Domestication of cereals in Africa

Domestication: What is it?

From the available evidence, we can see that the first experiments with farming plants began in the Near East around 8000 years ago. These included wheat, barley, lentils and peas. It was a thousand years later before there were significant morphological changes to the animals as a result of domestication. Only then can the skeletons of domesticated animals be recognised in the archaeological record, but people may well have been controlling the animals' movements and behaviour before that.

A simple definition of domestication for archaeological purposes is: *intentional manipulation of genetic material of select plant and animal species*. This implies that humans were choosing the traits that would benefit them, such as increased productivity and easier harvest/extraction, as well as easier control. All this has serious social implications because not only were the animals and plants becoming domesticated, but so were the people who now had the responsibility for them.

Why domesticate?

In many parts of the world hunting and foraging existed down to the 20th century. Many hunting groups even had contact with farmers or herders but did not become food producers themselves.

There are a number of different facets to the question. It would seem that some kind of pressure or inducement had to exist before people would become food producers, otherwise they would just continue their old conservative hunting/foraging existence. Having said that, one should not get the impression that the hunting life was necessarily static. There is good evidence from a number of parts of the world that changes were already taking place before the transformation to food production, even among people who did not become food producers themselves.

One aspect is the kinds of plants and animals which became domesticates. Some were obviously better than others when it came to a closer relationship with humans, including large stands of hardy cereals which could be moved to new environments and animals whose herd mentality could be exploited by humans.

Another aspect is the kinds of social and behavioural changes that were taking place among select societies throughout the world. This can partially be seen in the increased sedentarisation and the necessary social conditions that had to be in place for this to be successful for long periods of time.

The social implications of domestication

The transition to food production required considerable adjustment on the part of the domesticators. As hunters or foragers they could have followed the herds, or their movements to coincide with some aspect of herd behaviour or plant ripening. Once you start to control the herd, there are responsibilities tied in with it since it becomes a personal or corporate resource that has to be looked after. Equally, if you are selecting specific types of seeds and sowing it (perhaps even creating hybrids), like the animals they became yours but they are also targets for other people or animals so need to be protected. In other words, once you take responsibility for the herd and the preparation/harvesting of plants, you become constrained by having to look after them.

Let us first look at plant domestication. Like wild plants, you would have to be at the place of harvest when the plants ripened. But if you had already spent energy selecting the seed, sowing it (perhaps clearing fields), you would also like to make sure nothing else got to the plants before you. To protect your investment you, or at least part of your family, should stay in that place to guard the plants, chase the birds away, etc. One aspect of grain agriculture which is well known is that it can feed a lot of people, so population had the opportunity to increase. The more people you can feed, the more the population can increase, requiring ever more food and greater ingenuity in getting the food, i.e. technological improvements. This could only result in social accommodation to deal with larger numbers of people in the social group.

One of the major social effects of plant domestication would have been the increase in the number and size of settlements. Another change would have been delimiting space in family or perhaps individual hands. This would have been a direct result of controlling the planting space and investing energy in clearing fields in preparation for sowing. Thus land would start to have both social and economic value. Inevitably, anything with important social value would also become ritualised.

From all this you can see that food production had the immense potential for social change and it is really these social and behavioural aspects which interest us, trying to find methods that will allow them to be investigated and the timing and place determined. This is why so much energy has been invested in the transitional periods and continues to do so today. It is often the details of the arguments which allow the evidence to swing in one direction or the other, so we will look at some of the details of how we can distinguish hunting from food producing societies.

Archaeological evidence for domestication of plants

There is circumstantial evidence for the collection of grains from the artefacts used, such as grinding stones or silica gloss on sickle blades, or from impressions made on pottery. But the question always remains, were these wild or domesticated plants.

How do we recognise a domesticated grain from the wild? Wheat, for example, comes in two wild forms, emmer and einkorn. The distinction between these two and the domesticated varieties is in the way they attach to the stem. The point of attachment is called the rachis. In domesticated forms, the entire head stays attached to the rachis and

only comes apart with threshing. Since the head does not just drop off to allow germination, as it would in the wild forms, the tough rachis means that they need humans to propagate the plant by sowing the threshed seed. Having a head which stays on the plant, instead of being dispersed by animals walking through the grass, made it easier to harvest, and was probably why these varieties were selected over the more brittle heads of the wild ancestors.

