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Chapter 14

Crops, Techniques, and Affordances

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For about twenty years now it has become fashionable in many parts of France, as in many other so-called developed countries, to organize rural festivals where bygone works and crafts are demonstrated before a public of mostly city-dwellers. The number of such festivals in France must now be in the order of several hundred each year. Most of them are of course held in summer, the tourist season, although some must of necessity take place at another time of the year, as for example cider-making festivals in October or November. In most festivals, ploughing is performed with old wooden ploughs harnessed to horses or oxen, grain is harvested with scythes and harvester-binders, threshed with flails or in steam-driven threshing machines, and so on. There are sheep festivals, where the animals are shorn with hand-shears, the wool washed and combed in the old way, spun by hand, and woven or knitted on hand looms or old-fashioned machines. There are flax festivals, donkey festivals, blood-sausage festivals. Last year, a horse-carriage race was organized between the seaport of Boulogne and Paris (250 km) to revive the **chasse-marée** of old, when fish had to be carried from the Channel ports to Paris as quickly as possible before the coming of the railways. There is even a **Fête de la Bouse** (Cow-dung Festival), where cow droppings are collected and kneaded into cakes for use as fuel, as was still regularly done in the wood-deficient parts of the Poitou marshes in the 1950s.

One of the most interesting festivals I have attended is the **Fête du Millet** that has taken place in the village of Aizenay since 1989.[1] I knew that millets, mainly *Panicum miliaceum* L, had been a crop of some importance in western France in the nineteenth century and before. I also knew that many museums in the region

kept a few wooden mortars and pestles said to have been used for the husking of millet; but I had never met anyone who had used such a mortar, and it appeared that no one alive had ever done so. So it came as a surprise to learn that at Aizenay and in the surrounding area, there were indeed a number of such persons alive and well, not even very old but in their sixties and seventies. The tasks they demonstrated were also much more than just the use of the pestle and mortar. The ears of millet were first harvested by hand, one at a time, with the help of a pocket knife. The grains were then separated from the ears, not by threshing but by rubbing the ears between the naked feet. Afterwards came a first winnowing in a hand-driven winnowing machine, the husking in the pestle and mortar, a second winnowing with the help of a flat basket named **guenotte**, and finally cooking in a mixture of water and milk. The resulting **bouillie**, locally **pilaïe** (a kind of porridge), was sold to onlookers.

Of course, all this was not exactly as it was in older times. The standing crop of millet had received a dose of herbicide to make it the proper yellowish colour one month before maturity; for in September, the normal time when millet ripens, the tourists would be gone. And the **pilaïe** was in fact prepared not with the grains just harvested, but with millet imported from overseas (Colorado and Argentina were mentioned) and husked and cleaned beforehand in a nearby industrial mill, the only one processing millet in France. It was not an attempt to cheat, however. These adaptations to changed times were necessary to make the show possible. And if the show was indeed a show, there was an incontrovertible authenticity to it, because the tasks were performed in the only way people knew how to perform them, i.e. as they were performed in the 1950s and early 1960s, just before millet cultivation was abandoned.

The main reason why I was so excited by the **Fête du Millet** was that it featured, right in the middle of a typically French village, techniques of grain processing that, if observed out of context, would undoubtedly have been described as typically African or Asian. Of course, any such exotic influence was out of the question. And so was any argument of backwardness, for as far as grain-mills are concerned, the region was neither especially advanced nor backward. Water- and windmills had developed there in the early Middle Ages like everywhere else in western Europe, and people had long been in the habit of carrying their

breadgrains to the mill to have it ground into flour every other week or so. Still, those people perfectly acquainted with mills for centuries stuck to the pestle and mortar for the husking of millet.

