n° 5-1

HARVEST TECHNIQUES, IN CHINA AND ELSEWHERE

François Sigaut
Ecole des Hautes Etudes en Sciences Sociales, Paris

When I proposed as the title of this communication, "Harvest and post-harvest techniques in China after European sources", I was rather overconfident. I had in mind works such as Stenz's, Wagner's or Hommel's, in which harvesting practices are described, if not with all the particulars one would wish perhaps, at least with more detail than the usual and cursory remark that "when the grain is ripe, people cut it with sickles" — period. In fact, I had to realize that searching the European literature for information on harvest and post-harvest techniques in China would require the careful sifting out of hundreds of titles and thousands of pages. Without some guidelines on where to look and what to expect, the enterprise was just silly, which probably explains why nobody seems to have tried it as yet. After some thinking however, I came to the conclusion that two things could be useful. First, have a look at what interested Europeans authors in Chinese agricultural techniques, and why. And second, try to draw a blueprint of what could be a real fieldwork investigation of Chinese harvesting practices in the light of our present knowledge of harvesting in general. Those are the two tasks I put to myself in this paper.

*

By what were European writers interested in Chinese agriculture ?

That is still a very large question, which would require different answers for different periods of time. Most of the evidence has already been gathered by A.-J. Bourde (1967: 440-444), and of course by F. Bray (1984). I shall mention four examples only, because I happened to study them for reasons pertaining to European agricultural history. All are from the 18th century, and can be considered as classic. They are, (1) the seed drill, (2) the dibbling of wheat, (3) the winnowing machine, and (4) the étuves for drying grain in storage.

Let us first consider the seed drill and the winnowing-fan. It has been repeatedly hypothesized that both machines have been brought over from China by European travellers somewhere in the 17th or early 18th century. Indeed, F. Bray has spent a good deal of space discussing this possibility. On the basis of the evidence at her disposal, she rejected it for the drill, and cautiously accepted it for the winnowing-fan. But as she rightly emphasizes, no Chinese machine was ever copied for direct and immediate use in the West. Rather, Chinese contrivances were used as pieces of evidence, as it where : they were fed into a process of thinking and experimenting that had started before and was to continue afterward.

I believe we can go a little further and say that, in fact, Europeans were quite selective in their search for information. They looked for things which had a precise relevance to what they were doing at home. The example of the seed drill is very clear on this respect. We cannot altogether dismiss the possibi-

lity of earlier reports, but the first account of a Chinese drill we know of in the West appeared in 1752, in the Suite des Expériences et réflexions relatives au Traité de la culture des terres..., by H.-L. Duhamel du Monceau (1752: 133-144). Now, Duhamel was precisely busy developing new models of seed drills, after the one invented by Jethro Tull about fifty years earlier.

Until ten years ago, the example of the winnowing-fan could be seen to point out to different conclusions. It was due to insufficient evidence only. This machine is first described in European scientific journals in the 1710s, and reports on Chinese winnowing-fans appear in the 1720s, which made a direct borrowing from China quite plausible. Such was still the state of things in 1984, when F. Bray's book was published. Owing to the work of Uwe Meiners (1983), we have now a quite different chronology. Winnowing-fans were in common use among Swiss peasants in the 1650s, and a patent for a mechanical fan was granted in Amsterdam as early as 1604. This obviously rules out any direct borrowing from China. From the point of view of European history, the real question is to understand why the new machine only surfaced in the literature after more than one century of existence.

Whatever it may be, the pattern is remarkably similar in both cases. Europeans showed interest in Chinese machines once they had invented similar machines at home, and when they were actively engaged in the process of developing them and extending their use.

The promoters of the seed drill in Europe had several purposes in mind. But one of them, the saving of seed, was more

important, and more durably important, than the others. Broadcast sowing required something in the order of 150 to 200 kg/ha of seed, more or less, that is up to one fourth, and even one third, of the expected crop. Any proposition to save a part of it was therefore immediately attractive. Until the 1780s, however, the drill was not widely adopted, even in England. We have no really solid explanation for it, although a number of quite plausible reasons have been proposed. Perhaps the drill ceased to be seen as primarily a means to save seed (modern seed rates are not very different of traditional, broadcast rates). Anyhow, another technique became suddenly fashionable in the late 1780s, that of dibbling the seed.

On the face of it, dibbling looks, and probably is, the most primitive sowing technique. It is to be found sporadically about everywhere. In Europe, it had always been used for large-seeded plants sown in comparatively small plots, like peas and beans. For some reason, the technique was used for wheat from the late 16th century on in an area lying astride the border between Norfolk and Suffolk. There it was observed and described by Arthur Young and his arch-rival William Marshall, who even attempted to calculate the point at which the practice began or ceased to be profitable according to the relative levels of wages and grain prices. (Identical calculations were attempted in France independently a few years later.) The information soon crossed the Channel, with the prestige of everything English, under the patronage of none the less than the duc de La Rochefoucault-Liancourt, who had it experimented at home. The year was 1793 : those were not good times in France for quiet

agronomical research. However, the storm was comparatively short. Other experimenters again set out to work in the late 1790s and early 1800s, and it is hardly an exaggeration to say that then, the dibbling or plantage of wheat (as they said in French) was among the fashionable subjects to discuss, both in England and in France.[1]

