Food production and food procurement in the Bronze Age and Early Iron Age (2000-500 BC)

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10 The crops in Bronze Age and Early Iron Age: diversification?

10.1 Introduction

A crop is material culture made by people. Where a specific crop is concerned, its presence forms (by definition) the evidence of the decision made by a local farming community to cultivate (individual or combinations of) species, to introduce new species or to cease cultivating certain crop species. The present analysis of the cultivated plants from the study locations will concentrate on the presence and/or absence and the appearance and/or disappearance of various crop species. This analysis of the crop plants, actually, is a study of conscious human decision-making and reflects differing attitudes of the farmers towards food, food crops and their specific (cultivation) demands. That is: the different agricultural regimes with regard to the various crops will also be taken into account. Each species has its own specific demands with regard to soil conditions, soil working and (intensive) care during growth. The choice to grow certain crop types and to leave others aside, therefore predominantly reflects a shift in agricultural regimes.

In chapter 8, the basic data on the cultivated species of the Bronze Age and Early Iron Age locations in the two subregions, were presented. The interpretation of the evidence on crops in relation to agricultural change will be elaborated upon in this chapter. The different aspects with regard to the agricultural productive process in the Bronze Age and Early Iron Age in the Moselle region and the MDS region will be discussed. Therefore, the principal characteristics of the crops retrieved from the subregions are listed, their specific needs to (intensive) soil working and the use of manure are described, and an attempt is made to assess their relative importance in the total crop range.

Section 10.4 is dedicated to the interpretation of assemblages that consist of larger concentrations of (mixed) crops. In general, assemblages can be suitable for further analysis when they consist of a relatively large concentration of crop seeds which is (clearly) the result of one harvest. It will become clear that virtually no botanical assemblage in the present study was appropriate to such an analysis.

10.2 The range of crops

The most important questions or hypotheses brought forward which need confirmation, regarding the range of cultivated plants retrieved from our study materal, can be summarized as follows.

- A gradual widening of the range of crop species found in the course of time of the Bronze Age or the Early Iron Age. Many authors refer to this development in the Bronze Age for North-Europe (Harding 1989), Central Europe (Jacomet/Karg 1996; Kroll 1997), southern Britain (M. Jones 1984) and Western Continental Europe (Bakels 1991). This development is commonly interpreted as an aspect of agricultural intensification (see chapter 3).
- Related to the different crops under cultivation, a range of different cropping regimes could be suggested for the periods under study. In this chapter, we will try to assess whether the gradual widening of the range of species can be related to a widening of the range of agricultural practices.
- A shift in relative importance of specific food crops, possibly at the expense of others. Naturally, it is difficult to quantify relative proportions of crop species in the botanical record, but qualitative statements might be made on this subject. This phenomenon is especially related to two different aspects:

1. First, the apparent disappearance of species in the course of time. In general, it can be suggested that certain species (e.g. einkorn wheat, naked barley) are possibly gradually loosing their role of principal cereals or are completely disappearing from the botanical record in the course of time. Seen in this light, it is also worth taking into account that naked barley was possibly taken over by hulled barley.
2. Second, it is important to note and explain presumable first (re-)occurrences of species or the increasing importance of certain crops in the botanical record, as could be suggested — first of all — for spelt wheat, but also for common millet, Italian millet, various pulses (horse bean, pea, lentil) and flax and gold-of-pleasure. These "innovations" could be related to (experimental) forms of innovative agricultural strategies and cultivation methods, and simultaneously, to novelties in the prehistoric diet and culinary diversity.

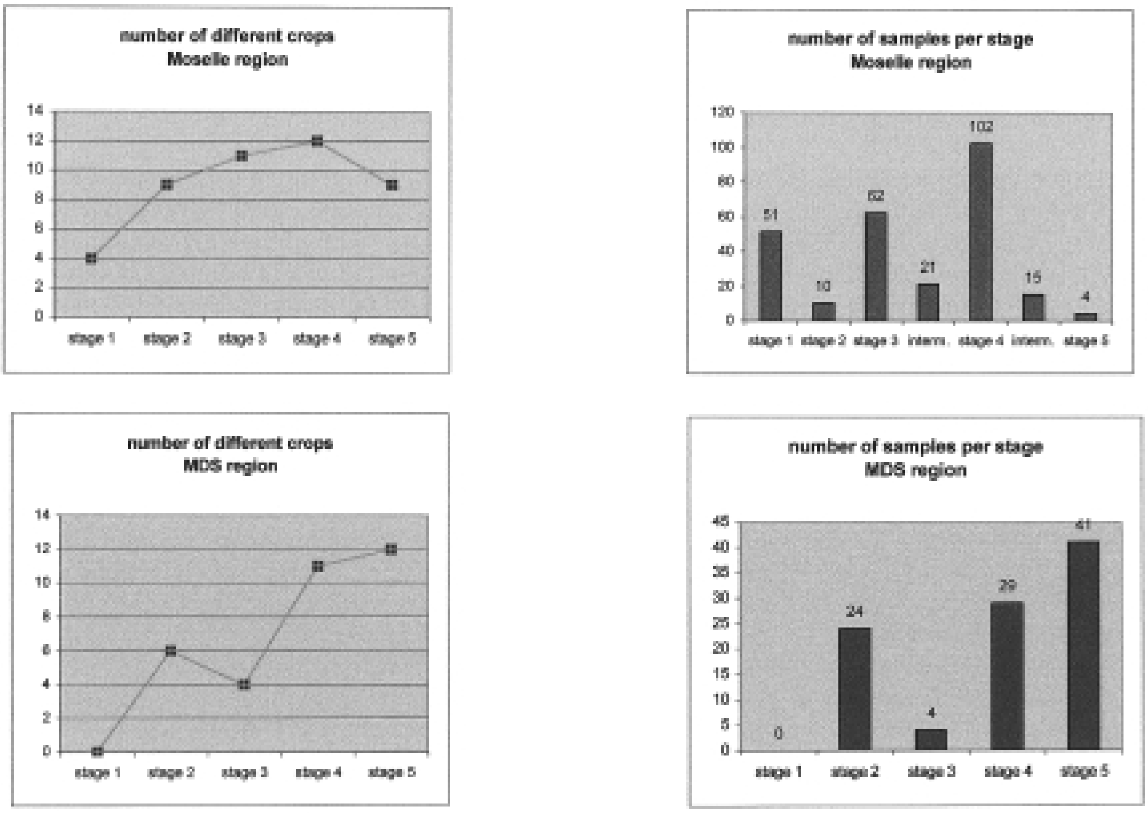


Fig. 10.1 Number of different crops per chronological stage

A chronological distribution of the crop species over the five chronological phases in both sub-regions was shown in the tables 8.1 and 8.4 (see chapter 8). In this chapter indications are given with regard to the relative importance of these individual crop plants during the period concerned by expressing their relative frequency (the number of samples in which they occur in relation to the number of samples available for that period). Although it is hard to offer quantitative values to the botanical data, general trends can certainly be observed.