There are a number of possible explanations. Millet was grown in comparatively small quantities and was preferred by the poor because its cultivation required more manpower and less capital than bread cereals. In addition, husked millet does not keep well, so that the husking cannot be done in advance in large quantities as with the grinding of breadgrain into flour (good and well-cleaned flour can be stored from a few weeks to a few months, according to the quality of the grain, the weather, etc.). All these explanations are valid, and others may be valid too, but it is not my intention to discuss them here. What I found fascinating in the Aizenay show was that it looked like a kind of thought-experiment, as they say in physics. Just imagine that for some reason, millet and not bread cereals had become the staple food of Europe for the two last millennia. What would the development of mills have been like? And what of the development of industry, so dependent on the mill's waterwheel for power until well into the nineteenth century? The whole history of Europe would obviously have been different. Just replace wheat and rye with millet, and Europe is not Europe any more.

As far as Europe is concerned, this is a historical fiction of course. Things did not happen this way. But something of the sort did happen in China, since millets and rice have been the staple cereals there for millennia. Indeed, the development of mills and of machinery and of many other things has been very different in China from the West. Joseph Needham was perhaps not the first to ask why this was so, but he was certainly the first to address that question seriously and to devote his entire life to trying to answer it. I have a boundless admiration for the works of J. Needham and his followers [e.g. Needham and Wang Ling 1965]. I must confess, however, that I have never found their answers quite satisfying. Perhaps the Needham Question is simply too global to be really answerable. Since it is by no means futile or meaningless, however, we ought to be able to transform it or split it up into smaller, more manageable, questions. The **Fête du Millet** was for me a live demonstration of what one of these manageable questions could be. If we follow up through time and space the techniques of grain processing for each cereal, including mechanics and biochemistry, what do we get?

Hulled Grains and the Winnowing Machine

It is well known that a first generation of machinery made its appearance toward the beginning of our era both in the West and in China. One of these machines was the rotating mill, an extremely important innovation, since it made possible the harnessing, first of animals, then of water-power, in grinding grain. The first evidence for watermills in the West dates back from the last half-century before the Christian era, and the first evidence for the adaptation of the waterwheel to industries other than milling dates from the tenth and eleventh centuries. For nearly one millennium afterward, the water-wheel was to prove an increasingly important source of power for all European industry. This development did not occur on the same scale in China, one possible reason being that the husked grains of rice and millet do not keep well. The consequences are that the husking has to be done day in, day out, using small quantities at a time, and so the processing of millets and rice tends to be more firmly retained inside the household, which clearly is an obstacle to the development of larger machinery.

But if the use of husked grains tends to limit the development of mills, it tends to enhance the development of another machine, namely the winnowing machine. This is at least one possible explanation of the fact that the winnowing machine, although used in China from the Han dynasty (2nd century BC to 2nd century AD), was not known in the West before the first years of the seventeenth century. For contrary to what occurs with wheat and other free-threshing cereals, for which winnowings are done only between threshing and milling to clean the grain in bulk, the processing of paddy and other hulled grains requires a number of winnowings, not only after threshing, but also after each of the several poundings or millings deemed necessary to get a thoroughly husked and cleaned grain.

As a problem in the development of machinery, the history of the winnowing machine is both important and ancient. It is important because in the West, the winnowing machine was the first agricultural machine proper to be invented after the water-mill itself, although much later. It thus opened the way for the development of modern agricultural machinery: the Scotsman Andrew Meikle, who designed the first successful threshing

machine in 1785, was the son of a millwright who had been the first maker of winnowing machines in Britain around 1710. And the problem is ancient because as early as the 1780s, the origins of the winnowing machine has already become a mystery. One of the few things known with any certainty was that it had come to Britain from the Netherlands. But beyond this, people could only speculate, and one of their first preferred speculations was that the machine was borrowed from the East Indies.

