

# African Archaeology

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# African Archaeology

## A Critical Introduction

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*Edited by*

Ann Brower Stahl

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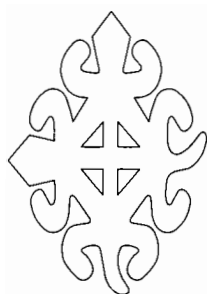
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## 10

# The Romance of Farming: Plant Cultivation and Domestication in Africa

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*Katharina Neumann*

The emergence of agriculture is a key topic in prehistory. Over the past half-century, numerous explanations have been proposed for the transition from foraging to farming, most of them deductive and “only minimally constrained by available information” (Smith 2001a:215). Africa is no exception. This chapter does not aim to give a comprehensive overview of all theories past and present. Instead, it is “data-focused,” written from an archaeobotanist’s perspective, and relying mainly on archaeological plant remains which are preserved either charred, desiccated, as phytoliths or in the form of plant impressions.<sup>1</sup> I explore available evidence against the background of earlier perspectives on the transition to food production in Africa. Which explanations have received support during the last two decades? Are the old models still valuable in the light of new data? And in broader perspective: how can Africa contribute to the discussion on the origins of agriculture on a world-wide scale?

### **From Gathering to Agriculture: Some Definitions**

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A dualistic concept of hunter-gatherers and food producers as opposite and exclusive is not appropriate for Africa. In diachronic as well as synchronic perspective, Africa presents numerous examples of the “middle ground,” the large transitional zone in the continuum between hunter-gatherers on the one end and agriculturalists largely depending on domesticated crops on the other (Harlan et al., eds., 1976; Harris 1989, 1996; Smith 2001b). Traditional land-use systems with little mechanization are still practiced on a large scale, and wild or semi-domesticated plants play a central role in contemporary African subsistence.

In the vast anthropological jungle of inconsistent terminology on the origins of agriculture, the terms “cultivation” and “domestication” have proved to be especially valuable (for a critical discussion see Haaland 1999; Harris 1989; Smith

2001b). Cultivation, in its broadest sense, can be defined as any human activity that increases the yield of harvested or exploited plants. Domestication designates genetic, morphological, and physiological changes of the plants resulting from cultivation and conscious or unconscious human selection (Smith 1998; Zohary and Hopf 2000). Cultivation can be practiced with wild or domesticated plants, but domestication occurs only under cultivation (Harris 1996; Smith 2001a), and the presence of domesticated plants marks a *terminus post quem* in the archaeological record. Their appearance is a safe criterion that cultivation was practiced from at least this moment onwards. This is the reason why the question “domesticated or not” is so crucial for archaeologists.

The biased search for the “oldest” domesticated plants in Africa has often led to a distorted picture of prehistoric economies. The presence of domesticated plants in the archaeological record does not signal reliance on agriculture; a single grain of domesticated sorghum does not justify calling the corresponding human population “farmers.” Rather, the status of domesticates must be defined in a broader economic and ecological context, based on complete assemblages of plant remains. Furthermore, the question “domesticated or not” cannot always be answered unequivocally, either because diagnostic features are not preserved, or because morphological differences between wild and domesticated varieties are insufficiently clear. Even in modern African agricultural systems, there are many plants with an intermediate status, e.g. fonio (*Digitaria exilis*) and trees such as the oil palm (*Elaeis guineensis*) and the shea butter tree (*Vitellaria paradoxa*).

### **From General to Regional Approaches: History of Research**

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Africa was not a focus of interest when research on the origins of agriculture started in the middle of the last century. Pioneering interdisciplinary studies of the 1950s and 1960s focused on the Near East and Mesoamerica (Smith 1998, 2001b). It was not until the 1970s that Africa became recognized as a place worthy of discussion. Jack R. Harlan, a plant geneticist, was especially interested in African domesticated plants, and he felt that biological investigations alone were not sufficient to explain the enormous genetic, morphological, and ecological changes that African crops underwent in the course of their evolutionary history. A Burg Wartenstein symposium organized by Harlan in 1972 brought together scientists from archaeology, agronomy, palynology, genetics, and plant taxonomy. During the next two decades, the symposium proceedings (Harlan et al., eds., 1976) became the main reference for the origins of African plant domestication.

Most of the overviews on African plant food production published in the two decades after the Burg Wartenstein symposium (e.g., Clark and Brandt, eds., 1984; Harlan 1992, 1995; Shaw et al., eds., 1993; Smith 1998) were either based on indirect archaeological evidence or on information about modern plants, but not on botanical remains from archaeological sites. In his compilation Shaw (1976) listed fewer than 20 archaeological sites for the whole continent which had yielded plant

remains. Only a few sites were old enough to contribute to the question of early plant food production, and none had been sampled systematically, the finds being more or less accidental by-products of excavation.

The conspicuous lack of direct evidence excluded Africa from ongoing world-wide discussions on the origins of agriculture. Data from Africa were not considered useful in a general theoretical framework. In recent compilations, Africa is either missing altogether, (Hather, ed., 1994; Harris, ed., 1996; Gebauer and Price 1992; Price and Gebauer, eds., 1995; Smith 2001a), or contributions refer to earlier field studies without adding new data (e.g., Harlan 1989, 1992, 1995; Smith 1998).

In the 1980s systematic archaeobotanical field and laboratory work started in Africa. More archaeologists cooperated closely with the natural sciences, as for example the long-term projects in the eastern Sahara (Kuper 1989; Wendorf et al., eds., 2001), Libya (Garcea 2001; di Lernia, ed., 1999), Ethiopia (Phillipson 2000), or West Africa (Breunig and Neumann 1999, 2002a, 2004). Wide-ranging considerations gave way to more regional or local approaches, and today archaeobotanical data are primarily interpreted within small-scale models. The search for the "origins" of agriculture and the oldest domesticated crop has changed into less spectacular attempts to reconstruct economic systems in all their aspects. Together with zoological, geomorphological, and sedimentological information, botanical data elucidate the role of the environment on human occupation and economy, and allow an assessment of how humans in turn modified their natural environments (e.g., Klee et al. 2000; Wasylikowa 2001).