*Range of crops in the Moselle region (*see figure 10.1)

1) From the periods preceding the Bronze Ancien (i.e. before 1800 BC), only emmer wheat is known. This result must be related to the very small numbers of samples available from the late Neolithic and Chalcolithic period. The list of crop species for the Bronze Ancien period (1800-1500 BC) consists of four crop plants: six-row barley, millet and emmer wheat and possibly also spelt wheat (uncertain identification of one glume base). (*4 crops*).
2) The available botanical samples for the second stage (Bronze Moyen and the first half of the Bronze final) were not at all abundant, but we still see a large extension of the range of crops in this period. From the Bronze Moyen onwards (1500-1250 BC), we find bread wheat (possibly from 1500 BC), einkorn (possibly from 1500 BC) and possibly spelt wheat. [13] Later on, from the beginning of the Bronze final (1250-1100 BC), there are regular finds of pea (from 1300 BC onwards), spelt (from 1250 BC), possible Italian millet (from 1250 BC onward) and horse bean (from 1250 BC). The assessment of lentil and rye in this period remains uncertain. Rye was exclusively found in two Walloon sites, outside of the study area. Very likely, it should be interpreted as an arable weed rather than as a crop species. The earliest records for the naked and hulled varieties of barley date from this period. (*9 crops*).
3) The period from Bronze Final IIb-IIIa (1100 BC) to the end of the Bronze final and the transition to the Hallstatt period (around 750 BC) are characterised by the maximum extension of the assortment of crops. Also, a more powerful presence of millet is observed from the period Bronze final IIb-IIIa onwards (the beginning of the 1st millennium BC). Bread wheat is absent from the record in this period. Lentil, flax and gold-of-pleasure are newly found food crops. (*11 crops*).

4) A wide range of different crops (gold-of-pleasure, Italian millet, barley, lentil, common millet, flax, pea, bread wheat, emmer wheat, einkorn, spelt wheat and horse bean) remains in existence in the Hallstatt period (750-450 BC). (*12 crops*)
5) The period from 450 BC onwards (Second Age du Fer) is characterised by the possible disappearance of horsebean and flax, but we should bear in mind that only a small number of samples was analysed, as this period, strictly speaking, falls outside the scope of this study. (*9 crops*)

*Range of crops in the MDS region (*see figure 10.1)
1) Botanical evidence from the earliest period (i.e. the period prior to the Middle Bronze Age, before 1800 BC) is lacking.
2) The earliest data that we have at our disposal from this region date from the Middle Bronze Age, i.e. from 1800 to 1100 BC. This wide time span converges with the Bronze Ancien, Bronze Moyen and the Bronze final I-IIa of Northern France. Clearly, the data on the MDS complex are more difficult to interpret due to this large time span of seven centuries. The introduction of new species cannot be dated more secure than "somewhere in the course of this period". This also hinders a comparison with the Moselle data. The crops cultivated in this period are naked as well as hulled six-row barley, common millet, emmer wheat, spelt wheat and possible einkorn and bread wheat. (*6 crops*).
3) The evidence for the Late Bronze Age (1100-800 BC) is rather scarce (only four samples were available, see chapter 8). This could be the reason that the range of crops is somewhat smaller: naked and hulled six-row barley, millet, emmer and spelt wheat. (*4 crops*)
4) From the Early Iron Age onwards (800-500 BC), the range of crops widens considerably: pulses appear in the botanical record (lentil, pea, and possibly horse bean) and also gold-of-pleasure and possibly flax are new species. Cultivated oats is attested only once for this period. The naked variety of barley disappears from the record. (*11 crops*)
5) The later periods (Middle and Late Iron Age, i.e. from 500 BC) — strictly — fall out of the scope of this study. In this period, twelve crop species are supposed to be cultivated in the MDS region. Lentil disappears from the botanical record, the cultivation of horse bean is certainly attested. We find roughly the same species as in the previous period. (*12 crops*)

10.3 The individual crops

The presence of the various crops in the MDS and the Moselle regions, throughout the chronological stages, is presented in figure 10.2.

Naked and hulled barley

Six row barley, together with emmer wheat, are regarded as the main species in Northwest Europe throughout prehistory. In our material, six-row barley is indeed present in all chronological phases, in the Moselle region as well as in the MDS region. Apparently, the cultivation of barley should be seen as a permanent factor and an indication of continuity within prehistoric agriculture.

Barley is not very demanding as far as soil conditions are concerned (Körber-Grohne 1987). Its indifference to soil conditions is marked by its cultivation in brackish environments (see e.g. Brinkkemper 1991), but it thrives at best in moderate climates and on fertile, loamy and well drained soils. Any particular differences between the two varieties of six-row barley with regard to soil conditions are unknown to the writer.

Naked and hulled barley are consumed as groats, porridge or bread, and are suitable for the production of beer. Küster (1995, 124) remarks that barley alone does not lend itself well to the baking of bread because of its low protein percentage. Barley flour should be mixed with flour of pulses (in particular) to make it suitable for bread baking.

Two questions with regard to barley especially need addressing here. The first is if a clear transition from the naked variety of barley to the hulled variety took place and if so, when and for which reasons. The second is how we should interpret the assemblages where the two varieties occur in combination.

