicher van Bath, 1963a; Titow, 1972). This startlingly low grain to seed ratio does not imply that each plant set only three or four seeds; rather it reflects everything that lowered yield, including failure of germination, losses to pests, harvest losses, etc. In such a system, fully a quarter to a third of each year's harvest would need to be set aside for next year's sowing, leaving little to buffer against fluctuations in yield. In the right environment, C_4 plants, such as maize, millet or sorghum, did better under preindustrial cultivation, but came nowhere near the standards of modern agriculture. (For the distinction between C_3 and C_4 plants and its importance for crop yields, see Hay and Porter, 2006: 99–104.)

population and traditional agriculture at the center of arguments concerning not only the evolution of farming systems but also that of preindustrial economies and political systems in general. And the fire was stoked (often to the point of overheating) by ecologists concerned with the "population bomb," some of whom formulated a kind of *über*-neomalthusianism that had little to do with what Malthus actually believed. Although the debate has lost some of its fervor in recent years, it remains important in such fields as economic demography, historical demography, economic anthropology, agricultural economics and geography, development economics and human ecology.

The Classic Debate

The details of the classic debate over population and agriculture will be presented in Chapters 5 and 6, and we need only sketch a brief outline of it here. Malthus believed that the size of a population, and its tendency to grow or decline, was determined by its food supply. Therefore, any increase in food supply resulting from improvements in agricultural practice would inevitably (in the absence of deliberate "preventive checks" on fertility) lead to population growth, which in the short term could be quite rapid.[2] This rapid increase in the number of people to be fed would quickly consume any temporary surplus generated by the new methods of farming, and population size would equilibrate at the level just allowed by the new farming system and the population's minimal nutritional requirements for sustaining itself. In this scheme, the food supply is the "independent variable" or driving force for demographic change. For Boserup, in contrast, food supply is quite elastic under any form of farming, and changes in population size or density are the primary force determining the level of food production: "population growth is here regarded as the independent variable which in its turn is a major factor determining agricultural developments" (Boserup, 1965: 11). Although Boserup recognized that there were many different ways preindustrial farmers could increase their food supply in response to population growth, she emphasized only one of them: how long arable land was allowed to lie fallow after a continuous period of cultivation. It is important to note that Boserup explicitly treated population size or density as an exogenous variable and was not much interested in why it might change. It just does – or doesn't, as the case may be. All this, in Boserup's own opinion, made her an anti-Malthusian.

Not surprisingly, the actual debate turns out to be more complicated, especially once the contributions of other, more recent writers are taken into account (see Chapter 6). But most participants still adopt a position that is recognizably either "Malthusian" or "Boserupian." Only fairly recently have several authors suggested that Malthus and Boserup may not be as incompatible as we have thought (see Pryor and Maurer, 1982; Lee, 1986; Turner and Ali, 1996; Wood, 1998).

[2] Malthus believed that human populations could double in size in as little as 25 years when conditions were favorable. Many of his contemporaries found this claim absurd. In fact, we now know of well-documented cases in which human populations have grown even more rapidly.

As I say, the debate has lost some of its fervor – but not because it has been settled. Instead, I will argue that the debate has languished mainly because it has been dominated by inappropriate or incomplete methods, models and scales of analysis, not because we know which side won. To go even further, the very fact that the debate has crystallized into two diametrically opposed "sides" has itself impeded understanding of the underlying issues. In later chapters, I will provide a detailed discussion of the classic debate as it stood at the beginning of the twenty-first century, but most of this book will involve an attempt to transcend the limitations of the debate or at least to reframe its basic terms so that we can better understand what the important questions are.