Agricultural domestication

As different crops have different distributional ranges in the wild due to differing ecological adaptations, reconstruction of these ranges can provide insight into where cereal domestications events occurred and their subsequent spread through diffusion and human population movement. Harlan has identified four wild races of the wild *Sorghum bicolor* and describes them as follows: (1) arundinaceum (forest-adapted), (2) virgatum (Nile floodplains), (3) aethiopicum (Sudan and following the fringe of the Sahara westward), and (4) verticilliflorum (eastern and southern Africa savanna, but sparse west of Nigeria). All the four races are interfertile and thus are classified as the same species.

The forest-adapted "race" is regarded as the progenitor of the domesticated sorghums which have also been divided into separate races: (1) Bicolor, (2) guinea (West Africa and the East African mountains), (3) caudatum (dominant in Chad, eastern Nigeria, Sudan and Uganda), (4) kafir (southern Africa), and (5) durra (Ethiopia and fringes of the Sahara, in Africa).

Harlan has recorded the harvesting of over 60 species of grasses as famine and staple foods in Africa: "*Aristida pungens*, a staple of the northern Tuareg; *Panicum turgidum*, basic in central Sahara; *Cenchrus biflorus*, a major food of the Sahel; *krebs*, a complex of a dozen or more species including *Panicum laetum*, several species of *Eragrostis*, *Dactylotenium*, *Brachiaria*, etc., providing staples from Bornu to Kordofan; *Oryza barthii*, widely harvested from swamps in the savanna, but a staple from Bornu to Kordofan; *Paspalum scrobiculatum*, a companion weed-crop of rice in the forest zone of West Africa; and *Echinochloa stagnina*, a sugar crop as well as a grain crop in the central Niger delta and around Lake Chad." (Harlan 1989, 79) Natural grasses can provide high quality and high volume yields, and have been observed ethnographically as harvested through threshing, or with a sickle, or by being shaken and beaten into a basket.

Based upon the present day distribution of the wild progenitors of sorghum and pearl millet in Africa, it has been proposed that their domestication occurred within a forest-savanna sub-Saharan band north of the equator, from the Atlantic to the Indian Oceans. Both sorghum and pearl millet are savanna crops. Pearl millet is more drought and heat tolerant, and is found in the Sahel which has 250-800ml of rain annually; it is therefore well adapted for marginal environments with low fertility soil. Whereas pearl millet is believed to have been domesticated along the southern edge of the central Saharan highlands, the broad centre for sorghum domestication has been placed in north-eastern Africa.

Competing models of cereal domestication

Sorghum

Issues surrounding the date of the domestication of sorghum and the history have crystallised around three hypotheses: The Early Hypothesis, the Late Hypothesis and the Haaland Hypothesis.

The Early Hypothesis is based upon three facets. The first is the opinion that wheat and barley would have been the dominant species in the modern Sudan if sorghum had not been domesticated in West Africa and spread to the Sudan prior to 4 500 B.C. The second is Ehret's linguistics claim of a sorghum domestication centre in the vicinity of Lake Chad c. 4 000 B.C. Thirdly, dates as early as 4 000 B.C. have been claimed for the presence of durra in India, implicating an intercontinental movement of domesticated sorghum from Africa.

The Late Hypothesis proposes that the earliest reliable evidence for domesticated sorghum is not present in Africa until the late first millennium BC and that the domestication of sorghum took place in Africa.

The Haaland Hypothesis proposes that wild *Sorghum bicolor* was exported to India, where it became domesticated durra and was subsequently reintroduced into Africa during Islamic times.

To help clarify the issue, DNA analysis was utilised in order to determine the degree of integrity between wild and domesticated *Sorghum bicolor*, and bicolor and durra. Greater integrity in the DNA locus would be a strong indicator of a late domestication event. The samples were taken from the Nubian site of Qasr Ibrim, where wild sorghum is present in the first millennium B.C., domesticated bicolor from 100 A.D. onwards, and domesticated durra from c. 1 200 A.D. The areas of the genome examined displayed a large degree of integrity, and thus have been seen as lending provisional support to the Late Hypothesis with the qualifier that no absolute molecular divergence clock could be ascertained.