This mystery has now been largely solved. A German linguist, Uwe Meiners [1983], has shown that there were at least two different types of early winnowing machines in Europe, appearing in two different places: the Netherlands, where a first patent for it was obtained in 1604, and Switzerland, where the machine was in common use among peasants in the canton of Zurich by 1664 and may have been listed in a German-Latin dictionary of 1592. There is no hard evidence for whether the Swiss and Dutch machines were invented independently or not. But the chronology, together with the fact that the early Swiss and Dutch models did not resemble either each other or Chinese machines, are strong arguments against the Far Eastern theory. On the other hand, no evidence has been found that Europeans became acquainted with the Chinese winnowing machine before the 1730s, a time when European models had begun to be actively extended throughout the continent. What made a Far Eastern theory so attractive in the 1780s was probably that engineers and scientists only became aware of the winnowing machine over a century after it had first been put to use among craftsmen and peasants. It was not referred to in the literature before 1709 and 1717, which suggested an introduction not much earlier that 1700 and made a direct borrowing from China quite plausible. It remained plausible until the publication of Meiners' book in 1983.[2]

Thus, I believe that China and the West developed a first set of winnowing machines at approximately the same time, toward the beginning of the Christian era, because their economic and cultural conditions were then similar. But these machines were different because of different crops, food habits, and so on. With an economy based on hulled grains (millets, rice and barley, requiring more and more frequent winnowings), the Chinese had every incentive to contrive a machine for winnowing, which was not very difficult to achieve, either by Chinese or by Roman

engineering standards. On the other hand, with an economy where wheat and bread became more and more dominant, the Greeks and Romans were interested in other machines, especially the flour-mill; they also made significant innovations in oven-building, for instance. By the sixteenth century, however, the situation was changing fast. Wheat bread was then firmly established as the food of the rich in most of Europe and as the food of most townspeople, including workers, in countries like France and England. In many countries, however, the peasants and the urban poor had increasingly to content themselves with less expensive staples: rye, barley, oats, millets, chestnuts, buckwheat, to which were later added maize, and later still potatoes. Some areas remained comparatively untouched by this change, as for example German-speaking Switzerland and the neighbouring region of Germany, where spelt, an ancient cultivar of hulled wheat, remained the main food cereal. There is now some pretty good evidence that in Switzerland and in southwest Germany, winnowing machines were used mainly for cleaning spelt after husking in the mill, whereas in the Netherlands, they were used mainly for cleaning buckwheat and pearl-barley. Thus in early modern Europe as in ancient China, there is little doubt that the winnowing machine was a specific invention answering the specific needs of processing hulled grains.

In technology as in other fields of anthropology, I do not believe in one-sided explanations, and I am not trying to propose one here. I am not trying to say that hulled grains 'explain' the invention of the winnowing machine: that would obviously be absurd, if only because hulled grains were the main crop in numerous countries where nothing of the sort ever happened. As is the case with every invention, a host of factors were involved. Hulled grains were only one among many, but they *were* one factor, and it is by no means absurd to say that without hulled grains the winnowing machine would not have been invented, at least not when and where it was. Neither would the threshing or harvesting machines, since the way for each invention was cleared by the preceding one. In this sense, the fact that grains are hulled or naked is a factor without which the history of machinery and of industry cannot be fully understood. What I want to emphasise here is (1) that it is an environmental factor, even if not usually recognized as such, and (2) that technological studies were the only means of identifying it.

Grinding Stones and Wooden Mortars

There is of course much more to say on grains than whether they are hulled or not, and hulledness itself is not that simple: it is not physically the same in barley and spelt, in emmer and rice, in oats and buckwheat, and in the score of different cereal species put together under the name of 'millets'. But to say anything more would be beyond the scope of this chapter. I now want to address another question: the relations, if any, between the morphology of the 'primitive' tools used for husking or crushing grains, and the techniques of grain-processing.