An Empirical Example

To convey something of the current state of the debate – and some of the problems with the way it has been structured – it is useful to look at some empirical results from a major survey of traditional farming in the southwest Pacific nation of Papua New Guinea (Bourke *et al.*, 1998; Allen, 2001; Bourke, 2001). I choose this example, not because it is egregious and thus an easy target, but precisely because it represents one of the best empirical studies done to date on this subject. Between 1990 and 1995 a group of geographers at the Australian National University developed a geographical information database known as the Mapping Agricultural Systems in Papua New Guinea Project (MASP). Local agricultural "systems" (the basic map units) were defined based on field data concerning six variables (Allen, 2001: 239):

- the type of fallow vegetation established on fields just before clearing for cultivation
- the length of the fallow period
- the number of years staple crops are grown before fallowing
- the principal staple crops
- the spatial arrangement of crops within and between cultivated fields
- techniques other than fallowing used to maintain soil fertility.

These data were linked in a GIS to demographic information from the 1980 national census and to other data sources (for technical details, see Bourke *et al.*, 1998). A total of 274 local systems were mapped, a remarkable achievement under trying field conditions.

Results from the MASP project that are most pertinent to the classic debate about population and agriculture are shown in Figure 1.1, which plots Boserup's preferred measure of agricultural "intensity" (intended to reflect the magnitude of nonland inputs into the farming system) against local population density for all 274 mapped locations. Despite considerable scatter in the data, Allen (2001) concludes that there is a significant, nonlinear relationship between the two. Since population density is plotted on the x-axis, the implication is that population density is the independent variable driving differences in agricultural intensity, just as Boserup believed. So much for Malthus.

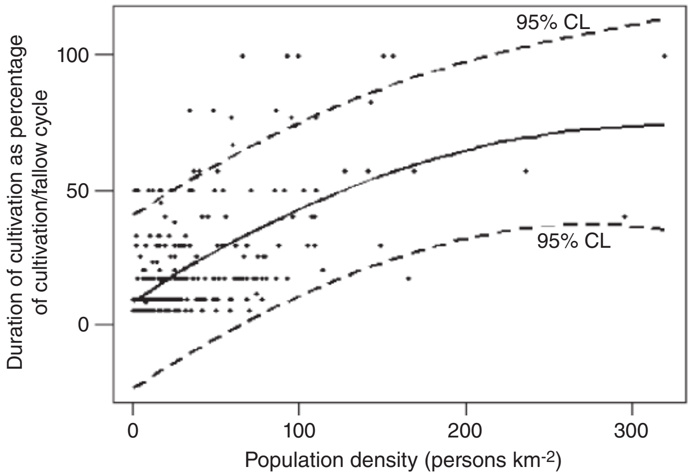

Figure 1.1 Agricultural intensity by population density, 274 local farming systems in Papua New Guinea, *c.* 1990–5. Agricultural intensity is estimated as the number of years the average field is continuously cropped as a percentage of the length of the total cropping/fallow cycle. Solid curve is a quadratic equation fit by OLS regression. CL, confidence limit. From Allen (2001: 241), with permission of John Wiley & Sons, Inc.

There are various problems of a purely statistical nature with this analysis, which its author readily acknowledges.[3] But there are deeper conceptual problems that are at least as important. First, do the two variables actually measure what they are supposed to measure? Population density is notoriously difficult to interpret. The quantity used here appears to be "gross" population density, the ratio of standing population to the area of all land that "belongs" to the farming community in question. As such, the denominator includes not only active and potential arable, but areas uncultivable because of high slopes, poor soils, waterlogging, rocky outcrops and so forth – or because they are taken up by house sites, ceremonial grounds or other nonagricultural features. Surely the different locales vary in the proportion of their territory consisting of such nonarable land. Population density is presumably intended as a proxy measure of what Boserup called "population pressure," itself a slippery concept discussed in Chapter 3. But surely the amount of "pressure" that a population exerts upon the land that feeds it is influenced in profound ways by elements of the physical environment (elevation, rainfall, temperature, slopes, soils, etc.). Rich environments can arguably support more people without undue "pressure" than poor ones. Despite the fact that Papua New Guinea encompasses an enormous range of local environments, there is no statistical adjustment for that variation in

3 Briefly, the bivariate relationship appears to "explain" only a small fraction of the variation in the data, although no R^2 value is reported. The apparent relationship may also be disproportionately influenced by a small number of outliers in the NE quadrant of the plot. And no test of nonlinearity is provided. Allen (2001: 241) himself points out that "the data do not satisfy many of the requirements of regression analysis" and thus the results should be interpreted with caution.