Six row barley is known in two varieties; the hulled and the naked variety. Not every archaeobotanist is used to discerning between the two types. In our material, when the identification permitted, a distinction was made between the naked and the hulled variety of six-row barley. In general, the ears of cereals are composed of a central rachis, which bears one spikelet on every rachis internode. In six-row barley, each rachis internode bears three florets per spikelet. In naked barley, the grains are loose in the spikelets, as the grains are not hulled tightly by the glumes.[14] In the hulled variety the glumes tightly envelop the grain, so that the palea and the lemma are virtually fused with the grain.[15]

Some archaeobotanists believe that the hulled variety of barley replaced the naked variety somewhere during the Middle Bronze Age. Others believe this transition took place in the early part of the first millennium BC or somewhat later, around 500 BC (Hillman 1981; van der Veen 1992). It may be possible that, in the coastal areas of Europe, naked barley cultivation remained important until the Iron Age. It is present in northern Germany until in the 2nd century AD and in Scandinavia until in the Middle Ages (Kroll pers comm). Buurman's study of agriculture in West-Friesland demonstrated that at the beginning of the Middle Bronze Age, in this Dutch coastal area, naked barley was evidently

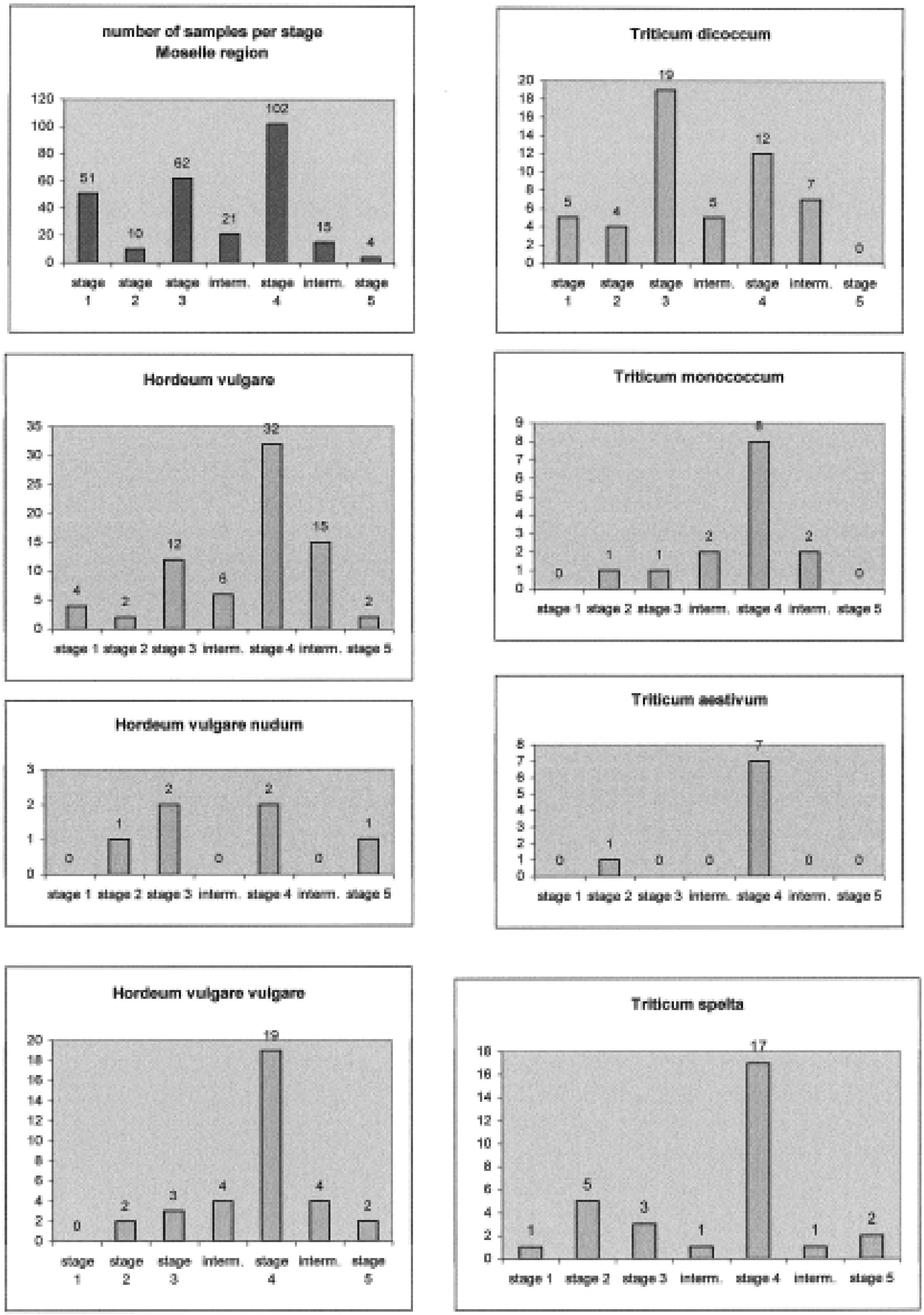


Fig. 10.2 Moselle region and MDS region - distribution of frequency of crops in five chronological stages