A lack of basic data still remains the major problem. Figure 10.1 shows the distribution of sites from which archaeobotanical remains relevant to the origins of agriculture have been published. For historical reasons, there is a strong concentration in Egypt. The Sahara and West Africa are represented with a number of studies, and data from East Africa are also available. But the central and southern parts of the continent remain *terra incognita*. Moreover, finds are only rarely described and illustrated. Many controversial discussions of the domesticated status of specific finds might have been avoided had they been documented in detail.

The growing need for basic data and a forum for their discussion resulted in the foundation of a workgroup for African archaeobotany in 1994. Three workshops have been organized: 1994 in Mogilany near Kraków (Poland); 1997 in Leicester (Great Britain); and 2000 in Frankfurt (Germany). The proceedings of these conferences (Neumann et al., eds., 2003; Stuchlik and Wasylikowa, eds., 1995; van der Veen, ed., 1999) are a major source of archaeobotanical data.

Of course some early published hypotheses and conclusions are outdated in the light of new data, but many have not lost their relevance, including: Purseglove (1976) on the geographical origins of crops in Africa; Harris (1976) on traditional systems of plant food production; Harlan and Stemler (1976) on modern races of *Sorghum bicolor*; and overviews on the archaeological background by Stahl (1984) and A. B. Smith (1984). The wealth of personal knowledge expressed in the publications of Jack Harlan and J. Desmond Clark, founders of the modern interdisciplinary approach to early food production in Africa (e.g., Clark 1976; Harlan 1992, 1995), continue to inspire.



**Figure 10.1.** Archaeological sites and regions mentioned in the text

### **Diffusion or Independent Invention?**

Early research was preoccupied with the question of whether African agriculture developed independently or as a result of diffusion, either by migration or stimulus, from the Near East. A very popular view was that agriculture started with Near Eastern crops in the Nile Valley and northern Africa. During periods of climatic amelioration in the Middle Holocene, people equipped with wheat and barley would have moved into the Sahara. With subsequent desiccation, these populations were forced to move further south, until they reached the ecological limits for cultivation of winter rainfall cultigens, and local sorghum and “millets” would have



been domesticated in their place (Clark 1964; for an overview see Stahl 1984: 15).

Today, the general discussion of diffusion or independent evolution has lost much of its intellectual glamour. But a diffusionary heritage which saw Africa as a recipient of cultural innovation is reflected in the concentration of sites with archaeological plant remains in Egypt. Because of its obvious relationship with the ancient civilizations in the "Fertile Crescent," Egypt became a focus of archaeological attention as early as the 19th century, and plant remains from tombs were among the first archaeobotanical samples ever collected (Germer 1985). However, most of these data do not contribute to the question of how agriculture emerged, and only in the last 20 years have sites predating the Dynastic periods been systematically sampled for plant remains (e.g., Barakat and Fahmy 1999; Wasylikowa 1997, 2001).

The influence of Egyptian agriculture on the development of sub-Saharan African agriculture remains to be elucidated. For the Sahara, the question of diffusion has been little discussed in recent years. The earliest evidence of Near Eastern crops in Egypt (mainly emmer wheat and barley in Fayum and Merimde) dates around the middle of the sixth millennium b.c. (Wetterstrom 1993; Zohary and Hopf 2000). Scattered finds of Near Eastern crops in Libya and the Maghreb do not allow us to reconstruct their movement along the northern fringes of the Sahara, or their hypothetical dispersal to the south. In a review of the evidence from Libya, van der Veen (1995) found that oasis agriculture in the northern Sahara based on emmer, barley, bread wheat, date palm, and Mediterranean fruit trees, could only be attested at the site of Zinchecra from the middle of the first millennium b.c. Older sites from the Libyan Sahara in the Acacus mountains yielded rich assemblages of wild plants, mainly of Sahelian affinity (see below), and do not furnish evidence for any type of plant food production, either with temperate or tropical crops.

Ethiopia is the second region where domestication of indigenous plants might have been triggered by the introduction of Near Eastern crops, but the question also remains open. Due to the special ecological conditions of the highlands, the indigenous agricultural systems of Ethiopia include winter rain crops from the Near East as well as indigenous African domesticates, some of which, such as tef (*Eragrostis tef*), the oil plant noog (*Guizotia abyssinica*), and enset (*Ensete ventricosum*), obviously originated there (Edwards 1991; Harlan 1969). Archaeobotanical evidence from Ethiopia is still confined to a handful of sites (D'Andrea et al. 1999). The earliest unequivocal archaeobotanical evidence for domesticated plants, dated around 500 b.c., comes from the sites of Lalibela, and consists only of introduced crops (Dombrowski 1970, 1971). In the archaeobotanical samples from the Aksum area dated to the middle of the first millennium b.c. (Pre-Aksumite), emmer, barley and flax are present together with tef as the only Ethiopian crop (Boardman 1999). Other African crops, such as *Sorghum bicolor*, *Eleusine coracana*, and noog are absent in Pre-Aksumite samples and only appear in Aksumite times, suggesting a later domestication or introduction. Several authors have argued for a much earlier introduction of winter rain crops through cultural contact with northeast Africa (Barnett 1999; D'Andrea et al. 1999:106), but these hypotheses remain unproved in the absence of archaeobotanical evidence.

## The Geographical Origins of African Crops

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Well-dated archaeological plant remains are the most valuable source of information for the study of early agriculture. Important information can also be obtained from living plants, mainly through studies of geographical distribution and the genetic relations between a crop and its wild ancestors (Zohary and Hopf 2000). African crops were first brought into view by Vavilov (1926) who, based on the diversity of cultivated plants, defined eight centers where agriculture could have emerged. In Africa, Vavilov considered the East African highlands to be a potential cradle of agriculture, where he thought barley (*Hordeum vulgare*), coffee (*Coffea arabica*), sorghum (*Sorghum bicolor*), and pearl millet (*Pennisetum glaucum*) originated. Vavilov's theory was largely dismissed in following decades because it became commonly accepted that a center of crop diversity is not necessarily identical to its area of origin. But Vavilov's idea had an enormously inspiring effect on later research on agricultural origins (Harris 1990, 1996), and at least eight plant species of his original list are commonly accepted as domesticated in Ethiopia (Barnett 1999:60; Edwards 1991).