Here is a paradox. In most villages of tropical Africa, the sound and sight of women pounding grain is ubiquitous; and it is or was much the same in most tropical countries. Still we have very few studies on what happens in and around the mortars. It is as if grain-processing was so self-evident a part of the daily routine that nobody ever thought it worthwhile to have a closer look. The same neglect seems to have long prevailed among archaeologists. In the 1930s Cecil Curwen had already denounced our 'blissful ignorance' of the subject; according to Kraybill [1978: 511] things had not changed much by the 1970s. They have begun to improve since as far as archaeologists are concerned; the work of Gordon Hillman [1984a, 1984b] in Turkey is one of the best examples. But among students of recent societies, mainly anthropologists, historians and geographers, the change remains timid. Comparative studies are rare and have not been really followed up.[3]

Emil Meynen was probably the first, in 1927, to notice that the wooden mortar was not universal. According to him, it was absent from the whole of Australia, from the southern tip of South America and from the highlands extending from the Andes to New Mexico. California should probably be added to the list, since, according to Carter [1978], 'The metate is known to have preceded the mortar in much of California [. . . .]. The data suggest an introduction of the mortar somewhere near central California and its slow gain of dominance over the metate in adjacent areas'. In Africa the wooden mortar may not have been as ubiquitous once as it seems today. In Nubia and northern Sudan for example, the traveller F. Caillaud [1826] noticed only grindstones in the 1820s, although the main cereal processed was

durrah (sorghum). And following hints obtained from students or colleagues, it is a question whether the wooden mortar did not arrive in some areas of the Western Sahel only after the colonial period.

By itself, the geography of the wooden mortar may seem an obsolete way of doing research; but as a way of finding out meaningful differences and changes it is not. Anyway, the field is so vast and our ignorance so deep that I cannot see why any means of posing useful questions should be scorned. The absence of the wooden mortar may be a matter of materials, for example. It seems to have been the case in Australia and California, where mortars and 'anvils' of stone were in common use, as well as 'pounding pits' hollowed out of the solid rock, or any conveniently hard surface on which it suffices to put some bottomless container for pounding something therein. The absence of wood may thus refer to a lack of the necessary wood-working techniques. It may also refer to the utilization of space, especially in Australia. Australian aborigines did not ordinarily carry with them heavy utensils like grindstones or mortars but used to leave them near the main food-gathering places where they returned season after season and where they expected to find them again, ready for use. It can easily be imagined that this would not have been possible with wooden utensils because they would not have long resisted the effects of weathering and insects.[4]

In other regions, the absence of wooden mortars suggests quite different explanations. In the Central American highlands, for example, there was a quite specific method of maize processing called 'nixtamalization'. Details differ somewhat, but one of the main features of the process was to soak the grains for one hour or so in a mixture of nearly boiling water mixed with lime or ashes. The whole was then left to cool for some hours (typically over night), after which a simple washing in cold water was enough to separate the grains from their envelopes. The cleaned wet grains were then ground on the **metate** (saddle-quern) with the **mano** (upper grindstone) into a kind of paste, to be cooked afterwards as tortillas on a hot plate. Nixtamalization has remarkable nutritional properties [Katz et al. 1974; Muchnik 1981]. Tortillas have for a long time been the preferred food of the Mexican peasants, who have always insisted that they must be eaten freshly made. This has made the whole process very

difficult to change and especially to mechanize [Bauer 1990]. The two points to be made here are (1) that while **metates** may be similar to Old World saddle-querns morphologically, they are very different functionally; and (2) that wooden mortars are completely out of context with such a method of grain-processing.

Or are they? I have been informed of another method used in Venezuela. Maize grains are soaked in hot water, ground wet into paste and cooked into tortillas as in Mexico. The difference is that no lime or ashes are added to the hot water, so that the grains have to be cleaned of their husks and germs by pounding in a wooden mortar before soaking.