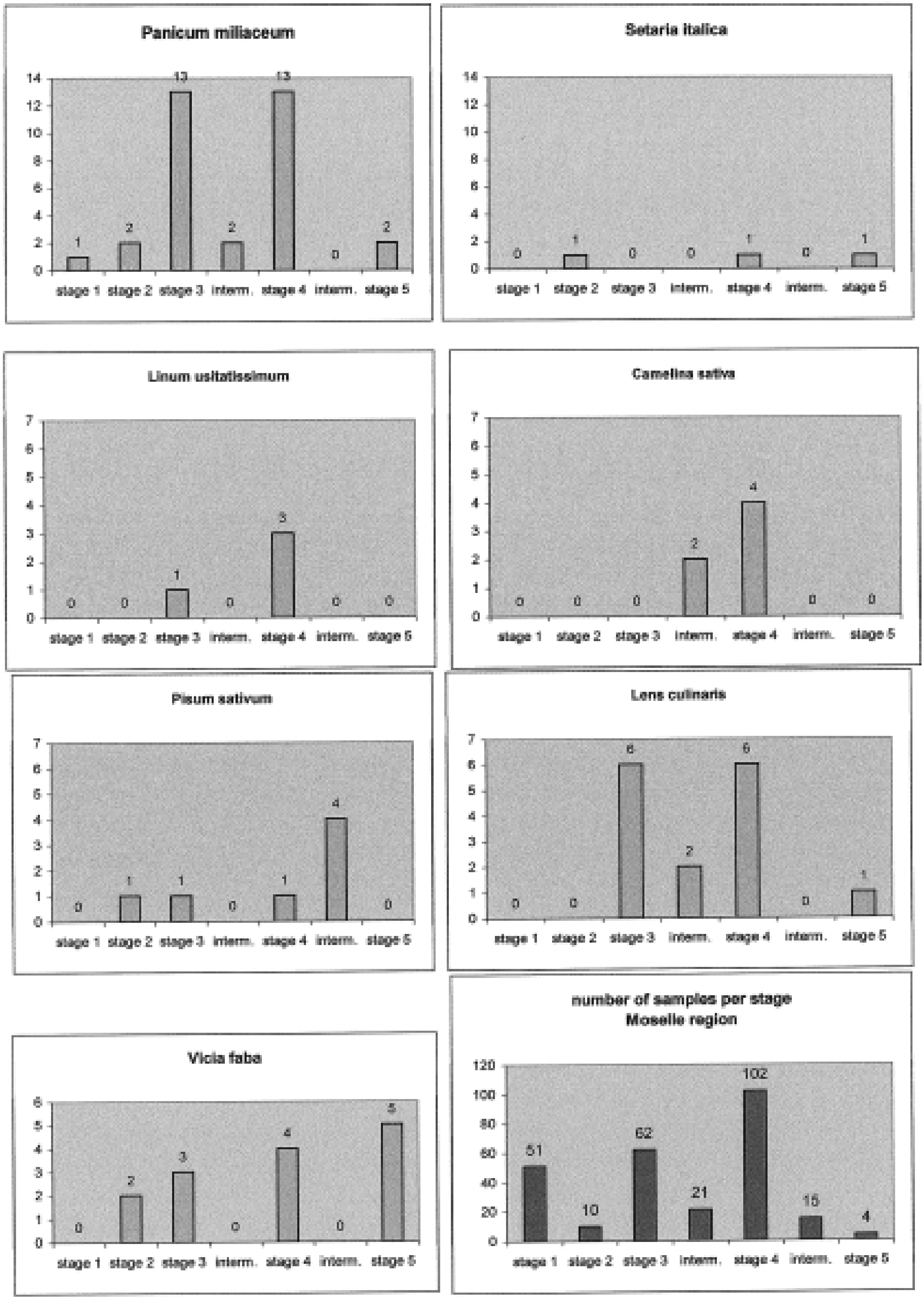
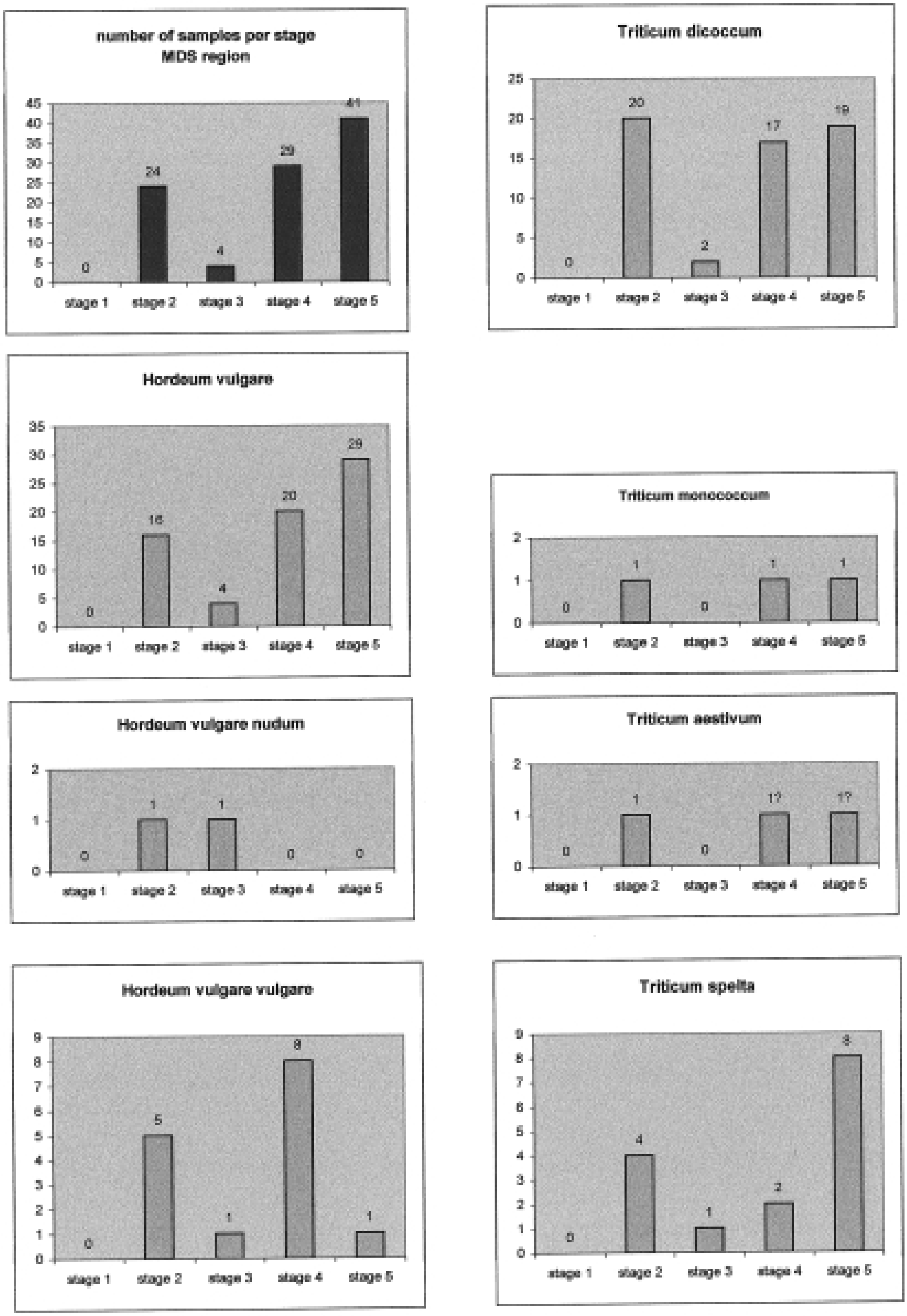