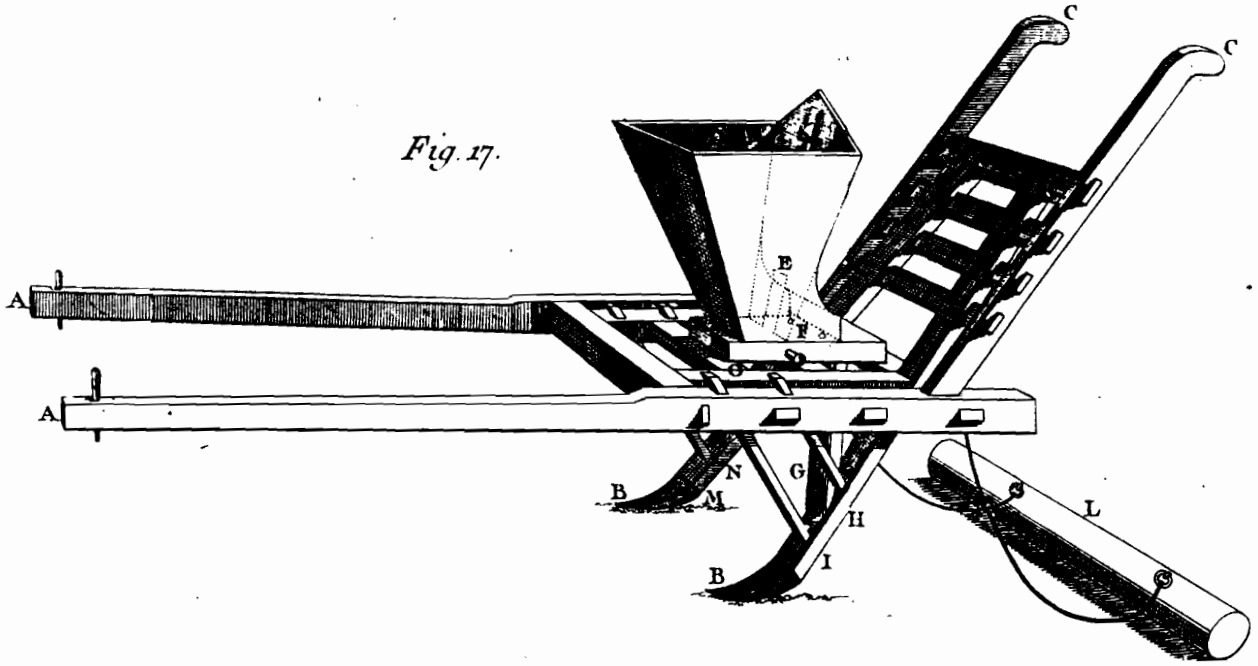
It is no surprise, then, to find the matter coming out under the pen of one of the participants of Macartney's embassy in China. The year was, again, 1793, and the relevant passage is the following (I am quoting it from a French edition I happen to own) :

> Les Anglais aperçurent près de San-Chou les premiers champs de froment qu'ils eussent vus depuis leur séjour en Chine. La terre était aride; cependant le blé croissait très bien, et avait déjà deux pouces de hauteur. Il était semé dans des espèces de rigoles faites par le plantoir, méthode que depuis peu on a essayé dans quelques comtés de l'Angleterre. Les Chinois pratiquent fort peu le procédé qui consiste à éparpiller au hasard les semailles; ils ont trouvé qu'il faisait perdre beaucoup de grain, et que la récolte n'était pas aussi avantageuse [...] Ce sont les femmes et les enfants qui font cette plantation. Une des personnes de l'ambassade calcula que ce qu'on épargnait en Chine, en se servant du plantoir, suffirait pour nourrir tous les sujets de la Grande-Bretagne en Europe. (Voyage en Chine et en Tartarie, ch. 15, in Smith s.d., vol. XI: 112.)

There is probably a translator's mistake, since the French term plantoir means "dibble", whereas the English author certainly referred to a seed drill. But this mistake itself is significant. It shows that the author and the translator were both thoroughly acquainted with the current discussion in the West on sowing techniques, a matter that nobody today except practical

Page 190

Fig. 17.



farmers would dare to mention in any occasion.

I shall not go any further. But the story does not end there. In a book published in 1929, P. Diffloth refers to a "Chinese" system, said to have originated in Manchouria, which was then actively extended by Russian agronomists. The logic was the same, by and large, than that of the drill : sowing less, spacing the plants more and cultivating them in order to enhance the size and yield of each individual plant, all this requiring a whole new set of machines. Diffloth had reservations on such methods, at least in French conditions. I do not know anything more on it. This is a theme for further research.

Finally, a few words on the étuves for the drying of grain before storage. Grain storage is a matter which reached first rank importance in France in the second half of the 18th century. The same Duhamel du Monceau we have met in connection with the seed drill is also the author of a Traité de la conservation des grains (1753), where he developed a whole new system based on the drying of grain in heated rooms, étuves, and its subsequent confinement in closed containers equipped with bellows for artificial aeration. Soon, the technicalities of grain storage and étuvage became as fashionable, and rather more, than those of wheat drilling or dibbling. As we can expect it by now, Chinese evidence was not long in being called up. "Sur la conservation des grains à la Chine", a lengthy "Mémoire envoyé de Peking" with the date of september 30, 1768, was published in E. Beguillet's Traité de la connoissance générale des grains [...] (vol. 2: 534-674) in 1775. In the main, it was a summary of the Shoushi tongkao (Will & Bin Wong 1991: 106).