From botanical and linguistic evidence, Chevalier (1938), Portères (1950, 1962), and Murdock (1959) questioned Vavilov's theory of a single Ethiopian center, favoring instead a West African origin of several cereals, including African rice (*Oryza glaberrima*) and pearl millet (*Pennisetum glaucum*). A milestone was set by J. R. Harlan, who localized the cradle of almost 30 crops in Africa based on the distribution of wild relatives, and presented a map for ten of them (Harlan 1971, 1992). In comparison with similar maps from other continents, Africa's difficulty is obvious and has wide-ranging implications for archaeological work. The search for agricultural origins in the Near East or Mesoamerica is restricted to a small area due to the limited distribution of wild ancestors (Smith 1998); however, no "centers" of African plant domestication can be defined. Instead, the hypothetical domestication areas are very large and only weakly overlap. Harlan termed the large, dispersed distribution areas as "non-centers." His map shows a comparatively well defined area in East Africa, which Harlan believed to be the home of *Eragrostis tef*, *Musa ensete*, *Eleusine coracana*, and *Guizotia abyssinica*. In the large savanna belt between Senegal and the Sudan he localized the origin of *Pennisetum glaucum*, *Brachiaria deflexa*, *Digitaria exilis*, *D. iburua*, *Oryza glaberrima*, *Sorghum bicolor*, and the pulses *Voandzeia subterranea* and *Kerstingiella geocarpa*. The hypothetical domestication area of yams (*Dioscorea rotundata*) was located along the fringes of the rain forest between Côte d'Ivoire and Cameroon. Although Harlan's map is incomplete, it presents a starting point for delimiting the key regions for research on agricultural origins.

In other parts of the world, especially the Near East and Mexico, new molecular and genetic methods have been successfully applied to delimit more precisely the hypothetical domestication areas of "founder crops" (Smith 2001a; Zohary 1996). In some cases, the question of single or multiple episodes of domestication can be tentatively answered from DNA evidence and enzymatic studies (Smith

1998; Zohary 1996). For Africa, such investigations are still rare (e.g., Coulibaly et al. 2002; Hilu et al. 1997; Pasquet et al. 1999). For pearl millet, a recent isozyme study has largely confirmed Harlan's ideas and, in addition, further limited its hypothetical domestication area to northern Senegal and Mauritania (Tostain 1998).

### **Myths from the Sahara and the Nile Valley: Broad Spectrum Revolution vs. Early Cultivation**

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From the early days of research on African agricultural origins, the Sahara has been an object of particular attention. First, from a diffusionist viewpoint, it was assumed to be a hypothetical center of early agriculture. Second, based on Harlan's (1971) map of hypothetical domestication areas, one could assume that during the more humid Early and Middle Holocene, the distribution areas of wild *Sorghum* and *Pennisetum* extended further north than the Sahelian zone where they are found today. And third, it was in the Sahara and the Nile Valley where the supposedly oldest remains of domesticated cereals were found.

Scholarly discussions about African agricultural origins were profoundly influenced by the implicit and poorly defined concept of the *Neolithic* which, originally developed for Europe and the Near East, was uncritically transmitted to Africa (Chapters 8, 9). In other world areas, the earliest Neolithic is usually characterized by use of domesticated crops; domesticated animals appear either much later or, at the earliest, contemporaneously (Smith 1998). The implicit equation of the *Neolithic* with plant food production led to the expectation that early polished stone tools, pottery, and cattle in the Sahara should be associated with domesticated plants. This has led to "a great deal of tortuous reasoning" (MacDonald 2000:9) to explain the absence of domesticated crops in Early and Middle Holocene sites – or, conversely, to premature inferences of plant cultivation based on the most meager evidence.

This explains why the sites Amekni, Meniet, and Adrar Bous in the central Sahara (Shaw 1976) continued to be cited as references for early agriculture in the Sahara up to recent times (e.g., Harlan 1992; Smith 1998). In Amekni and Meniet the evidence consisted of pollen grains of hypothetically domesticated cereals (Camps 1969; Hugot 1968). But in contrast to Near Eastern cereals, African domesticated grasses cannot be palynologically distinguished from their wild relatives. In Adrar Bous some plant impressions in pottery studied by the French botanist H. Jacques-Félix were thought to belong to domesticated sorghum. The issue was discussed in letters between J. D. Clark and H. Jacques-Félix (Garcea, letter to the author, July 18, 2002), and even though Clark was very suspicious and never published the results, the hypothetically domesticated sorghum entered as an undoubted fact into Shaw's (1976) compilation, and from there into the secondary literature.

Intensive research on agricultural origins has been conducted in the eastern Sahara. In Wadi Kubbaniya, Egypt grains of domestic barley found in late Pale-

olithic sites seemed to indicate incipient plant food production 18,000 years ago (Wendorf et al. 1979, 1980). Later it turned out that the grains were uncharred, making preservation through such a long time improbable, and they were directly dated by AMS to a maximum age of 4850 b.p. (Hillman 1989; Wendorf et al. 1984). At Nabta Playa, the presence of barley in the levels dated around 8000 b.p., stated by el Hadidi (1980), has not been confirmed by later careful archaeobotanical investigations at the site (Wasylikowa 2001). Ironically, work at Kubbania and Nabta Playa, where archaeobotanical work was oriented toward a search for the earliest domesticates, has produced the best documented evidence for wild plant use in the Late Pleistocene and Early Holocene. In Wadi Kubbania, Hillman and colleagues found remains of *Cyperus rotundus* and other tuber plants, as well as evidence for a very high dietary diversity and early infant weaning 18,000 years ago (Hillman 1989; Hillman et al. 1989). At Nabta Playa more than 120 plant taxa have been identified at site E-75-6 (dated around 8000 b.p., 6900 B.C.), including wild grasses, small seeded legumes, fruit and tuber plants, and firewood species (Wasylikowa 1997, 2001; Wendorf et al. 1998). The inhabitants of E-75-6 collected wild sorghum and several grasses from the subfamily Panicoideae. Storage facilities have also been reported and certain grasses, including *Sorghum bicolor*, were gathered separately. The sorghum grains are morphologically wild, and attempts to prove their domesticated status with the help of gas chromatography (Wendorf et al. 1992) have had equivocal results (Biehl et al. 1999). Thus the question remains open if it was gathered or cultivated.