Fig. 10.2 continued



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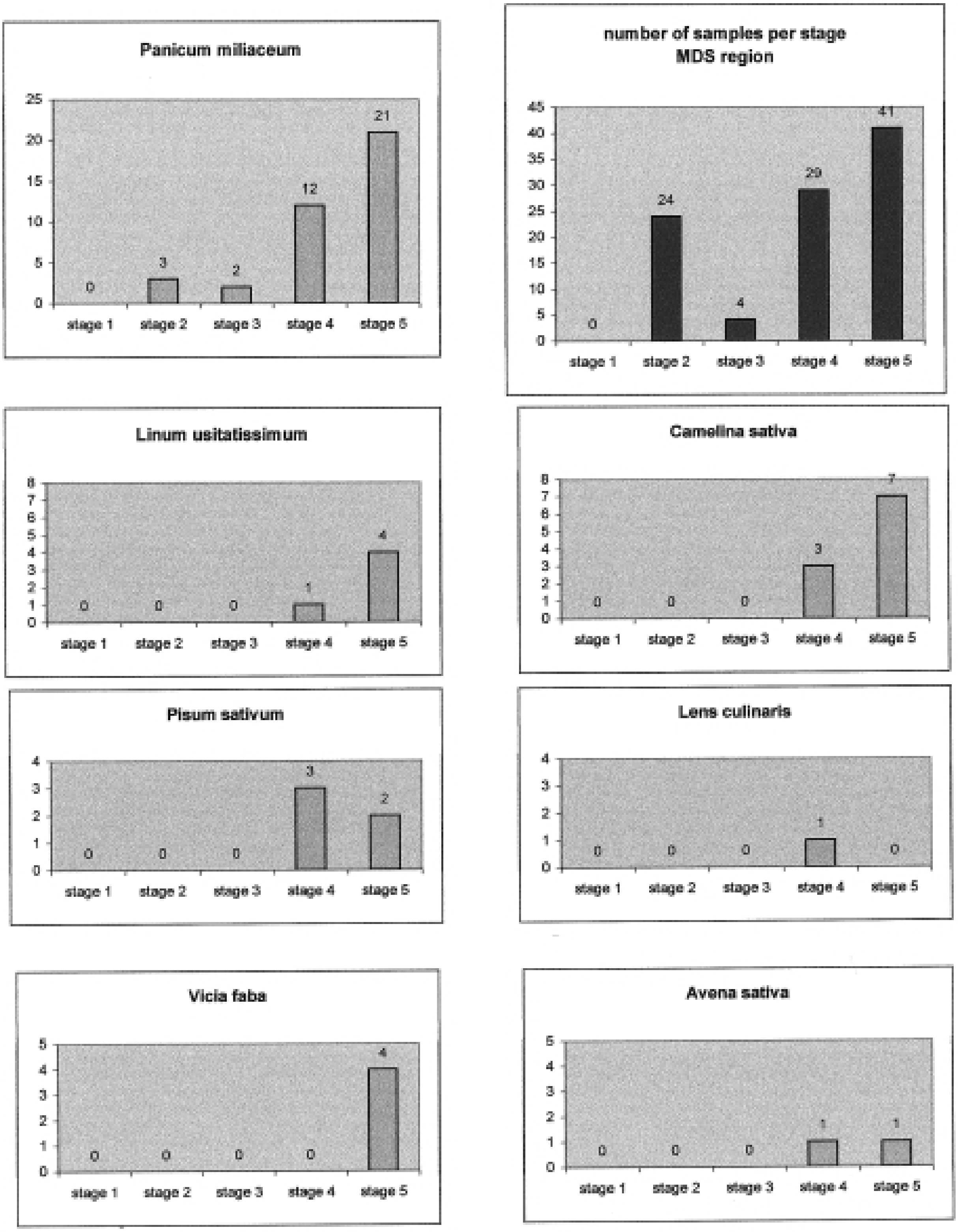

Fig. 10.2 continued

still the more important variety, but that in the course of the Middle Bronze Age it began to be replaced by the hulled variety. In her study area, the naked barley had totally disappeared in the Late Bronze Age. However, the specific (wet) environmental conditions in this area should seriously be taken into account and could be at the basis of the developments in this coastal region (Buurman 1996). The Middle Bronze Age site of Eigenblok (around 1470 BC) in the Dutch riverine area produced predominantly hulled barley (Brinkkemper, pers comm). In the central Netherlands, hulled barley was indeed already fully in cultivation in the Middle Bronze Age (van Zeist 1968/1970). Bakels assumed that hulled barley had already replaced the naked variety by the beginning of the Bronze Age (Bakels 1991, 287).
In the botanical record for the MDS complex, hulled barley is present throughout the Bronze Age and Iron Age. Naked barley was only found in the early chronological phases. From the Early Iron Age onwards, traces of this variety are completely lacking. At first sight, we could assume that from this period onwards the hulled variety had completely taken over in this region. However, one important side-note must be made: this is only true if we can be certain that all barley grains found in these contexts can be attributed to the hulled variety, which is not the case. The majority of the barley in the Brabant sites is identified as plain barley (*Hordeum vulgare* s.l.).[16]
In the Moselle region we recovered hulled as well as naked barley in all chronological stages, until in the La Tène period. Their relative proportions seem to remain equal. Other finds in Northern France seem to confirm the co-existence of both varieties throughout prehistory. For the Aisne valley in Northern France, Bakels ascribed the introduction of hulled barley as early as to the Neolithic Michelsberg culture (Bakels 1999). Matterne (1997) distinguished naked as well as hulled barley in the Middle Bronze Age assemblages of the site of Saint-Vaast-la-Hougue (Normandy). The data for Northern France show (in general) the omni-presence of naked and hulled barley throughout the whole prehistory, also in the Late Iron Age (Marinval/Ruas 1991). In the löss-area of the German Rhineland, to the north-east of the Moselle region, it is noted that exactly in the Middle and Late Iron Age, hulled as well as naked barley both frequently (re-)occur (Knörzer 1980; Simons 1993). In brief, we should state that a transition from naked to hulled barley, if any, remains very unclear and hard to date for the Northern French and adjacent regions.

Where indications for a transition are believed to exist, that is in the more northerly parts of our study region, the explanations of this development are varied and numerous. Viklund (1998) supposed that the cultivation of hulled barley in Scandinavia started around 1000 BC and completely took over the cultivation of other cereals from then on. This development is associated with a shift in farming practices. The two main expedients of this new agricultural regime are the use of manure and the development of a new harvest method of cutting close to the ground with the iron sickle. To compensate for the increased removal of organic material from the fields caused by the use of the iron sickle and to be able to uphold the permanent field system, the cultivated fields had to be manured. Hulled barley, according to Viklund is the cereal that is most responsive to manuring and was thus newly introduced in this intensified crop system (Viklund 1998, 171).
Van der Veen suggests that the change-over from naked to hulled barley in the first millennium BC was probably the result of two altogether different factors. One is a climatic reason as in this period rainfall is supposed to increase. The more open spikelet structure of naked barley implies that in wet weather the ear holds more water. This could encourage fungal diseases and sprouting of the ear (van der Veen 1992). More authors refer to the fact that hulled barley was more resistant to fungi and diseases because of the protection by the glumes. A need for cereals that were better protected or more resistant to moist possibly in relation to climatic developments is also assumed by Buurman (1996, 189). This factor does not however explain why the naked variety is still frequently present in so many Early and Middle/Late Iron Age (esp. French) sites. In contrast, it is suggested by others that naked barley is a very hardy grain crop and that its cultivation is more advantageous than that of hulled barley, as the latter requires a more complex dehusking sequence (Kroll pers comm).
An additional explanation often given is a socio-economic one, as the utilisation of barley could have undergone a transformation from human food to animal fodder in this period. If barley was used as food for animals there would have been no further need to remove the hulls of the hulled barley grains. [17] If we would follow this explanation up, it would have implications for our understanding of the development of animal husbandry (the supply of grain in addition to leaf fodder or grazing) (van der Veen 1992, 74-75). It would be tempting to relate the introduction of the longhouse (or any indication of increasing indoor stalling and foddering of cattle) with the introduction of hulled six-row barley.
If we assume that the hulled type of barley was also still in use as human food, we should add one important remark: a transition from naked to hulled barley cannot have had a reason of efficiency in terms of labour (see also chapter 3). As this is an important remark for the further analysis of agricultural change, I will elaborate further on this subject. As described above in naked barley the grains are not tightly hulled, but lie loose in their spikelets. In the hulled variety,