Figure 1.1. And it is likely that there are many other unobserved variables whose potential confounding effects have not been controlled.

Similarly, cropping frequency is a problematic measurement of "agricultural intensity" (another slippery concept). The meaning of agricultural intensity will receive considerable attention in later chapters. For now it is enough to say that it reflects the magnitude of nonland inputs (labor or capital) into food production designed to increase or at least maintain crop yields per hectare of cultivable land. Cropping frequency at best tells us something about the amount of potentially cultivable land that is actively devoted to farming in a given year, but nothing about other possible inputs such as mulching, manuring, irrigation, drainage, soil preparation, weeding and other widespread traditional farming practices.[4] And note that the measure of intensity used in Figure 1.1 cannot exceed 100 percent, corresponding to permanent cultivation; it therefore cannot distinguish farming systems in which each field yields one crop per year from more intensive multicropping systems.

There is an even deeper problem with this analysis. Even if the data were sufficient to convince us of a close causal relationship between population density and agricultural intensity, they tell us nothing about the *direction* of causation. If we were to switch the x- and y-axes in Figure 1.1, we might conclude that the level of agricultural intensity determines population density – that is, that the food supply is the main factor determining population size or density, just as Malthus believed. So much for Boserup.

There are other conceptual problems. Both Malthus and Boserup talk of changes over time *within* populations. Their predictions are thus inherently dynamic and should be tested against longitudinal data. As remarkable as the MASP dataset is, it is still a cross-sectional snapshot of the situation in Papua New Guinea as it existed in the early 1990s. It is at least imaginable that (for example) the one farming system represented by the point at $x > 300$ and $y = 100$ could have, if followed prospectively for several decades, headed toward the southeast, contrary to both Malthus and Boserup. Given the lack of control for environmental variation and non-fallow methods of intensification, any number of single-system dynamic trajectories could have been observed, some consistent with existing theory, some not.

The foregoing difficulty points to the final problem with this analysis, something statisticians call the *ecological fallacy*. The ecological fallacy can occur whenever we try to draw causal inferences from data reported at a level of spatial aggregation higher than the level at which the actual causal processes are occurring – as when we try to understand the behavior of individuals by analyzing the behavior of crowds. The classic example of an ecological fallacy was a study of the epidemiology of tuberculosis conducted in the 1930s using data aggregated at the level of US states

[4] In fairness, I hasten to point out that this very point has been made by the members of the MASP project (Allen, 2001). The MASP data suggest that nonfallow soil conservation practices also vary by population density and cropping frequency (see Bourke, 2001, and Chapter 5 below for further discussion of these practices in Papua New Guinea).

(Cowles and Chapman, 1935). Each state's mortality rate from tuberculosis was analyzed in terms of several purported explanatory variables, all of which were statewide characteristics or averages. One finding considered especially important at the time was that the state's average altitude and hours of sunshine each year were negatively correlated with statewide tuberculosis death rates, suggesting that patients ought to be moved to mountainous regions in sunny climes. Unfortunately for people who rushed to build sanatoriums in the "right" locales, when the study was redone years later using data on individual patients the apparent beneficial effects of altitude and sunshine disappeared (Morgenstern, 1982). The state as a whole, it turns out, is just too far above the pathologic processes operating in the infected individual for meaningful results to be derived.[5]

The data in Figure 1.1 are presented and analyzed at the level of the "farming system" (Allen, 2001). We are not told how big a "system" is, but it seems to be a regional community sharing a fairly homogeneous set of farming practices. But regions aren't cropped and then allowed to lie fallow – individual fields are. And in the absence of a clearer understanding of what we mean by "population pressure," it difficult to know whether its effects play out at the regional level or at the level of the individual farm. How do we decide at which scale to pitch our analysis? In the absence of a clear answer, it's almost always best to disaggregate. We can always reaggregate our observations later if we wish to.