Other factors may also be relevant. In California, the saddle-quern is said to have been used to grind grass-seeds only, whereas acorns, the other staple food of the area, were pounded [Testart 1982: 95–6]. But in France, the recently excavated chalcolithic village of Boussargues (Hérault) has yielded a number of saddle-querns for which no evidence of use could be found other than for the grinding of acorns [Colomer et al. 1990]. Although acorns have been more important for human food (and until quite recently) than is generally realized, including in Europe, acorn-processing techniques have rarely been described and our information about them is poor. However, what we do know is enough to remind us that grindstones and mortars have been used for many other purposes than merely processing grain. In West Africa especially, the prevalence of the wooden mortar may be due to its plurifunctionality. It is everywhere used for husking and breaking grains into grits or flour. But it is also often used with small quantities to separate the grains from the ears instead of threshing. And chiefly, the wooden mortar is also currently used in the processing of yams, bananas, etc. In the southern Ivory Coast, for example, they are prepared into a kind of hard mash called **foutou** in the following way. The yams or bananas are peeled, cleaned, cut into pieces, and boiled in water. If merely crushed afterwards, one obtains a slightly fluid mash called **foufou**, which is consumed on certain occasions but is not a main dish. To obtain **foutou**, the mash has to be pounded for a fairly long time in the wooden mortar, and it hardens considerably as a result. I have no idea why pounding makes yam or banana mash harder, nor why Africans should prefer a hard mash; but this preference is a very definite fact, with consequences possibly as far-reaching as the preference of Mexican

peasants for freshly made tortillas. My point here, however, is only that the wooden mortar has probably more uses than the grindstone in West Africa, which may go some way toward explaining why it seems to have in part superseded it there.[5]

It goes without saying, but it goes better still by saying it, that our knowledge of the basic processing techniques of yams, bananas and many other starchy tubers and fruits currently used by millions of people today is hardly better than our knowledge of the processing of acorns. Perhaps because it is so open to view, that part of everyday life seems all but invisible, like *The Stolen Letter* of Edgar Allan Poe.

Threshing, Harvesting, Sowing, etc.

It is a long time since Eduard Hahn [1896] proposed a distinction between hoe agriculture (*Hackbau*) and plough agriculture (*Ackerbau*). His proposal was questionable, and it was indeed soon criticized by another German geographer, Karl Sapper [1910], who rightly pointed out that many so-called 'hoe agricultures' did not use hoes at all, but digging sticks, spades, etc. Nobody now, if asked, would explicitly endorse Hahn's theory anymore. And yet a large majority of anthropologists endorse it unwittingly when they speak of 'horticulture', not in the current sense of the term (gardening, specialized production of fruit, vegetables, etc.) but to designate agriculture without animal-drawn implements as it was or is practised in pre-contact America and in many tropical regions. Worse still, the societies concerned are often labelled 'horticultural' as others are 'hunting-gathering', 'pastoral nomadic', 'agricultural', etc., which refers to an implicit classification of societies after arbitrarily selected cultural traits.

There are a lot of reasons to contest the validity of such labelling. Mine are technological. I believe that all technical elements of a culture are relevant, so that to select one and to declare it crucially important to the exclusion of others is flawed logic. Hahn was right to decide that the plough is important; but so are the wooden mortar, the flail, the sickle. And he was wrong to ignore the fact that the hoe cannot be the basic tool of ploughless agricultures because most hoes have iron blades, or at

least iron-shod blades, so that typical 'hoe-agricultures' could not really have evolved before the coming of iron.

It is always a little unfair to criticize an author working a century ago, and I would not have done so if Hahn had not been criticized by Sapper in his own time. Moreover, I certainly do not want to hint that Hahn's work is worthless. It still makes interesting reading today. Indeed Hahn's error, to use technology before being acquainted well enough with it, can be seen as a warning for us. For technological studies look so little rewarding by themselves that many people are tempted to 'use' them in support of supposedly more interesting aims as soon as they believe it possible. I am not immune to this bias myself. But there are rules to overcome it. The rules I am trying to follow may look contradictory; they are (1) make sure you have gathered all that it is possible to know about a technique before using it for any 'theoretical' purpose, and (2) do not hesitate to multiply hypotheses, because it is the only means we have to guard against attaching too much significance to any one in particular.

Following this line, we can say today, I believe, that Hahn's geographical approach was not intrinsically bad, it was only premature and lacking in accuracy. Hahn failed to distinguish between tillage hand tools, especially those having iron parts and those not. He failed to distinguish between ploughs and ards and did not attempt to identify their functions accurately (something rarely done even today, however). And he probably did not ascribe enough importance to the use of animal power in other agricultural tasks such as threshing, transport, water-hauling, etc. In a sense, Hahn's programme was sound, but led astray by naive intuitions and insufficient scholarship. The same can be said, with qualifications, of a later American geographer, Carl O. Sauer [1952]. Here, I only want to add a few remarks to substantiate this opinion.