One of the most controversial issues is the domestication of sorghum in the Nile Valley. Based on plant impressions in ceramics and circumstantial archaeological evidence, Abdel-Magid (1989) and Haaland (1995, 1999) claim that sorghum was cultivated from 6000 b.p. (4900 B.C.). The striking fact in this scenario is the absence of domesticated sorghum in all of Africa before the beginning of the Christian era (for a review of the evidence and arguments see Breunig and Neumann 2002a; Neumann 2003; Rowley-Conwy et al. 1997; and Wetterstrom 1998). Abdel-Magid and Haaland argue that harvesting techniques and cross-pollination of the sorghum plant were responsible for delayed domestication. In the light of experimental studies on cereal domestication rates (Hillman and Davies 1990), it is improbable that the domestication process of sorghum would have taken almost 5,000 calendar years, even if a high percentage of 30 percent outcrossing is assumed. It is more parsimonious to infer intensive gathering for the Middle Holocene sites in the Nile Valley.

The intensive use of wild plants is also documented from other sites in Egypt and Libya. Wild grass assemblages comparable to those of Nabta Playa have been described from the Egyptian sites Hidden Valley/Farafra and Eastpans/Abu Ballas, dated between 7100 and 6000 b.p. (5900-4900 B.C.; Barakat and Fahmy 1999). A large range of herbaceous species, grasses from the tribe subfamily Panicoideae, and remains of edible tree fruits were found in the Acacus rockshelters of Tin-Torha, Uan Muhuggiag, Uan Tabu, and Uan Afuda, dated between 8800 and 4900 b.p. (7900-3700 B.C.) (Mercuri 2001; van der Veen 1995; Wasylikowa 1992, 1993; Wetterstrom 1998). Unfortunately no data are available from the central and

western Sahara, the hypothetical homelands of *Pennisetum*, and it is unknown how long and in which way wild pearl millet was used before its domestication.

From the data of the eastern Sahara, Libya, and the Nile Valley intensive exploitation of wild resources, together with the development of appropriate technology such as large grinding stones and pottery (Barich 1998; di Lernia and Manzi, eds., 1998) was characteristic of the Early to Middle Holocene. This is an impressive example of Flannery's (1969) *broad-spectrum revolution*. Wild grass exploitation was a successful aspect of this new economy for some 6,000 years. Cultivation may have been practiced from time to time, but probably on an irregular and small-scale basis. Domesticated cattle were added to this hunter-gatherer complex by around 6500 b.p. (5400 B.C.), and pastoralism spread throughout the Sahara and Sahel during the next four millennia (Marshall 1998; Smith 1992; Chapter 8). Although information about plant exploitation is missing for most Saharan pastoral sites, it is conceivable that the herders collected wild grasses and fruits. Modern analogs of pastoralism with wild grass harvesting include the Tuareg and Zaghawa societies of the southern Sahara and the Sahel (S. E. Smith 1980; Tubiana and Tubiana 1977).

### **Climatic Change and the Beginnings of Agriculture in the Southern Sahara: Is There a Causal Relation?**

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Climatic change, human population dynamics, and technological development are commonly invoked as causes for the origins of agriculture (Bar-Yosef 1998). In Africa, it is evident that the drastic fluctuations between more humid and arid phases, particularly in the Sahara, must have had an enormous impact on human populations and their subsistence patterns. Two lines of argument can be distinguished. The first deals with the climatic "amelioration" in the Early Holocene and the subsequent extension of exploitable resources as a necessary condition for the intensification of plant use which would – some thousand years later – lead to agriculture. Formerly harsh and empty desert changed into a mosaic of lakes and rivers, surrounded by grasslands and savannas which harbored a large variety of exploitable plants and animals (Chapters 7, 8).

The second line of argument concerns the processes and causal relations of a transition from collecting to cultivating. A common idea for the Sahara is that, with the onset of drier conditions, a steep ecological gradient developed between a few well-watered areas with rich resources and their dry surrounding environments which were unsuitable for human exploitation. This would have led to concentrations of populations and an increasing need to develop new subsistence strategies to cope with the challenge of restricted resources (Clark 1976; Smith 1998; Stahl 1984; Stemler 1984). The large seasonal river valleys of the southern Sahara play a crucial role in this scenario.

Stahl (1984:16), in referring to Wagner's (1977) and Harris' (1977) general critique of environmental determinism, has questioned the causal relationship between climatic developments and the origins of agriculture in Africa. Should a correlation exist, it would not explain *per se* why a shift to agriculture occurred and would leave

the open question of how such changes affected particular subsistence strategies. But even a simple correlation in time and space between paleoclimatic events and archaeologically traceable cultural developments is difficult to establish in Africa. Often pseudo-paleoclimatic information is deduced from indirect archaeological evidence (i.e., the distribution and frequency of sites) resulting in circular arguments. Only in rare cases are independent paleoenvironmental and archaeological data available from the same region.

Although several studies in Africa have contributed to our knowledge of Holocene paleoclimates and paleoenvironments, their time resolution is usually too coarse to support arguments about causality. At least a century order of precision, or ideally, a quarter of a century level (one human generation) would be necessary (Vernet 2002). This level has obviously not been reached in the southern Sahara, although numerous paleolakes – the main source of paleoecological information – have been studied (Guo et al. 2000; Hassan 1997). Moreover, the knowledge of humid episodes is usually better than that of dry ones, which in most cases are not dated directly.