Rethinking the Relationship between Human Population and Traditional Agriculture

What kinds of questions do we want to ask about the relationship between a system of agriculture and the characteristics of the population it feeds – the population's size, density, growth rate, age structure, fertility and mortality levels, migration patterns and so forth? If the goal is to move beyond the conventional debate, the following questions would seem to need answering first.

[5] Another example is more germane to the subject of this book. In one of my demography classes I discuss the wide disparities that have been observed among countries in their average length of life. I ask my students what variables might be useful for predicting a country's average life span, and they suggest plausible possibilities such as per capita GDP, mean household income, and access to modern medical care. I then suggest that quite a good predictor might be the fraction of the country's citizens who are morbidly obese: the higher the fraction, the longer the average life span. At first they are puzzled by what they take to be an assumption on my part that obesity is good for you. But then they get it – they have fallen for the ecological fallacy. Rich countries have good medical care and public health facilities. As a result they experience very few deaths among infants and other young children – the primary determinant worldwide of variation in average life span. They also have abundant and reliable sources of food and very few jobs requiring heavy physical work, a prescription for obesity. Thus, at the country level, lots of obesity is positively associated with comparatively long life. If the data were reanalyzed at the *individual* level, where health, fatness and life span are determined, they would no doubt provide plenty of evidence that extreme obesity is strongly predictive of early death. At the aggregate level, obesity may be positively correlated with long life, but that does not mean it *causes* it.

Is the Relationship Simple or Complicated?

Despite their disagreements, both Malthus and Boserup (and their respective supporters) make the linkage sound simple and straightforward. But there may in fact be multiple linkages at many different spatial and temporal scales, not all of which linkages operate in the same direction or with the same intensity. One problem in reframing the issue is to identify all the important linkages, while recognizing that there may be a practically unlimited number of unimportant ones – a nice sense of judgment is needed. One failure of the current debate on population and traditional farming is, I would argue, that some of the important linkages have been ignored.

Is the Relationship Unidirectional or Reciprocal?

Food supply and population size may be positively correlated, but does food supply determine population size, or does an increase in population size induce increases in food supply – or both? Malthus and Boserup preferred unidirectional linkages.[6] I can think of no *a priori* reason to reject reciprocal relationships. Could Malthus and Boserup *both* have been right?

What are the Precise Mechanisms Underlying the Relationship?

This is the crucial question. If food supply is to influence population, it must do so through at least one of the basic "forces" of population change – fertility, mortality or migration.[7] It is startling, then, to realize the extent to which these essential demographic processes have been ignored in the recent debate regarding the linkage between population and agriculture. A population can be growing at a certain rate (for example) because it has low mortality and modestly high fertility *or* because it has high mortality and very high fertility, two scenarios that imply rather different things about dietary sufficiency and its effects on mortality or fertility. By the same token, if population is to influence agriculture, it must do so through at least one of the physical, temporal or spatial components of the agricultural process – the allocation of land, labor and other scarce resources, the use of manures, soil tillage, the choice of crops, the scheduling of sowing and so on (see Chapter 2). Again, the classic debate has mostly ignored all details of agricultural practice except the one emphasized by Boserup: the length of time a particular piece of land is actively and continuously cropped relative to the time it lies fallow. But there may be no predictable relationship between population density and the length of the cropping/fallow cycle if all fields are well manured. By identifying and linking specific demographic and agricultural mechanisms, we stand to gain greater insight into the relationship between population and farming.

[6] This is not quite correct. In various editions of his *Essay on the Principle of Population*, Malthus allowed for reciprocal interactions between population and agriculture that in many ways sound downright Boserupian (Wood, 1998). Chapter 5 presents some of the details.

[7] As a demographic force, migration should be differentiated into immigration and emigration. To spare the modern reader (and me!) the need to remember the difference, I will adopt the inelegant practice of referring to *in-migration* and *out-migration*.