Maize is a good case in point. We have just seen how the food-processing techniques associated with maize could be conservative, i.e. impervious to change (nixtamalization). The same can be said of nearly all the other operations of maize-growing and processing. Thus, there is no threshing proper, but each cob is rubbed against the edge of some hard and fixed object to separate the grains. The cobs themselves are harvested one by one by hand and maize may be the sole food plant in the world for which no harvesting tool other than the bare hand was ever

developed before the corn-picker in the twentieth century. Maize-planting and weeding are also mostly done by hand using the simplest implements. The size of the plant and of the seeds make elaborated techniques of sowing and tillage both impracticable and unprofitable. With seed-yield ratios easily reaching 200:1 and more, there is little incentive to go beyond dibbling, which does not require more than a pointed stick. And except where irrigation is practised, dibbling only requires a minimum of tillage. It has often been remarked that maize is one of those plants whose morphology has been most transformed by artificial selection. It can also be said, I believe, that until very recent times maize has been the most adverse to the development of new tools and mechanical devices. The domestication of maize in the New World is much less ancient than the domestication of Old World cereals (except rye and oats probably). But I do not think the difference is enough to account for the fact that the tool-kit of the maize growers was always so limited and changed so little. This cannot have been without consequences for the evolution of Amerindian societies.

A corroboration of this can very probably be seen in the absence of the ard and plough in Sub-Saharan Africa. This absence has long puzzled scholars, who proposed a number of not very convincing explanations, including a cultural 'refusal' to adopt ploughs, more mysterious than the fact itself. I think that the real explanation may be, quite simply, that the main cereals of Sub-Saharan Africa are bulrush millet and sorghum, two plants which, like maize, are large, give high seed-yield ratios and are most usually dibbled. Ards are indeed irrelevant in agricultures based on dibbling. Ethiopia is a nice counter-example, because small-sized cereals are grown there where the ard is in use (barley, emmer, teff, etc.). And there is also the much more recent but paradoxically little-known example of colonial French Guinea. Contrary to what happened in most other parts of tropical Africa, the plough, when first introduced there in the early 1920s, met with immediate success. Later events (the 1929 recession, World War Two, and administrative nonsense there-after) reduced this success to little. But for a time, at least, success was real, although in one region only, the Central Guinean plateau. The reasons were (1) a pretty regular and moist climate, without too severe a dry season, (2) a large deforested area with grass cover, (3) a relative plenty of cattle, and (4) main crop rice,

not sorghum, bulrush millet, yams or bananas.[6]

I am pretty sure that owing to the diversity of the practices still to be observed there, Africa can give us a large number of similar examples as soon as we are prepared to conduct some serious investigations. One such example concerns the sickle. I have no Hahn-like theory based on the sickle, although it would not be more improbable than the original. The sickle proper is rare in tropical Africa, and even rarer is its use in the harvesting of cereals. Its main use is in the harvesting of straw, so extensively used in the Sahel in housing and furniture. But this straw is harvested in the bush from wild Gramineae such as *Andropogon gayanus*. Now, if looked at in comparative perspective, it is by no means obvious that the sickle should be the most ancient and the most general of harvesting tools, as archaeologists usually assume. There are, in fact, a number of simple and efficient techniques requiring no sickle, indeed no cutting implement at all, for harvesting grains – but grains only, not the straw, and this is probably the nub. When people do not have much use for straw they do not need sickles. When they do need straw (or grass) but obtain it from wild plants, they use sickles, but not in the harvesting of grain, and so the sickle does not become especially important. Only when straw is needed *and* obtained from the same plants as grain does the sickle become of primary importance. This is probably what happened very early in the Near East with cereals like barley, emmer and wheat, and much later in the Far East with rice. These may rightly be called **céréales à paille** ('straw cereals') according to the current French usage. Large-size cereals like maize, sorghum, bulrush millet, etc., give no 'straw' in the technical sense of the term, and so sickle-like implements never developed with them.