The data from the Sahara suggest that the humid phase after 9500 b.p. (8800/9100 B.C.) was interrupted by series of dry spells and progressive desiccation after 5000 b.p. (3800 B.C.; Guo et al. 2000). If, as it is generally assumed, the increasing desiccation of the southern Sahel was the driving force for migrations to the south and for innovations including agriculture, it would be important to define accurately the climatic events in the period when this is supposed to have occurred, i.e. the third and second millennia b.c. Unfortunately, there is no general agreement on when to place these dry spells. Guo et al. (2000) have identified a phase of extreme aridity around 4000 b.p. (2500 B.C.) which might have been as dry as the Late Pleistocene. Vernet (2002) and Vernet and Faure (2000) also mention a severe dry episode in the Sahara around 4200–4000 b.p. (2800–2500 B.C.). Hassan (1997:218), in a compilation of African paleoclimates, does not recognize a dry spell around 4000 b.p., but places the period of droughts in the southern Sahara and the Sahel between 3800 to 3600 b.p. (2200–1900 B.C.).

Although not consistent in detail, Maley (1997), Guo et al. (2000), and Vernet (2002) report a return to wetter conditions in the southern Sahara in the fourth millennium b.p., with numerous lacustrine formations and high population densities. Ceramic impressions of domesticated *Pennisetum* are the first signs of cereal cultivation which appear during this period, but the evidence is meager, and no recent archaeobotanical data are available. It is important to mention that the earliest traces of agriculture are not linked to a period of extreme dryness, but, in contrast, to one of climatic amelioration, followed by resettlement of previously uninhabitable areas (Vernet 2002). The dominant economic pattern during this period was pastoralism, and several pastoral complexes have been described, from Mauritania to the Nile Valley (Smith 1992; Chapter 8).

From the key area of pearl millet domestication in the southern Sahara between Lake Chad and the Atlantic, only two sites contribute to our knowledge of early agriculture: Karkarichinkat and Dhar Tichitt. Although no systematic archaeo-

botanical sampling was done at either site and the evidence is meager and ambiguous (Wetterstrom 1998), they act as a "starting point" for future research and are therefore be described in some detail.

In the lower Tilemsi Valley at Karkarichinkat, A. B. Smith (1974, 1975, 1992) excavated seasonally occupied settlement sites dated between 4000 and 3300 b.p. (2500–1600 B.C.). Botanical and faunal remains suggest a Sahelian riparian environment associated with wooded grassland. The sites were occupied by pastoralists with cattle and small stock, who also practiced fishing, hunting, and collecting of tree fruits. Continued re-occupation led to an accumulation of cultural debris in the form of settlement mounds. Impressions of wild and domesticated *Pennisetum* in potsherds from Karkarichinkat Sud were identified by de Wet (Smith 1992:74, 1984:89). As these sherds were collected from the surface and have not been precisely dated, their interpretive value is quite low. The seasonality pattern reconstructed from fish and fruit remains suggest that the sites were visited during the autumn and winter months. The status of pearl millet in the Karkarichinkat economy cannot be determined from these finds, let alone a development of cultivation practices related to environment change.

The archaeological sites of Dhar Tichitt in Mauritania are unique: along the escarpment of Tichitt and Oualata the oldest villages of Africa, including stone architecture and granaries, were constructed during the period of 3500 to 2500 b.p. (1800–800/400 B.C.). The origins of the Tichitt culture are still not well understood, and the chronological sequence relevant to the development of agriculture is a matter of debate (MacDonald 1998; Wetterstrom 1998). The archaeobotanical evidence consists of grain and chaff impressions in potsherds (Amblard and Pernès 1989; Jacques-Félix 1971). Munson (1971, 1976) claims a shift from gathering to pearl millet cultivation in the period between 3500 to 2800 b.p. (1800–950 B.C.), which he relates to increasing aridity. Amblard rejects Munson's interpretation and claims that pearl millet was cultivated from the beginning of the occupation. Her hypothesis is corroborated by two radiocarbon dates around 3500 b.p. (1800 B.C.), directly obtained from organic material in a potsherd tempered with pearl millet chaff (Amblard 1996). The environmental data from Dhar Tichitt are very sparse. From the occurrence of lacustrine sediments which were still deposited during the period of occupation, Person et al. (1995) conclude that the region of Dhar Tichitt received slightly higher rainfall than today and acted as a refuge in comparison to the surrounding arid regions because of its special geomorphological situation.

The southern part of the eastern Sahara and the adjacent Sahel between Lake Chad and the Nile Valley are the key areas for sorghum domestication. Under slightly more humid conditions prevailing in the third and second millennia B.C., the distribution of wild sorghum might have extended into the region of Wadi Howar where detailed paleoenvironmental and archaeological studies have been conducted (e.g. Hoelzmann et al. 2001; Neumann 1989; Pachur and Kröpelin 1987; van Neer and Uerpman 1989). Hoelzmann et al. (2001) have demonstrated a relation between climate, paleoenvironment, and settlement patterns in the southern part of the eastern Sahara during the Middle and Late Holocene. A stable,

favorable environment with a chain of lakes in western Nubia supported sedentary or semi-sedentary hunter-fisher communities from 5300 B.C. and pastoralists from 4000 B.C. onwards. After 3000 B.C., with increasing desiccation of the lakes, seasonal migrations of pastoral populations increased. The crucial period for the establishment of agriculture might be that after 2500 B.C. when pastoralists were forced to concentrate in the Wadi Howar and Jebel Tageru south of 18°N. However, for the time being there is no evidence for plant cultivation in the Wadi Howar where settlement activities finally ceased around 1000 B.C. In the Nile Valley, no sites are known from 4000 to 2000 b.p. (2500 B.C.–0 B.C./A.D.), and populations might have shifted there to a purely pastoral adaptation (Haaland 1984; Wetterstrom 1998). The first domesticated sorghum appears in the Nile Valley only after the beginning of the Christian era, at the sites Qasr Ibrim, Meroë, and Jebel Tomat (Rowley-Conwy et al. 1997; Wetterstrom 1998). For the time being, there is no conclusive model which would explain the beginning of sorghum cultivation between Lake Chad and the Nile Valley during the first millennium B.C. in relation to climatic change.