But there is an interesting post-scriptum, beginning as follows :

> P.S. Les étuves qu'a imaginées M. du Hamel pour faire secher les bleds, nous ont fait ouvrir les yeux sur les kangs Chinois, & sur l'usage qu'on en pourroit faire en France pour cela; plus nous les avons examinés, apres cette premiere idée, plus il nous a paru que ce seroit rendre service à notre Patrie de les lui faire connoître.

The description that follows does not concern us here. (I shall only add that the kangs were not meant for the drying of grain.) What I find important here is an author acknowledging that questions coming from France "made him open his eyes" on Chinese realities. This is exactly the point I have tried to make all along.

*

A comparative analysis of harvesting techniques

Unfortunately for us, there was next to no question coming from the West regarding harvesting practices. Contriving a reaping machine was not seriously attempted before the 1790s, and there was nothing in China which could be of use to European inventors in their efforts. Even the traditional harvesting practices in Europe were widely disregarded. "The works of harvest having no place in the plan of the Board's Reports !!" wrote W. Marshall indignantly in his Review and abstract of the county reports to the Board of Agriculture (1818, vol. 2: 356). Finally, the broad similarity that seemed to obtain between Chinese and

Western techniques made detailed observation look pointless. The two following quotations, from Duhamel du Monceau and Ekeberg respectively, probably show the most we can expect to find in the European literature – very little indeed.

> Quand le riz est parvenu à sa maturité; ce qu'on reconnoît à sa couleur, qui devient jaune comme le blé, on le coupe avec des faucilles, on le met en gerbes, on le porte à l'aire, où on le bat avec des fléaux peu différens des nôtres, on le nettoye de sa grande paille, avec la fourche & la pelle... (Duhamel du Monceau, 1752: 140.)

> Dès que le ris commence à blanchir, signe de sa maturité, on le coupe avec des faucilles à main, dont le tranchant est dentelé comme une scie; on le lie en gerbe, & on le met dans un endroit sec & élevé, pour qu'il y sèche & qu'il y demeure jusqu'au tems qu'on le bat. [...]
>
> Leur manière de battre le bled & le ris est la même & se fait comme chez nous avec des fléaux... (Ekeberg, 1771: 16, 20.)

I do not know whether there is anything more in the European literature of the 19th century. The second period where we find something of substance is the beginning of the 20th century, with authors like G.M. Stenz (1906), F.H. King (1911) or Wilhelm Wagner (1926), to be followed by R.P. Hommel (1937).

King's contribution is still very short, however. He alludes once to the "old time sickle", not te be replaced by machines, nor even by the "cradle" (<u>faux armée</u> in French) because of the small size of the fields (p. 301). His most interesting remark is that "between Tientsin and Pekin all wheat was being pulled, the earth shaken from the roots, tied in small bundles and taken to the dwellings..." (p. 341). Wagner confirms the importance of the practice in North China, and explains it by the dearth of

fuel there. But since King adds that millet has been planted between the rows of wheat, and that soybeans would be planted soon after ~~in~~ onto them, another explanation becomes possible. Pulling up a crop with its roots is indeed an expeditious method of clearing the ground for a following crop. The practice was not absent from the West, even in the 19th century. It had already been mentioned by Plinius the Older (1st century A.D.), who reported – and questioned – this explanation : "stipulae alibi cum radice uelluntur, quique id faciunt proscindi ab se obiter agrum interpretantur, cum extrahunt sucum." (Hist. nat., XVIII, 72.)

Another interesting detail, given by Stenz (p. 857), is the practice of cutting down the very high sorghum stems with a sharp hoe before reaping the ears, which would be out of reach otherwise. Again, unsurprisingly, this practice is common troughout Africa.

The other data on harvesting techniques in our sources usually pertain to the tools, and, notwithstanding a few exceptions, not to the practices themselves. The tools thus considered are :

(1) the so-called harvesting knife, discussed at length by Francesca Bray (1984: 323-331);

(2) sickles of different sizes and shapes, reported by Wagner and Hommel;

(3) two kinds of scythes; the first, described by Wagner and Hopfen (1970: 113, 116), outwardly looks like European scythes, although its structure is quite different; it is reported from Honan (Wagner) and "Ngan-houei" ([?] Hopfen); the second, descr-

ibed by Hommel (p. 67 & fig. 105 to 107), looks like a double-cutting machete put at the end of a long handle; it is used in Chekiang for harvesting fodder

Thinking in terms of tools when attempting to describe techniques is a general but unfortunate bias of modern Europeans. As a matter of fact, any technological description should begin by the material to be processed, the results of this processing (products, by-products, refuse), its conditions (e.g. whether the field to be harvested is still under water), and of course the processing itself, to which the tool or tools used are but a part. In addition, the persons involved should be socially identified, always by gender and age, usually by rank, craft, caste, etc. From this point of view, the best approach I know of is certainly that of Liu Xianzhou, author of Ancient Chinese agricultural machines and implements (1962), of which the fifth chapter deals with harvesting implements. After the translation obligingly provided to me by G. Métailié, Liu Xianzhou distinguishes three basic modes of harvesting :

(1) selective harvesting of the ears (i.e. the ears only);

(2) harvesting the stalks with the ears (without the roots);

(3) harvesting the plant with its roots.