My last example will take us back to Europe. It concerns harrows. Harrows, like sickles or wooden mortars, are usually looked upon as too common or simple to be of interest. But harrows in non-Mediterranean Europe have something quite specific about them: they are used to bury the seeds after broadcast sowing. This is not the case in the Mediterranean and in western Asia, where the seeds are commonly buried with an ard; elsewhere, it is infrequent too, if only because broadcast sowing is not the dominant mode of sowing.

To my knowledge, harrowing in the seed is a comparatively late innovation. It is only mentioned by Plinius the Elder in the

first century AD, not by earlier Roman agricultural writers, and the first archaeological evidence for modern harrows in that sense dates from the third or fourth century AD. The reasons why harrowing in the seed developed and eventually supplanted their ploughing under are not quite clear to me, and anyway it would be impossible to discuss them here. But there can be little doubt either about the fact or about its importance. The point I want to make is that the practice of harrowing in the seed led to the use of horses, and especially of large horses, in agriculture.

There are in the world a number of cases where horses, donkeys, mules or camels were used to draw ards and carts instead of oxen. These cases are rather scattered and did not lead, to my knowledge, to any significant technical change. One gets the impression that in the absence of oxen, any other animals could do as a second choice, but it did not make much difference. In northern Europe too by, say the early Middle Ages, the oxen were the preferred plough-drawing animals; horses were only used for the saddle and the pack, and also for drawing carts where there were passable roads. So there developed a situation where farmers, at least well-to-do farmers, had two sets of animals: oxen for the plough, and horses for transport.

There was no reason why this situation should not have lasted indefinitely. Indeed, in many areas it lasted until the nineteenth century, and for good reasons. Only oxen were bred to make powerful draught animals. Horses were too small to be of real use for the plough; their use in ploughing was infrequent and usually a consequence of impoverishment. There was one agricultural operation, however, where horses were better than oxen because they were more rapid: harrowing. Medieval miniatures quite often show ploughs drawn by a team of oxen, whereas harrows are drawn by one horse, often mounted by its driver, in the same field where the seed is being scattered broadcast by another worker. As I see it, the use of horses in harrowing tilted the balance. It created conditions under which the two sets of animals, horses for transport and oxen for fieldwork, could begin to be mixed up. With horses increasingly being used in the field, a demand for heavier animals arose, until it was realized that oxen could be entirely dispensed with. In the more advanced regions of northwest Europe, i.e. northwest Germany, the Netherlands, northern France and southeast England, the replacement of oxen by horses was completed by the early

seventeenth century, if not earlier; in backward regions like Scotland, it did not begin before the second half of the eighteenth century. My contention is that without the practice of harrowing in broadcast seed, this process would not have taken place, or at least not where and when it did.[7]

Conclusion: Technology, Environment and the Concept of Affordance

Is grain to be husked before being pounded into grits or milled into flour? How many winnowings does it take to clean it thoroughly? How well do grits and flour keep in storage? What difference does it make to add lime or ashes to the hot water for soaking maize as far as the adherence of the envelope to endosperm is considered? What happens to banana or yam mash when it is pounded vigorously for half an hour? How exactly can acorns be made edible? Which species of oaks yield tannin-free acorns? What is the size of the seeds of this or that cereal crop, to what depth must they be planted, how much do they yield when they are dibbled, drilled or sown broadcast? Of what speed are horses and oxen capable, and for how long?

This list of odd questions could be made much longer. It is in fact interminable. For what it is, however, this one gives a pretty good idea of what 'environment' is from a technological point of view. Environment is an interminable list of unanswered (and sometimes unanswerable) questions.