Clark (1976) argued that two main subsistence systems existed side by side in the southern Sahara and these reacted in different ways to the challenge of restricted resources. Pastoral groups would have been more reluctant to adopt cultivation because the sedentary or semi-sedentary lifestyle required for effective agriculture conflicted with their nomadic or transhumant lifestyle. Clark suggested instead that the initial steps to cultivation began among hunting-gathering-fishing populations at the edges of the remaining water bodies. Casey (1998), in pointing out seasonality as an important factor for the emergence of agriculture in West Africa, also stresses the dichotomy between herders and fishers. However, the archaeological data from the southern Sahara and the Sahel indicate that more complex subsistence patterns have to be assumed for the second millennium b.c., with pastoralism, hunting, gathering, and facultative cultivation as flexible modules of an economy of diversified risks. Sites like Karkarichinkat, Gajiganna (northeast Nigeria) Wadi Howar, and others in West and Central Africa furnish evidence for pastoralists exploiting fish and other wild resources which were eventually cultivated (Breunig and Neumann 2002a; Keding 1997; Smith 1992; van Neer 2002).

Because longer chronological sequences with occupational, paleoenvironmental, and paleoeconomic information are unavailable for the southern Sahara, the existing models on the emergence of agriculture as an adaptation to more arid climate are largely deductive. Either the evidence for plant cultivation is missing altogether (such as in the Wadi Howar) or, in the case of pearl millet at Dhar Tichitt and Karkarichinkat, it is so weak and ambiguous that we cannot assess whether the crop was introduced or locally domesticated, or the role that cultivation played in the economy. A detailed model for pastoralists as the first cultivators in Africa remains to be developed and poses a challenge to notions that sedentism is a crucial factor in the shift to agriculture (MacDonald 2000; Marshall and Hildebrand 2002; Chapter 8). The southern Sahara between Mauritania and the Nile Valley remains the key area where the origins of pearl millet and sorghum domestication should be sought.



## The Spread of Plant Food Production in Africa

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Surprisingly, the spread of pearl millet from the southwestern Sahara to West Africa seems to have been rapid. Almost contemporaneously with the finds of Dhar Tichitt around 1800 b.c., domesticated pearl millet is recorded in the archaeological sites of Windé Korodji (Mali), Ti-n-Akof (Burkina Faso), and Birimi (Ghana) (Breunig and Neumann 2002a; D'Andrea and Casey 2002; D'Andrea et al. 2001; MacDonald 1996; Neumann 1999; Vogelsang et al. 1999). The open West African savannas probably favored the distribution of people and ideas, and there were strong population movements from the desiccating Sahara into the Sahel and further south in the second and first millennia b.c.

In the West African Sahel, patterns of occupation and subsistence are comparatively well studied, and archaeobotanical data exist from a number of sites. For Burkina Faso and the Chad basin of northeastern Nigeria, a team from the University of Frankfurt (Germany) has explored an archaeobotanical, paleoenvironmental, and archaeological sequence spanning the period from around 1800 B.C. to modern times (Albert et al. 2000; Breunig and Neumann 2002a, 2002b, 2004; Höhn et al. in press; Klee and Zach 1999; Klee et al. 2000; Neumann et al. 1998; Vogelsang et al. 1999). Based on the data of numerous well-dated sites, Breunig and Neumann (2002b) and Neumann (2003) have presented a two-stage model for agricultural development in the West African savannas, each characterized by specific crops and markedly different technological, social, and economic patterns. In the classical terminology, phase I corresponds to the final period of the Late Stone Age in the second millennium b.c., and phase II to the beginning of the Iron Age in the second half of the first millennium b.c. (Peregrine and Ember, eds., 2001).

In phase I, pearl millet is the only crop recorded so far. The absence of other crops might be due to bad preservation, but Breunig and Neumann (2002b; Neumann 2003) argue that this evidence reflects the comparatively minor role of cultivation in the subsistence systems during the second millennium and the first half of the first millennium B.C. In Gajiganna and Kursakata (Nigeria) pearl millet cultivation was integrated into a mixed economy of sedentary or semi-sedentary populations at least after 1200 B.C., with a strong focus on cattle-keeping, hunting, fishing, and gathering of wild grasses (Klee and Zach 1999; Klee et al. 2000; Neumann et al. 1996). In Burkina Faso and Mali a more mobile way of life can be inferred from scattered pearl millet finds in sites of mobile pastoralists or hunter-gatherers (MacDonald 1996; Vogelsang et al. 1999). Only in Birimi, a northernmost site of the Kintampo culture, might pearl millet cultivation have been a dominant activity for the sedentary population (D'Andrea and Casey 2002; D'Andrea et al. 2001), but interestingly *Pennisetum* is also the only crop recorded so far.

Breunig and Neumann (2002b) claim that dramatic economic, technological, and social changes took place in the West African Sahel during the first millennium bc (phase II) which were eventually correlated with climatic fluctuations. The development of iron technology, social stratification, and larger villages and urban

centers, together with a highly diversified Iron Age agriculture, are poorly understood. Important crops which became the main components of modern West African agriculture, such as sorghum, African rice (*Oryza barthii*), cowpea (*Vigna unguiculata*), bambara groundnut (*Voandzeia subterranea*), and okra (*Hibiscus esculentus*), appear between 500 B.C. and A.D. 500 (Neumann 2003; Wetterstrom 1998). The roots of the very productive Iron Age subsistence systems in the West African savannas in the first millennium b.c., based on agro-forestry and mixed cropping of cereals and pulses, still remain to be elucidated.