This a first step in the right direction. To go further, we shall have to make more precise distinctions in the kind of material to be harvested. But before that, we must be more precise also in defining the operation of harvesting itself. As we have seen with sorghum, for exemple, there are two successive operations : (1) cut down the stems to be able to reach the ears, and (2) cut the ears themselves; let us say that (1) is a prelim-

inary operation, because it prepares the operation of harvesting proper, (2), which consists in taking something away, in this case the ears. Another example, mentioned by Liu Xianzhou, relates to a certain kind of millet (sù) : the plants are (1) harvested with a sickle as usual, then (2) the ears are separated from the stalks by cutting them off with a small knife; in this case, we shall say that (1) is the harvesting proper, and (2) a subsidiary operation by which people get rid of the straw, enabling themselves to carry away the ears more quickly when they are in a hurry to protect them against the rains. R. Dumont (1935: 350-351) described the same practice in Tonkin for paddy. Both he and Liu Xianzhou state that this method is more rapid than the selective cutting of the ears with a harvesting knife.

Let us summarize. In harvesting (broad sense), we must distinguish three kind of operations :

(1) preliminary operations, such as cutting down the sorghum stems (there are other examples, such as laying down the paddy stalks in Cambodia, etc.);

(2) the operation of harvesting proper, that is, of taking away some part (or the whole) of the plant from where it has grown;

(3) subsidiary operations, such as cutting off the ears for carrying them away more quickly.

Of course, there are other operations such as tying the stalks into sheaves, carrying them away, threshing, winnowing, sieving the grain, etc. Discussing them would be beyond the scope of this paper. I shall only add that there may be several operations of harvesting proper, as many as there are "things" to be harvested.

When only the ears are harvested, for instance, the stalks left standing will often be harvested some days, or some weeks, later. In these cases, there is one harvesting operation for the ears and another for the stalks. A practice of the same kind has been common in the West from Roman times (and probably much earlier) to the 19th century. The cereal was cut in the middle of the stalk with a sickle, bound into sheaves and carried away; a few weeks later, the high stubbles left standing were harvested in their turn.

Having all this in mind, we can now consider the materials and results (products, by-products and refuse) of the harvesting process.

Defining the materials is quite simple. Any herbaceous plant with stalks, leaves and seeds is capable of being harvested as we understand it here. This makes a very broad category, encompassing all the cereals of course, but also pseudo-cereals (buckwheat, etc.), legumes, fiber plants (flax, hemp, etc.), fodder plants (except possibly tree-leaves), aquatic plants (reeds, rushes, sedges...), and even sometimes weeds. But rather than attempting an impossible enumeration, it is important to notice that any herbaceous plant can be harvested,

(a) for its seeds only or mainly,

(b) for its stalks only or mainly,

(c) for both.

Wheat, barley, rye, rice, flax, etc. are the classical examples of category (c). In the West, grasses for hay and reeds for thatch are the classical examples of category (b), but there are many more in other countries. In subsaharian Africa, the

staple cereals, sorghum and pearl millet, give no "straw" in the technological sense of the term. So, people go into the bush to harvest wild grasses they can use as "straw" for thatching their houses, for making mats and other pieces of furniture, etc. The use of Flechtpflanzen (Fesca 1890-1893, vol. 2: 547 passim) was also very developed in Japan; several species such as Juncus effusus L. or Cyperus rotundus L., known only in the wild elsewhere, were grown in Japan with all the care and sophistication of industrial crops in the West.

Finally, there is category (a). Strictly speaking, only wild grasses such as Zizania aquatica L., Glyceria fluitans L., and wild species of rice are known to have been harvested for their seeds only. (But we must beware : Z. aquatica is listed among the best Flechtpflanzen in Japan by Fesca !) However, any herbaceous plant whose stalk and leaves happen to be valueless falls into this category; that makes it rather elastic. For our purpose, moreover, any plant whose stalk is usually not harvested along with the seeds technically belongs to category (a), because the techniques for harvesting the seeds will develop more or less independently of the techniques for harvesting the stalks. Such is the case of sorghum, pearl millet, and maize.

Having considered the material (any herbaceous plant) and the results of the harvesting process, there remains the process itself, i.e. the kind of action by which such or such results are obtained in each actual observed case. Discussing all the possible kinds of action would involve a presentation of all the relevant technographical evidence, which is well beyond the scope of this paper. The best that I can do is to give the solut-

ion that I have found a dozen of years ago and that I have used ever since. It is a double-entry table, where the parts of the plants to be harvested are crossed with the kinds of action with which they are known to be harvested in at least one ethnographical report. This table is as follows :

IDENTIFICATION TABLE OF HARVESTING TECHNIQUES

The kind of action used to harvest it \ Part of the plant to be harvested	The Whole Plant	Seeds Spikelets	Ears Panicles	Handfuls of Stalks	Stalks
Pulling Arracher Ausreissen	1				
Picking up Ramasser Auflesen		2	2'		
Beating Battre Ausschlagen		3			
Stripping off Erusser Abstreifen		4	5		
Breaking off Briser Abbrechen			6		
Pressure cutting			7	8	
Slash cutting				8'	9

To my knowledge, all the harvesting techniques for which there is sufficient evidence available can be put into one box or another of this table. Blank boxes correspond to the absence of such evidence, either because the relevant technique or tech-

niques are not known from the ethnographic record, or because they are inherently impossible.[2]

As far as China is concerned, we have already met descriptions of techniques (1), pulling a plant with its roots, (7), cutting the ears off (e.g. with a harvesting knife), (8), reaping (with a sickle), and (9), mowing (with a scythe). Other techniques are so plausible as to be considered practically certain : (2'), gleaning, (6), breaking the ears off (a technique universally applied to maize). Others still are known to exist not far from China, (4), stripping off the grains (among some Mountaineers of Vietnam, and here and there in Indonesia), and (5), stripping off the ears (in some valley of Nepal and Bhutan, for barley and possibly wheat). Only techniques (2) and (3), usually linked with the harvest of wild grains, are not attested within the Chinese borders. It may be a matter of insufficient ethnography, or of my insufficient knowledge of it.