This is nothing new. Everybody knows that the concept of environment has no content itself, it can only be given one by reference to the thing or things environed. However, if everybody pays lip service to this truism, most environmental studies tend to ignore it, either because environment is confused with nature, or because the mere fact of focusing one's attention on the environment is already a first step toward reifying it. I feel quite at ease with the natural sciences, in so far of course as I am able to understand what is going on. I often feel ill at ease with environmental studies because I usually cannot find answers to my odd questions among the numberless data they accumulate. It is only when we know something precise about how a society works that we can ask relevant questions about its environment.

So any environmental study that does not begin by looking for relevant questions within society itself runs the risk of being futile.

The idea of relevance is therefore crucial, and it certainly has to be included in the concept of environment if the latter is to make any sense. This is why I welcomed with enthusiasm the concept of 'affordance', of which I was made aware by Ad Smitsman quite recently.[8]

As a matter of fact, the concept of affordance was developed in psychology about fifteen years ago. Affordances are defined as 'environmental resources for behaviour': a flat and smooth surface of ice 'affords' physical opportunities that are put to use by a skater; air 'affords' properties that will be exploited by a young bird as soon as its wings reach a sufficient size; the earth affords us all a surface on which we can walk or run, etc. I cannot develop the implications of the concept further here, if only because it is still too fresh knowledge to me. Of course, this concept belongs to psychology and refers to the behaviour of individuals, whereas my interest is with techniques as social facts. But I think it is not a real obstacle. There is nothing in the concept of affordance that prevents it being adapted to the use of anthropologists. And if it is only a word, it is a very useful one. The fact that wheat and rice produce both edible grains and usable straw, whereas reeds and rushes produce only usable straw, and maize or sorghum only edible grains, points to different affordances, with which different cultural traditions have evolved. To be able to give them a name is something.

Notes

1. Aizenay is a large village or small town of the département of Vendée (western France), situated 90 km due south of Nantes. On the growing and uses of millet in the Vendée see Hongrois [1991]. See also Hörandner [1995].
2. I have presented elsewhere evidence for the early history of winnowing machines and its relevance for the history of mechanization [Sigaut 1989a, 1989b].
3. I do not want to suggest that the immense literature on the history, prehistory and ethnology of grain-processing tech-

niques is worthless: quite the contrary. But this literature is so heterogeneous and scattered that it can hardly be taken as a corpus of usable data. The only partial but true attempts at a synthesis I know of are the antiquated papers of Meringer [1909] and Meynen [1927] in an ethnogeographical perspective, and those of Carter [1978] and Kraybill [1978] in an archaeological perspective, to which must be added an interesting if not quite successful attempt at classifying grain-milling devices by Anderson [1938]. With two colleagues at the EHESS, Rolande Bonnain and Françoise Sabban, we have set up a seminar on the food uses of cereals and other starchy plants in order to explore the possibility of a meaningful synthesis.

4. For data on Australia and California, I have relied mainly on Carter [1978], Hamilton [1980], Heizer and Elsasser [1980: 91–101, 114–16] and Testart [1982: 95–7].
5. On acorns in the western Mediterranean, the main recent paper is by Lewthwaite [1982]. My information on West Africa comes from a number of sources, of which the most informative have been a mimeographed study by Chateau [1973] and an African student at the EHESS, O. Gnabro.
6. This is a very short summary of an argument that I have presented with some more substance elsewhere [Sigaut 1985, 1989c]. The 'refusal' theory is more often implied than stated, but it has been stated at least once [Paulme 1961: 122]. Ethiopia is one of the few regions of Africa where the geography of agricultural implements has been extensively studied; see e.g. Alkämper [1971] or Westphal [1975] for the literature. For the history of the plough in French Guinea in colonial times, see Bigot [1989].
7. On the relation between sowing techniques on the one hand and the uses of ards, ploughs and harrows on the other, see Sigaut [1988]. On the relation between harrowing in the seed and the replacement of oxen by horses in agriculture, see Sigaut [1982].
8. The concept of affordance was proposed by Gibson [1979]. See also Smitsman et al. [1987].

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