the glumes tightly envelop the grain and cannot be removed by threshing. The removal of the hulls requires extra processing time. In other words, not so much the growing but especially the processing of hulled barley could be very labour-intensive. In my view, the explanation with regard to animal fodder (and time saving crop processing) is too rationalistic-functionalistic oriented and does not hold true for the prehistoric agrarian communities. In chapter 3, it was already argued that there is no reason to believe that prehistoric farmers reasoned from the perspective of the Law of Least Effort, or from an efficiency point of view. They would probably not make decisions with regard to the introduction of new varieties on efficiency grounds alone and, moreover, the presence of the various hulled wheat species (generally interpreted as human food crops, see below) in later periods would be problematic if we would follow this efficiency line.
In general, we could state that if a transition from naked to hulled barley took place (e.g. related to environmental circumstances), this could be interpreted in terms of an intensifying agricultural regime, especially where increasing labour investments and its responsiveness to manuring are concerned.

Quite frequently, barley assemblages produce evidence for the combination of both hulled and naked six-row barley, whether in equal or uneven proportions. Several instances of these mixed barley assemblages are recorded in the botanical record from the Moselle region as well as from the MDS region (see table 10.1). For the interpretation of these assemblages, the results of the study of maslins by Jones and Halstead (1995) is very useful. They investigated, among other things, the maslin cultivation of two bread wheat species by farmers on the Greek island of Amorgos. These maslins included bread wheat and macaroni wheat. The rationale behind this cultivation was the fact that the principal hazard to cereal growth on Amorgos is drought to which macaroni wheat is more tolerant than bread wheat. Thus, after some years of cultivating the wheat maslins, there was a great chance of macaroni wheat becoming dominant in the fields and in the sowing seed stocks.
In analogy to this Greek example, we could assume that in prehistoric Europe after a few (wet?) growing seasons, if farmers had made no attempt to manipulate the composition of their seed corn, hulled barley should have become dominant. This is the case indeed for the majority of our barley cereal samples. In the mixed barley assemblages from our study sites, naked barley indeed is never dominant, except for the site of Late Iron Age Woippy, despite its inferior tolerance of moisture (see also chapters 5 and 8). It might be possible that the farmers of this settlement deliberately selected or created naked barley rich seed corns.
The mixed cultivation of hulled and naked barley could also be interpreted from the following perspective. Jones and Halstead concluded — on the basis of their investigations on Amorgos — that the boundaries between crops for fodder and crops for human consumption are relatively flexible and depend on yearly circumstances (Jones/Halstead 1995, 111). This would imply that in bad (i.e. wet) years with small yields (esp. of naked barley) farmers are more willing to interpret their harvest (including the hulled barley) as human food, and in good (i.e. dry) years the hulled barley could be separated from the naked barley (by sieving?) and declared fodder.
This would imply that the two varieties are cultivated as mixtures, and are probably also processed as mixed assemblages. Where crop processing of the two different varieties are concerned, we could follow the argument formulated by Nesbitt and Samuel (1996). On the basis of a combination of archaeological, ethnographic and experimental data, they demonstrated that parching or roasting is not necessary for processing hulled wheats. This could also be implied for hulled barley as the techniques for dehusking hulled wheat and hulled barley are practically identical (Nesbitt/Samuel 1996, 49). Nesbitt and Samuel pointed out that dehusking hulled cereals is best accomplished by pounding in wooden mortars after sprinkling the cereal grains with a little water. For the aim of pounding was not to crush the grains but to free the grain from its tough glumes. In this way, we can very well imagine the processing of the two barley varieties simultaneously.

Wheats

In general, wheats are the most demanding cereal species in their cultivation as they need a humus-rich, loamy soil and

			naked barley	*hulled barley*
Crévéchamps	Zone B 2625	Bronze Moyen?	71	231
Boxmeer	silo 26-1-648	Middle Bronze Age	4	950
Frouard “Haut de Penotte”	structure 2091	Hallstatt A2/B1	thousands	thousands
Beloeil-Tourpes	pit	Bronze final	dozens	dozens
Woippy	structure 111	La Tène C/D	40	5

Table 10.1 Ratio naked and hulled barley in five selected assemblages

thrive in nutrient rich soils (Körber-Grohne 1987, 28). On the other hand, it is reported that hulled wheats in particular are known to be especially resistant to poor soil conditions and a range of fungal diseases (Nesbitt/Samuel 1996, 42).
The genus of *Triticum* (wheats) comprises several species. They can be divided into hulled and naked wheats. In hulled or glume wheats, the glumes hull the grains tightly; the grains of naked or free-treshing wheat species are very loose in their spikelets, falling easily out of the glumes when ripe. Emmer wheat, einkorn and spelt wheat are all glume wheat species and bread wheat is the naked wheat species found in our material. Arranging wheat species in terms of Linnean categories is, naturally, a western, modern, scholarly way of conceptualizing agricultural regimes (Kroll pers comm). We should note that, in the perception of prehistoric farmers, the differences between the various hulled wheats emmer, einkorn and spelt could have been of minor importance, as they are very similar in their appearance and demands.
The difference between hulled and naked wheats manifests itself in crop processing, among other things. When free-threshing wheat is threshed (as its name implies), the rachis segments stay attached to each other and the glumes and other chaff break, thus releasing the free grain. When hulled wheat is threshed, it breaks up into single spikelets, with the grain hulled in its tough glumes and attached to one rachis segment.
Hulled wheat grains were probably only dehusked on a daily basis, before their preparation. Traditionally, it is assumed that parching (roasting or heating) is necessary to dehusk glume wheat. As mentioned above, Nesbitt and Samuel (1996) recently demonstrated (on the basis of ethnographic evidence) that parching is not necessarily an integral part of hulled wheat processing. Their study demonstrated quite succesfully that there is no need to parch in order to dehusk hulled wheat and that it suffices to wet the grains before pounding or grinding. This evidence is of major importance, for a common assumption used to be that hulled wheats are always over-represented in the botanical record as they are more likely to be accidentally charred than free-threshing wheats. This assumption has now become invalid (Nesbitt/Samuel 1996, 45).