One last remark. The last but one column in the table reads "Handful of stalks". This is not quite coherent with the other items of the same level. But in reaping with a sickle, handfuls of stalks are exactly what is harvested in every case known to me, and I thought that this evidence should be accepted. With the other techniques, the part of the plant that is harvested can be identified in purely morphological terms. In reaping with the sickle, it cannot. To exclude the term "handful" for reasons of formal logical coherence would lead to unnecessary complications.

*

Reaping, and the sickle

It may happen that one box in the table refers to one technique only. Such is the case, more or less, with pulling the whole plant, (1) or breaking the ears off, (6). More commonly, however, one box refers to a number of cognate techniques, to which the name of lignée (lineage) comes naturally to the mind (in French at least). Such is the case of reaping with a sickle. There is not one technique of reaping but several, involving different movements and tools. An idea of this diversity is to be gained if technographic descriptions of sickle-reaping are to yield sufficient and relevant details. Due to time and space limitations, however, I shall be quite schematic on these details.

First, what characterizes sickle-reaping, as opposed to all the other harvesting techniques, is what we may call an elementary sequence of movements, running as follows :

- (B), grasp with the left hand the stalks to be cut, and
- (C), cut them with an implement whose blade is held in the right hand and moved about horizontally, between the left hand and the ground, in a direction that, relative to the body, is diagonal from front-left to rear-right.[3]

This basic two-movements sequence may be said to be the definition of sickle-reaping. But in many cases, there is a third movement taking place before, which is the gathering of the stalks to be cut with the help of the sickle itself for making it easier to grasp them with the left hand. In those cases, the elementary sequence runs as follows :

- (A) gather the stalks to be cut with the sickle,

- (B) grasp them with the left hand (as above), and
- (C) cut them.

Since those two or resp. three movements are made in very quick succession, they may be hard to detect for the untrained eye. A little attention will enable anyone to see them clearly, however. The composition of the elementary sequence is very basic, because, as I have been led to suppose, the length of the blade is related to movement (A), the gathering of the stalks, much more than to movement (C), the cutting itself. Moreover, the presence/absence of movement (A), and the length of the blade connected with it, show a surprisingly clear-cut areal distribution in Eurasia. Ignoring the exceptions for the moment, we can summarize these supposed connections as follows :

(I) two-movements elementary sequence (B + C, grasp & cut) : used with "short" (15-25 cm) and "middling" (20-35 cm) blades in Eastern Asia, from Pakistan to Japan;

(II) three-movements elementary sequence (A + B + C, gather - grasp - cut) : "long" blades (40 cm and more) used in Western Eurasia, from the Atlantic to Afghanistan.

It seems that in India at least, this schema works pretty well (see e.g. Beutler 1984). But in fact, China, Corea and Japan are a blank on the map, for we are remarkably ill informed on the exact movements used there in harvesting grain. We have data on the sickles themselves, from museum specimens, objects brought back by travellers and a number of field reports (in addition to Wagner and Hommel, Janata et al. VI, 1976, and Pauer 1976 are useful on Japan). We know therefore that Eastasian sickles are usually of the "short-bladed" variety. But we do not know exactly with what kind of movements they are used.

Among the exceptions mentioned above are two kinds of Southeast Asian sickles, the so-called "V-sickle" of North Vietnam and "S-sickle" of South Vietnam and Cambodia. Both sickles are short-bladed. But in both cases, the blade is inserted in a wooden or bamboo handle, the distal end of which is lengthened into a curved part looking somewhat like the curved blade of Western sickles and used in the same way for gathering the stalks prior to grasping them (movement A). Let us call "forehandle" this part of the Indochinese sickles. We can say that they represent an exception because, although short-bladed, they are used with the three-movement elementary sequence (II). But this exception is apparent only, because in the absence of the long blade, there is another part of the tool, the forehandle, for enabling movement A. This can be summarized as follows :

Western sickles	Long blade, used both for movements A, gathering, and C, cutting
Eastern sickles	Short blade, used for cutting (C) only; no gathering
V- and S- Indochinese sickles	Short blade, used for cutting only (C); forehandle, used for gathering (A)

This table represents, in my opinion, what is nearest to an actual proof that the length and curvature of Western sickle blades is in connection, not with the necessities of the cutting itself, but with the necessities of gathering the stalks before grasping them with the left hand.

There are of course a number of other elements to take into account for a complete analysis of the harvesting operation.