Analysis

Starting with the mitochrondrial DNA evidence. The genetic sequences examined actually exhibit very little variability; in other words, the particular genetic sequences which were examined are not particularly suitable for determining degrees of separateness. This re-opens the possibility that the oldest published evidence for domesticated sorghum, of late 1st millennium BC, is no more than an artefact of the limited recovery and identification of relevant botanical remains.

Dorian Fuller's recent re-analysis of claims for domesticated cereals in India, confirmed the presence of pearly millet, sorghum and two legumes (cowpeas and hyacinth beans) by the mid-second millennium BC. Finger millet is present from around 1000 BC. The introduction of these crops to southern Asia could have come from sustained or episodic direct or indirect contacts with Africa. The nature of these contacts is beyond our discussion today. Suffice it to say that, on the surface, such an analysis would appear to support the Haaland hypothesis. But there is a further twist to the discussion.

Remember back to our earlier discussion on how we defined domestication as a series of genetic changes. What you should be continually asking yourselves is to what degree and in what circumstances can such rigid definitions be applied. This is one such case where focusing solely on morphological domestication is too limiting a strategy for understanding the origins of domesticated sorghum. It is now well established that sorghum at least will not undergo the morphological changes that identify it as domesticated if harvested by stripping the grain from the stalks or beating it into baskets. Sorghum impressions (all morphologically wild in status) are plentiful on early Holocene potsherds in Nubia; grindstones are numerous and settlements occur in alluvial settings with heavy clay soils, contexts well suited for growing sorghum, whether for food or beer.

In addition, because wild sorghum varieties are widespread in tropical Africa, genetic isolation would have been needed to allow altered harvesting practices to operate effectively as selection pressures to bring about detectable morphological change.

The conclusion that can be drawn from these observations is that sorghum has at least been harvested or cultivated for far longer than the morphological evidence displays.

Pearl Millet

These arguments are encouraged by other recent paleo-botanical finds. Fully domesticated pearl millet grains from the West African country of Burkino Faso are, for example, dated directly to 1035 – 916 BC, others from northern Ghana to 1740-1130 BC. The oldest known examples come from the site of Dhar Tichitt (in the West Saharan country of Mauratania), that date to 100 years earlier than Ghana.

In order to examine the pattern of the spread of domesticated Pearl Millet, let us examine in detail the region of north-east Nigeria.

The Chad Basin in north-east Nigeria is the location of around 120 sites allocated to the Gajiganna Complex. Phase I spans 1 800 – 1 400 B.C., Phase IIa 1 500 – 1 200 B.C., Phase IIb 1 200 – 1 000 B.C. and Phase IIc 1 100 – 400 B.C.. Inorganic-tempered pottery is characteristic of Phase I and the accidental plant impressions on the sherds are of wild grass species; the latter, *Oryza* (rice) and *Peniceae* (which includes several species of *kerb*), are also the only plant impressions on pottery from Phase IIa. When domesticated

pearl millet (*Pennisetum americanum*) grains first appear at the start of Phase IIb, also as sherd impressions, they comprise only 10% of those impressions identified. This percentage rose to 60% by Phase IIc. There are no impressions of intermediary stages of domestication and this fact strongly indicates that the origin of pearl millet should be sought elsewhere.

The distribution pattern of the earlier pastoral compared to the agro-pastoral sites is suggestive of an origin to the west or north-west of the Chad Basin. Pastoralism was well established in the Sahara by this time and, with the increasing desiccation of the desert, the first inhabitants of the Chad Basin were pastoralists from the Sahara.

The sites from the Manga Grasslands, located near the Niger-Nigerian border, may hold the key to tracing the migration route. Similar pottery styles have been found to the north in the Central Sahara, with the "triangular stamping forming a zigzag pattern in combination with horizontal bands of comb impressions as well as grooved lines have parallels along the Gajiganna materials" (Breunig and Neumann 2002, 146).

Thus the centre for millet domestication can now be reasonably located in the Central or West-Central Sahara prior to 1 200 B.C. It is possible that, with the desiccation occurring in the Central Sahara, the inhabitants domesticated millet to maintain a ready source of food.