Emmer wheat
As mentioned above, emmer wheat was found in all periods as well in the Moselle region as in the MDS region. Together with barley it can be considered as the principal cereal of these prehistoric communities and a constant factor in their agrarian regimes.
Emmer is considered a species that is most exacting of soil conditions, fertility and soil working. It demands a humus-rich loamy soil. It does not thrive on loose sandy soils or peaty or wet clayey soils (Körber-Grohne 1987). Emmer wheat is therefore, often associated with an intensive cultivation regime. Van der Veen (1992) found that emmer wheat was often associated with arable weeds indicative of intensive working and manuring. Experimental growing of emmer wheat demonstrated however, that successive cultivation of eight years without additional fertilization did not reduce yields in the least (Reynolds 1981). Nonetheless, it was observed additional manuring did produce higher yields.
Emmer grains, like the other hulled wheats einkorn and spelt, can be used for the production and preparation of various cereal products, bread and porridge, and also as groats. The spikelets of untreshed grains are also suited for animal fodder (Körber-Grohne 1987, 326).

Einkorn
This wheat species was present only in limited quantities in the material studied. In the MDS region it is found only in the Middle Bronze Age (1750-1100). In the Moselle region its only certain presence is in a Hallstatt context (750-450). As a result of the very low numbers in our record, we can either assume that einkorn should be interpreted as an arable weed in this period, or that it did not play an important role (anymore) from the (Middle) Bronze Age onwards (see also Bakels 1991, 288).
Einkorn is sometimes associated with extensive (large-scale) cereal growing, as described by Kroll for the Early Bronze Age in Feudvar (Kroll 1997). In this extensive agricultural system, einkorn would have been cultivated as the principal crop on large arable fields without much regard for its specific demands.
The grains of einkorn are nowadays processed into groats, flour for dough or into bread and pastes (Körber-Grohne 1987, 322).

Spelt wheat
In the present study, spelt was found from the Middle Bronze Age (1800-1100 BC) in the MDS region and from the Bronze final I-IIa (1250-1100 BC) in the Moselle region. From this period onwards, it is continuously present throughout later prehistory, though not in a dominant way. Although spelt remains already occur at later Neolithic sites in Eastern Europe especially, its general rise in North-West Europe is placed somewhat later (see also chapter 8). The introduction of spelt wheat in our regions is generally placed in the Bronze Age or at least, at the very beginning of the first millennium (Marinval/Ruas 1991, 417; Bakels 1991; Bakels 1999; De Hingh/Matterne/Wiethold in prep; Karg 1996b).
In southern Germany and in Switzerland, spelt is abundantly present from the Bronze Age onwards, and it even replaces emmer as the principal wheat species in the Iron Age in these regions. A similar development seems to take place in

Britain, with spelt appearing at the end of the 2nd millennium and replacing emmer at sites in southern Britain by 500 BC (Nesbitt/Samuel 1996, 85; van der Veen 1992; van der Veen/O'Connor 1998).

Some suggest that the shift (from emmer) to spelt in different areas points to the same trend. This transition would be part of the expansion of agriculture onto poorer soils. Spelt wheat is believed by some to be (in contrast to emmer wheat) a species that is less demanding of soil conditions, fertility and soil cultivation (Körber-Grohne 1987; van der Veen 1992). It can grow on the heavier clay soils and is hardier than emmer wheat and is therefore very suitable for winter sowing (M. Jones 1984; van der Veen/O'Connor 1998, 131). Hypothetically, spelt is regarded as indicative of an extensive agricultural system, as it requires no manure and not much working of the soil (van der Veen 1992, 145-6). Van der Veen and Palmer (1997) demonstrated on the basis of British wheat growing experiments, that spelt yielded higher than emmer when the temperatures in winter were low, which confirms the hardiness of spelt wheat. They therefore suggest that a shift towards spelt can be related to its tolerance of heavier soils, its hardiness and its higher yields. For them, these three closely interrelated factors are evidence that agriculture expanded to previously marginal soils.

Enklaar (1850), by contrast, suggests that spelt poses higher demands on soil quality than emmer wheat. According to the investigations by Matterne, spelt wheat is a species characteristic to calcareous and dry soils (of the Ardennes and Champagne region in northern France) (pers comm). In brief, we could establish that the evidence for the relative performance and the demands of spelt wheat is contradictory (see also Nesbitt/Samuel 1996).

As shown in the previous chapter, the spelt finds that were associated with their arable weeds (like the assemblages of Boxmeer 26-1-648, Frouard 61, Gondreville 4214) were not unambiguous with regard to their cultivation regimes. Spelt grains in these assemblages were primarily associated with nitrogen-loving weed species and indicators of intensive soil working. It should be noted however, that these assemblages did not lend themselves very well to such an analysis, as they were all mixed crop assemblages. Additional research should be done to see if the association between spelt wheat and arable weeds indicative of extensive soil working is correct.

In contrast to bread wheat, crop processing of spelt wheat requires laborious effort. At threshing, the ears break up into their individual spikelets, each consisting of tough glumes attached to a rachis segment. The grain(s) in the spikelets are not yet freed from their chaff but still hulled by the glumes. The thick, tough glumes give excellent protection to the grains not only in the field but also when stored. At food preparation, the spikelets are further dehusked by pounding. Nesbitt and Samuel (1996) demonstrated that parching is not necessarily part of the dehusking sequence of hulled wheats, like spelt. Spelt is used for bread, porridge and dough products (Körber-Grohne 1987, 70).

Bread wheat

We can infer from our diagrams that bread wheat was present in the Middle Bronze Age (1750-1100 BC) of the MDS region, though only in small numbers. It virtually disappears from the botanical record after this period. In the Moselle region, it seems to have been introduced from 1500 BC onwards, but on a very small scale (that is, only small numbers of grains and chaff of bread wheat were found). Ruas and Marinval have evidence of this wheat species from northern France in all chronological stages (Marinval/Ruas 1991).