Such are, for example, the height of the cutting plane, and the way in which the cut stalks are disposed of. The height of the cutting plane can vary between 5 cm and less (as near of the ground as possible) and 60-80 cm and more (as high as possible under the ears). In the latter case, the question of what is done with the long stubbles ought always to be asked (in many parts of France, they were harvested later to be used as thatch, hence the fact that in French, chaume means both "stubble" and "thatch"). As for the disposal of the cut stalks, there seems to be two main ways to manage it. The first and most usual is the following. When his/her hand is full of cut stalks, the harvester puts down his/her handful on the ground behind him/herself, and somebody else (or the harvester him/herself, but later) will come to gather the handfuls and tie them into sheaves. The second method is more difficult and requires a pretty long time of training to be able to practice it. The harvester does not simply put down the handfuls. Instead, he ties the cut stalks in two stages as he goes, so to speak, and when he finishes a reaping sequence, he has in his left hand a sheaf considerably larger than what would have been possible with untied stalks. This sophisticated technique is as difficult to describe as to practice, and I shall not attempt to do it here. It is known to me from the Maghreb and South Italy only. I do not expect to find it anywhere in Eastern Asia, but I think useful to mention it all the same, because the possibility of other but similarly sophisticated techniques should not be excluded from there beforehand.

The last three points to be dealt with in analysing sickle-reaping are the sociology, the ergology and the yield.

By sociology, I mean here the network of relationships in which the different components of the harvesting operation are embedded. First the people themselves, of course : who does what (age, gender, social status), who owns what (the field, the crop, or rather such or such part of it), who has such or such duties and rights, etc. There is no need to elaborate this point, because it belongs to any anthropologist's basic programme anyway.

The term "ergology", on the contrary, needs a little explaining. I use it as meaning, not the study of tools and implements (Hirschberg & Janata 1980), but the study "of human activities in real life situations from the point of view of human biology and relevant areas" (Kogi 1972). Ergology understood this way does not differ from ergonomics in content, but in its aims, which are analytical and descriptive rather than practical and normative. Ergonomics belongs to the engineering sciences, ergology to anthropology.

Unfortunately, the only thing I can say on the ergology of sickle-reaping (and of harvesting in general) is that it is non-existent. We have some vague idea that the posture of the workers differs from one area to the next (standing and stooping, squatting, even sitting...). We have also some idea on the movements of the hands and arms, such as have been discussed above. A few authors have spoken of the long hours of toil, of the scorching heat of the sun made worse by the reverberation of the ground, and of the wear and tear of the hands against the

abrasive stalks and pricking awns. We hear of unquenchable thirsts and of sudden deaths caused by catching cold after an especially hard bout of work. But even that valuable literary lore has not been properly compiled. And all that does not amount to a serious knowledge of the multiple relations between work and body in sickle-reaping such as we should expect from state-of-the-art ergological research.

The question of yield, or rather of yields (there are several rates to put under this name) allows us to finish on a more optimistic note. For after the technological analysis of sickle-reaping presented above, the identification and calculation of the components of yield become comparatively easy. I do not refer here to 19th century data on the area that one worker is able to reap in a day. Although not properly compiled and criticized, those data are of some use in providing us with an order of magnitude — say, between 0.10 and 0.20 ha per day. What I have in mind here is a way to understand how the yield is connected with different details of practice, and accordingly how analysing the yield can help us understanding these differences.

We have seen that in sickle-reaping, the worker proceeds by elementary sequences of movements, "I = grasp + cut", or "II = gather + grasp + cut". Let us call "section" the result of any one sequence, i.e. the set of stalks cut at a time. Usually, the worker repeats the elementary sequence several times, until his/her left hand cannot held any more stalks. At this point, he/she has a "handful", made of a number of "sections", which he/she then puts down in order to start over again the same

process. The rates to begin with, because they are easiest to measure directly on the field, are the following :

* the number of sections in a handful, p, and
* the number of sections per unit of time, P.

Both countings can be made by the sound, since each cut (i.e. each section) makes a distinct, easily recognizable noise; only a watch is needed. However, it is advisable to count P over a pretty long period, in order to have the time spent in putting down the handfuls and the short rest going with it included in the calculation. The two other measurements to make on the field are :

* the number of stalks in a handful, N, and
* the number of stalks in a square meter, Q.

Usually, handfuls are left lying on the field as separated units long enough to make it possible to count an average number of stalks in each, and the measurement of the number of stalks per square meter does not present any difficulty, as long as the field is not ploughed again or trampled by cattle.

At this point, it is useful to calculate three intermediate rates :

* the number of stalks per section, $n = N/p$,
* the number of handfuls per square meter, $q = Q/N$, and
* the number of handfuls per unit of time, $r = P/p$.

Finally, there are two kinds of yield to calculate. First, the number of stalks cut per unit of time, R : it is the most general, because it is valid in all situations, quite independently of the distribution of the plants in space. Second, the number of square meters reaped per unit of time, S : this is the yield typically used in homogeneous fields such as have been a feature of Western landscapes for centuries — and, I

suppose, in most of China too. Now, these two yields can easily been calculated as follows :

$$* \; R = P \times n = \frac{P \times N}{p}$$

$$* \; S = q \times \frac{1}{r} = \frac{Q \times p}{N \times P}$$

Some readers may wonder what is the point of all those formulae. I do not know. The only true answer I can make is that if the point of any research was to be made before the research began, really new researches would be rare indeed. However, I can add that a comparative study of yield ratios such as the one proposed here is also a rare possibility. I do not know of so many pre-industrial techniques that can lend themselves so easily to quantitative analysis, and from this point of view, the analysis of reaping techniques could be an instructive first example. Besides, as I feel it, the real choice is the following. Either we are contented with our present state of ignorance about harvesting techniques, and nothing that has been said above is of any use, or we are not, and the comparative study of yield ratios will be done some time, if only because it is possible to do it.