Little progress has been made in recent decades on the origins of agriculture in the humid tropical zones of Africa. Evidence is almost as scarce as in the 1970s, when Coursey (1976) published his ideas on the origins of yam domestication. It is commonly assumed that the emergence of agriculture in the western and central African rain forest areas was stimulated from the north, and that grain crop agriculture in Africa preceded tuber crop cultivation (Harris 1976), but neither archaeological nor archaeobotanical data are available which might confirm diffusion between the West African Sahel and the rain forest area. A valuable cultural complex for the study of diffusion processes are sites from the Kintampo complex in Ghana which are distributed from the dry wooded savanna to the margins of the rain forest. The presence of domesticated *Pennisetum* at Birimi around 1800 b.c. (D'Andrea and Casey 2002; D'Andrea et al. 2001) evokes the question of how subsistence at the forest margins was influenced by the introduction of domesticated cereals some hundred kilometers further north. The available archaeobotanical evidence from the southern Kintampo sites in the second millennium B.C. is weak and could be interpreted in terms of either a hunter-gatherer subsistence or incipient cultivation (Casey 2000; D'Andrea and Casey 2002; Stahl 1986).

Yams, the most important crop of the rain forest complex, are particularly difficult to find in the archaeological record. Attempts have been made to trace yam cultivation indirectly, most often through the presence of oil palm (*Elaeis guineensis*) fruit stones or pollen. *Elaeis* is a natural component of forest margin vegetation and a pioneer which colonizes open ground. In a review of the palynological evidence, Sowunmi (1999) states that the distinct increase of *Elaeis* in the pollen profiles of West and West Central Africa after 3000 b.p. (1200 B.C.) indicates cultivation. This view has been questioned by Maley and Chepstow-Lusty (2001), who interpret the high oil palm percentages in rain forest pollen profiles as resulting from a dramatic forest decline due to an abrupt climatic crisis which culminated around 2500 b.p. (800/400 B.C.). It has often been stated that bad preservation of plant remains in the rain forest is the main obstacle for the study of agricultural origins in the rain forest. However, charred wood and fruit remains of *Canarium schweinfurthii* and oil palm have often been found in Central African archaeological sites as well as in Kintampo K6 in Ghana (Eggert 1993; Stahl 1985; Chapter 9) which suggests that the problem lies with lack of appropriate recovery techniques.

Surprisingly, the first and up to now single direct archaeobotanical proof for agriculture in the rain forest consists of phytoliths of the cultivated banana (*Musa* sp.), a crop introduced from Asia (Mbida et al. 2000; Mbida Mindzie et al. 2001). Its

early presence at the site Nkang in the Cameroonian rain forest around 800/400 B.C. raises more questions than it solves. How did the banana cross the Indian Ocean and East Africa before it entered the rain forest? Did the introduction of Asian crops act as a stimulus for the development of indigenous rain forest agriculture? What is the role of the banana in an agricultural system which enabled the occupation of the rain forest in the first millennium B.C.? And last, but not least: is the emergence of agriculture related to climatic change which seriously affected the central African rain forest in the first millennium B.C. (Maley and Brenac 1998; Schwartz 1992)?

There are hardly any new archaeobotanical data on the spread of agriculture to southern Africa. Research on one of the most fascinating problems in African archaeology, the origin and spread of "Bantu" communities from their supposed homelands in West Central Africa all over the continent, is mainly in the hand of linguists and archaeologists working with indirect circumstantial evidence (Chapter 12). The enormous intellectual distance between the indirect approach and concepts based on "hard evidence" is illustrated by Vansina (1994/95:15), who states that "a complex based on grain crops and the herding of domestic stock developed in northeast Africa during the sixth millennium B.C. and spread southward." The gap of 6,000 years between Vansina's "grain crop complex" and the first appearance of domesticated sorghum in the archaeological record reflects the incompatibility and the mutual ignorance of two fundamentally different approaches. Stahl (1984:20) sees the attempt to correlate the spread of ironworking, agriculture, and Bantu-speaking peoples as an "an archaeological cul-de-sac." The surprises that can be expected in the future if plant remains from archaeological sites are interpreted without prejudice are shown in the study of Jonsson (1998) on Iron Age sites in Zimbabwe, dated between 400 and 1600 a.d. Besides domesticates such as sorghum, finger millet, and bambara groundnut, the sites yielded several wild grasses and fruits harvested for food, a further example of a mixed economy already known from western Africa. This has no equivalent in the crop-centered linguistic concepts. Studies from Europe and the Near East have demonstrated how much a generalized picture of agricultural diffusion has to be modified and corrected in the light of new data (Harris, ed., 1996). The archaeobotanical evidence for southern Africa necessary for such a correction remains to be found.

### **Why So Late?**

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The most striking pattern in the available archaeobotanical information is the very young age of the indigenous African crops. Of course the absence of evidence does not inevitably mean evidence of absence. We have to admit that for some areas, especially the rain forest and its margins where the origin of tuber crops is assumed, no data are available at all. However, the archaeobotanical assemblages from the Sahara, the Sahel, East Africa, and southern Africa draw a consistent picture of agriculture as a late phenomenon, developing slightly before 1800 b.c. in the southwestern and south-central Sahara, and much later, from the middle of the first mil-

lennium b.c. onwards, in other parts of the continent. Comparison of the African data with those from other continents reveals a gap of several thousand years in the appearance of domesticated plants. Even if only the “safe” archaeobotanical finds are considered and controversial older evidence is regarded with caution, the gap between the earliest domesticates in Africa and those from other continents would be at least 1,500 years for America, 5,000 years for China, and 6,000 years for the Near East (Neumann 2003).

Especially striking is the large gap between the emergence of agriculture in Egypt and that in sub-Saharan Africa. At least 3,000 years before pearl millet and 5,000 years before sorghum were domesticated, agriculture based on crops of Near Eastern origin is attested at Predynastic sites dated to the sixth millennium b.c. (Wetterstrom 1993; Zohary and Hopf 2000:219). It has often been argued that the Near Eastern domesticates could not spread to sub-Saharan Africa with its monsoonal climate, because they are long-day plants and must be planted in the winter (Willcox 1992). However, diffusion of the idea of agriculture might well have been possible. Ancient Egypt was not isolated, and it is conceivable that during the periods when its agricultural system flourished, people in the Sahara or the adjacent Sudan might have taken up the idea of cultivation and converted it into the domestication of tropical summer crops. Why did this not occur, or why did it occur so late?