There are a few reasons to believe that it may be useful, anyway. One is the problem of gender in reaping. The whole of Eurasia is divided into three kinds of areas, according as, (1) men do the reaping, (2) women do the reaping, and (3) both men and women do the reaping, working together side by side. Now, as has been seen above, two basic elements in the calculation of the yield are the section and the handful, both of which

are certainly related to the size of the hand, and especially to one of the most antique measures derived from it, the span (Fr. empan, G. Spanne, "the distance from the end of the thumb to the end of the little finger in the spread hand"). The question then is to know whether the span differs significantly in men and in women. I have not been able to find relevant data in the technical literature (e.g. Napier 1993) as yet, but this question should not be very difficult to answer, once it has been asked.

I am quite aware that the distribution of tasks between men and women is not a rigid consequence of such materialistic considerations. In Northwest India, for example, the reaping is done by men among Muslim peasants, whereas it is done by women among Hindus, exactly the same tools and techniques being used in both cases. It is an obvious example of a social pattern of work organization, the Mediterranean and Neareastern pattern, being carried elsewhere by religion. But Islam did not create the Neareastern mattern, it certainly found it already established, so that we have to look elsewhere to find more solid explanations. Elsewhere, that is among material factors and yield calculations.

Finally, a few actual figures are in order, although they are so few and far between that it is not possible to consider them as usable data. C. Beutler observed the reaping of wheat near Delhi (India) in april 1982; she found the following figures :

- number of cuts (sections) making one handful : 4 women, resp. 4 to 11, 8 to 11, 16, and 6 to 13; 1 man, 7 to 19;

- number of ears (stalks) in a handful : 2 women, resp. 75 and 70; 1 man, 118; 1 young man, 65.
- reaping time for 1 handful of 9 sections : 1 woman, 19 to 33" and 37 to 52".

In september 1956 in the parish of Kinvara (Galway, Ireland), R. Cresswell observed an old man reaping wheat; he worked on his knees, and was alone among about 300 local farmers to do it that way.

The man proceeded by "fingerfuls" : he took the first section between his thumb, index and middle finger, the second between his middle finger and his ring-finger, and the third between his ring-finger and little finger. These three "fingerfuls" (sections) made one handful, which he put down behind him. Three handfuls made one "sheave".

In the summer of 1983, a man from Setif (Algeria) accepted to make a demonstration of the reaping technique used in his native country, in a wheat field put at the disposal of fellow archaeologists in the Aisne valley, about 100 km Northeast of Paris. He first cut 3 to 5 sections which he held between his thumb and forefinger, and bound them summarily without dropping his sickle (a tour de force few of us were able to imitate). Then, he cut 2 or 3 more sections which he received between his other fingers, and bound the whole solidly into a sheaf, always without dropping his sickle. That makes a total of 5 to 8 sections per handful.

Finally, Janata et al. (1976: 33) report that in Japan, 2 to 4 or even 6 sections make one handful, which is then put down. This handful, called tabari, is a unit of measurement; 2, 3 tabari or more make one sheaf, called taba, shima or hitohaka.

A few more examples could certainly been found in the literature. But there would be no point in multiplying them, because they are too haphazard. They are good as examples, not

as data to be reliably used in yield calculations.

Collecting such reliable data cannot be left to opportunity and chance, if only because even the grasping of opportunities requires a minimum of preparation. What is needed is a real research project, around which could be gathered the people and means necessary to further field investigations with a minimum of planning and coherence. I could not see real possibilities of successfully setting up a project like that until now. But things may change, and the idea will be with us till the last person having learnt to reap grain with a sickle in his or her youth dies.

Le 4 février 1994

François Sigaut
Ecole des Hautes Etudes
en Sciences Sociales

* NOTES *

1. I have dealt in more detail with the history of the drill, of sowing techniques and of the winnowing-machine in Sigaut 1989a, 1989b and 1992.

2. On the identification of harvesting techniques and some of its consequences, see Sigaut 1978, 1985, 1989c, 1991 and 1993.

3. This description is valid for right-handed persons. In principle, nothing prevents left-handed persons to invert the role of each hand, i.e. to use their right hand for grasping and their left hand for wielding the sickle. But since harvesters rarely work alone but in teams, I am not sure that it would be either practically possible or socially acceptable. The inversion of basic movements by left-handed workers within a line of right-handeds could possibly be a cause of disorder or even danger such as not to be tolerated by the right-handed majority. Anyway, this is the obvious case with tools used with a broad, sweeping movement, like the scythe. The greater or lesser repression of left-handedness in different cultures has usually been ascribed by anthropologists to ideological factors mainly or exclusively. The examples of reaping and mowing — and many more could be found — show that technical factors may be at work too.

* BIBLIOGRAPHY *

BEGUILLET, Edme
1775 Traité de la connoissance générale des grains et de la mouture par économie. Paris, Pankoucke, 2 vol.

BEUTLER, Corinne
1984 Moissonneurs européens d'hier ? Moissonneuses indiennes d'aujourd'hui ?, Journal d'Agriculture traditionnelle et de Botanique appliquée, 31, 1-2: 33-42.

BOURDE, André J.
1967 Agronomie et agronomes en France au XVIIIe siècle. Paris, S.E.V.P.E.N., 3 vol.

BRAY, Francesca
1984 Science and Civilisation in China, Vol. 6 part II : Agriculture. Cambridge, Cambridge University Press.

DIFFLOTH, Paul
1929 Labours et assolements. Paris, J.-B. Baillière & Fils.

DUHAMEL DU MONCEAU, Henri-Louis
1752 Suite des Expériences et réflexions relatives au Traité de la culture des terres, publié en 1750. Paris, H.-L. Guérin.
1753 Traité de la conservation des grains, et en particulier du froment. Paris, H.-L. Guérin & L.-F. Delatour.

DUMONT, René
1935 La culture du riz dans le Delta du Tonkin. Paris, Société d'éditions géographiques, maritimes et coloniales.

EKEBERG, Charles-Gustave
1771 Précis historique de l'économie rurale des Chinois, présenté à l'Académie Royale des Sciences de Suède l'an 1754. Milan, Chez les frères Reycends.

FESCA, M.
1890-1893 Beiträge zur Kenntnis des japanischen Landwirtschaft. Berlin, Paul Parey, 2 vol., Atlas.

HIRSCHBERG, Walter, & JANATA, Alfred
1980 Technologie und Ergologie in der Völkerkunde. Berlin, Dietrich Reimer.

HOMMEL, Rudolf P.
1937 China at work. New York, The John Day Co.

HOPFEN, H. J.
1970 L'outillage agricole pour les régions arides et tropicales. Rome, Organisation des Nations Unies pour l'Alimentation et l'Agriculture.

JANATA, Alfred, KREINER, Josef, & PAUER, Erich
1976 Bodenbaugeräte Japans, VI : Reisernte (inekari), Erntemesser und Sichel (kama), Archiv für Völkerkunde, 30: 31-99.

KING, F. H.
1911 Farmers of Forty Centuries, or Permanent Agriculture in China, Korea and Japan. Emmaus (Pa), Rodale Press Inc.

KOGI, K.
1972 Ergological Research and the New Journal, Journal of Human Ergology, 1, 1: 1-2.

LIU Xianzhou
1962 [Histoire des inventions dans le domaine des machines agricoles en Chine ancienne], Acta Agromechanica Sinica, 5, 1, 1. [In Chinese, French transl. of Chap. 5 by G. Métailié.]

MARSHALL, William
1795 The Rural Economy of Norfolk. London, T. Cadell, 2 vol. [See vol. 2, Minute 23, pp. 35-44.]
1818 The Review and Abstract of the County Reports to the Board of Agriculture. York, Thomas Wilson & Sons, 5 vol. [See vol. 4 p. 356.]

MEINERS, Uwe
1983 Die Kornfege in Mitteleuropa. Münster, F. Coppenrath.

NAPIER, John
1993 Hands. Princeton, Princeton University Press.

PAUER, Erich
1976 Aso, Vergangenheit und Gegenwart eines ländlichen Raumes in Südjapan; II, Der landwirtschaftliche Gerätebestand des Aso-Gebietes. Vienna, Institut für Japanologie.

SIGAUT, François
1978 Identification des techniques de récolte des graines alimentaires, Journal d'Agriculture traditionnelle et de Botanique appliquée, 25, 3: 145-161.
1985 Moisson et fenaison, Nouvelles de l'Archéologie, 19: 28-38.
1989a La Chine, l'Europe et les techniques agricoles, Annales E.S.C., 44, 1: 207-216.
1989b La naissance du machinisme agricole moderne, Anthropologie et Sociétés, 13, 2: 79-102.
1989c Ernte und Erntegeräte, in H. Beck et al. (eds.), Reallexikon der Germanischen Altertumskunde, vol. 7, pp. 518-527.
1991 Les techniques de récolte des grains : identification, localisation, problèmes d'interprétation, in M.-C. Cauvin (ed.), Rites et rythmes agraires, Lyon, Maison de l'Orient, & Paris, de Boccard, pp. 31-43.
1992 Rendements, semis et fertilité : signification analytique des rendements, in P. Anderson (ed.), Préhistoire de l'agriculture, Nouvelles approches expérimentales et ethnographiques, Paris, C.N.R.S., pp. 395-403.

SIGAUT, François
1993 Moissons sans faucilles en Europe, in H. Cheape (ed.), Tools and Traditions, Studies in European Ethnology presented to Alexander Fenton. Edinburgh, National Museums of Scotland.

SMITH, William
S.d. Voyage en Chine et en Tartarie, par Lord Macartney, Ambassadeur du roi d'Angleterre, in Voyages autour du monde [...] depuis Christophe Colomb jusqu'à nos jours (Nouvelle Bibliothèque des voyages), Paris, Librairie de l'Encyclopédie du XIXe siècle, vol. 11, pp. 1-160.

STENZ, G. M.
1906 Der Bauer in Shantung, Anthropos, 1: 435-452, 838-863.

WAGNER, Wilhelm
1926 Die Chinesische Landwirtschaft. Berlin, Paul Parey.

WILL, Pierre-Etienne, & BIN WONG, R.
1991 Nourish the People, The State Civilian Granary System in China, 1650-1850. Ann Arbor, The University of Michigan.