Several lines of argument can be distinguished (Neumann 2003). Unfavorable preservation in tropical soils or taphonomy and site context might be responsible for the missing evidence (Young and Thompson 1999). Stemler (1984), Haaland (1995, 1999), and Abdel-Magid (1989) see cross-pollination and harvesting techniques as the major factor preventing the selection of domestication traits, especially in *Sorghum* and *Pennisetum*. Diamond (1997) also regards cross-pollination in wild grasses as the main obstacle for the domestication process, and holds that Africa was at an environmental disadvantage because it does not possess enough plant species suitable for domestication to compete with other continents.

Claims that agriculture in Africa must be older than attested by archaeobotanical data get their support from the persisting paradox that several African crops appear earlier in India than on their home continent Africa. A recent review has established the reliability of the Indian finds which formerly had been a matter of debate (Fuller 2003). *Sorghum bicolor*, *Pennisetum glaucum*, and *Vigna unguiculata* became available in India during the first half of the second millennium B.C. As the wild ancestors of these crops are distributed in Africa, but not in India, initial domestication must have taken place on the African continent, and the period required for this process would be the end of the third millennium b.c., for which evidence is still completely missing. But even if remains of domesticated sorghum, pearl millet, and cowpea dating to the third millennium b.c. were detected, thus furnishing the “missing link” between Africa and India, this would not generally change the picture, as it would only slightly reduce the time gap between sub-Saharan Africa and the other continents, especially the Near East.

J. D. Clark (1980:59) suggested that the very nature of African ecosystems maintained population densities below the maximum carrying capacity and thus post-

poned the emergence of agriculture much longer than on the other continents. In this scenario, the savannas play a prominent role. Savannas cover large parts of the continent and extended far into the Sahara during the Early and Middle Holocene. The "Garden of Eden" hypothesis (Neumann 2003) explains the late emergence of agriculture with the special ecological conditions of the savannas which harbor a wealth of wild plants and animals which, however, are unequally distributed in time and space and can be best exploited by mobile populations.

A further reason is Africa's special development of animal domestication. Pastoralism with cattle emerged much earlier than plant cultivation and was a well-established system in the Sahara from at least 5000 B.C. (Chapter 8). Herding of cattle requires a nomadic or transhumant way of life which fits better with a flexible exploitation of abundant wild plant resources than with plant cultivation (Marshall and Hildebrandt 2002). Farming on a larger scale is inevitably connected with a sedentary way of life, and both developed only late in the savanna because mobile economies were so successful.

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## Conclusion

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The use of wild plants was an important element of African subsistence throughout the Holocene and continues to be successful up to modern times. Africa presents the greatest example of the "vast middle ground" in the transitional zone between foragers and agriculturalists. Given the intimate knowledge of wild resources which has a long tradition in Africa dating back to the Pleistocene, it is conceivable that some "low-level food production" (Smith 2001b) was practiced long before domesticates appear in the archaeological record. However, this can only be detected if the biased focus on domesticates is given up in favor of studies on complete plant assemblages. Our understanding of "middle ground economies" can be greatly enhanced by ethnobotanical information on the modern use of semi-domesticates and the management of wild plants as well as on traditional plant cultivation and processing.

Modeling the role of plant cultivation in an economy of diversified risks, including stock-keeping, foraging, fishing, and hunting, is a key issue for studies on the emergence of agriculture in the southern Sahara. A relationship with increasing climatic insecurity during the third and second millennia b.c. can be assumed, but for the time being the paleoenvironmental and archaeobotanical data are too sparse to formulate a conclusive model. The fact that pearl millet remains the only domesticate for more than a millennium may be due to the small number of sites from which plant remains have been studied. But it may equally reflect the minor role that cultivation played in the subsistence systems.

The absence of evidence for agriculture in central, eastern, and southern Africa until the middle of the first millennium b.c. is often put down to preservation, site context, or recovery problems. A gap of 6,000 years or more between the emergence of agriculture in the Near East and Africa seems inconceivable – and may be unacceptable if it is implicitly taken for granted that all continents must have had

their “Neolithic revolution” early in the Holocene. Would it not be much more consistent to assume that Africa’s way was unique, because of its rich environmental resources, especially in the savannas, and the particular role of mobile pastoralism as two factors postponing agriculture for several millennia?

The first millennium b.c. seems to be of fundamental importance for the development of sedentary agriculture all over Africa. Or is it a mere coincidence that domesticates of all kinds (cereals, pulses, and even introduced Asian crops) show up at the beginning of the Iron Age in West, Central, and East Africa? The relationship between the emergence of iron technology, social complexity, and diversified agricultural systems is almost completely unknown – at least if regarded from a “data-focused” perspective. In my view, the emergence of diversified agricultural systems and the rapid spread of crops all over the continent in the first millennium b.c. is one of the most challenging research topics for the future.

It can no longer be said that evidence is absent because no one looks for the plant remains in African archaeological sites. Numerous studies, mainly from the Sahara and West Africa, have contributed to our knowledge of prehistoric plant use. However, the lack of basic data still remains the major problem in the search for agricultural origins, especially in regard to central and southern Africa. A general experience from archaeobotanical work in Africa is that new data often open the way to surprising insights and lead to a revision of former models. More surprises can be expected in the future.

## NOTE

- 1 A major problem for any discussion of the transition from gathering to plant food production is temporal inaccuracy. The inconsistent use of uncalibrated and calibrated dates in the literature makes direct comparison difficult, especially with older material where the deviation between calibrated and uncalibrated dates can be considerable. Direct AMS dates on plant remains and calibration programs have brought considerable progress. For a better comparison within this chapter, all available b.p. dates have been calibrated with OxCal v3.5 © Bronk Ramsey 2000 (Bronk Ramsey 1995) with atmospheric data from Stuiver et al. (1998). Calibrated dates are expressed as B.C./A.D.

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