Concerning its cultivation and requirements, bread wheat is the most demanding species of all cereals. It needs humus rich soils which are not acid. Bread wheat is a free-threshing cereal species which indicates inconisiderable laborious crop processing regimes. Nowadays, it is used for bread-making, dough, and beer. Its flour and dough properties are superior and very different from those of e.g. einkorn and emmer. As the data in our botanical record are so scanty, the role of bread-wheat in the agricultural productive system remains rather enigmatic. We may assume that its role in Bronze Age and Iron Age agriculture was of minor importance (cf. Rowley-Conwy 1984).

M. Jones (1984, 123) noted the increasing frequency of bread wheat in Britain, and indeed, in the whole of north-western Europe in the (late) Iron Age and Roman periods. He believed this trend can be reasonably associated with the contemporary expansion of agricultural settlement into clay areas and the deep ploughing of these soils.

Rye

Grains of rye (*Secale cereale*) were attested only twice in Walloon sites just outside the study region. It was absent in the Moselle and the MDS region. As a result of its scanty presence in the botanical record, we may assume that rye must have played a subordinate role in the subsistence economy. Its rare occurrence even suggests an interpretation of this species as an arable weed. It is left out of the further analysis.

Oats

It is uncertain if oats (*Avena sativa*) were cultivated in our study regions. Remains were found in the Iron Age context of the MDS region and because of its scanty presence in the botanical record as well as its absence in the Moselle region, this species is excluded from further analysis.

Millet

Common millet *(Panicum miliaceum*) occurs very regularly in various sites in both regions. In the Moselle region, it is present in the Bronze Ancien (1800-1500 BC) and begins to play a more important part from the Bronze final I-IIa period onwards. In the MDS region, common millet is cultivated from the Middle Bronze Age onwards. Possible Italian millet (*Setaria italica*) was found three times in the Moselle region only, always in combination with common millet.

Millet is very sensitive to frost and are therefore cultivated as a summer crop. According to Brinkkemper (1991, 127), it needs humidity, but according to Körber-Grohne (1987) drought causes no problem for the cultivation of millet. It should be noted that common millet is very appropriate to cultivation on sandy soils and light, sandy loam soils. This could account for its widespread presence in the MDS region. Italian millet demands loamy and sandy soils with a high nutrient availability. Furthermore, the requirements of both common millet and Italian millet are the same.

The growing season is rather short as millet is sown in mid-May, Italian millet in April and both are harvested in August or September. A single growing season thus lasts only 2 to 5 months.

Growing millet implies an intensive cultivation regime. The crop needs a special treatment, i.e. the soil should be loosened up by two fold hoeing, intensive weeding is required and plants growing too close together need to be thinned out. Ethnographic and archaeological investigations demonstrate that the cereal is harvested by hand-plucking or is cut right under the ear (high cutting), and that this task is often performed by women in particular (Lundström-Baudais/Dietsch pers comm). As millet is a hulled cereal, its processing needs to pass through a dehusking stage, e.g. in mortars. The advantage of their being hulled is that millet can be stored for years (Kroll pers comm).

According to some, one major reason for taking up the cultivation of millet could have been that it has a growing season which can be as short as 40 days. Much of the millet cultivation could therefore take place within a slack season in the agricultural year (Nesbitt/Summers 1988, 94). Both species can be sown and harvested very quickly. This would be useful for example, in the case of a crop failure or inadequate yields of other crops. We could interpret the cultivation of these species as a strategical element of risk reduction. And this, in turn, forms an important indication of an intensifying agricultural regime.

On the other hand, it should be noted that the (modern) yields of millet are generally much lower than of other cereals, i.e. 630 kg/ha (Grigg 1992, 72) or even only 400-600 kg/ha (Jacomet/Karg 1996, 240). This is low compared to the yields of emmer wheat of 1200-1500 kg/ha or even more on fertile soils and of 1500-2100 kg/ha of barley (Bieleman 1992, 160).

Millet is suited for human consumption in the form of porridge and possibly also as bread (Körber-Grohne 1987, 331). According to Jacquat (1988, 84) millet was primarily suited for soups, which she considers to be the main element in the diet of the Swiss Bronze Age site of Hauterive-Champréveyres. According to Behre, the strong advance of common millet in the Bronze Age all over Europe can be put in a causal relationship with the innovative making of bread (Behre 1998). This would be confirmed by a find of millet bread in northern Germany, dated 713 cal BC. Could the introduction and the prominence of millet in our material from the (Late) Bronze Age onwards be related to culinary innovation?

It is believed that millet was cultivated individually: not as a mixed crop. This is inferred from the frequent discoveries of millet as monospecific heaps of grains. The possibility of joint cultivation of the combination of Italian millet and common millet could be assumed, however (Marinval 1992a, 266; Hopf 1985). Bakels, in her study of Early Bronze Age to Early Iron Age "Le Fort-Harrouard" (Aisne valley) presented the remarkable finds of millet lumps of common millet kernels sticking to each other, free from other cereals or weeds. She concluded that common millet was obviously grown and stored separately from other products (Bakels 1982/1983; 1984, 7).

The fact that millet requires such a particular cultivation regime makes it easy to understand that a combination of cultivation with other crops would hardly be possible. The consistently observed occurrence of the combination of Italian and common millet implies the possibility of the mixed cultivation of the two cereals in the Moselle region.

It is interesting to note the possibility of adding millet grains to barley and/or wheat storages in order to assure a better preservation. This custom is known from 17th century France and can easily be explained. The principle of mixing grains of different sizes would be to reduce intergranular voids and therefore prevent the penetration of grain weevils. At the point of food processing, the different cereals could easily be separated by sieving (Marinval 1992a). This storage method could also be related to an agricultural regime aimed at risk reduction.

To conclude, the widespread cultivation of millet from the Bronze Age should be related, in my opinion, to an increasing variety of cultivation regimes, an increasing specialisation of labour and storage regimes in possible relation to risk reduction, and finally as as an element of the differentiation of food habits.

Pulses

Various pulses were attested on a regular basis in our study material from the Bronze final I-IIa (1250-1100 BC) onwards for the Moselle region and from the Early Iron Age (750-500 BC) onwards for the MDS region.

In general, I believe that we can relate the increasing importance of pulses in the repertoire of food stuffs to a changing attitude of farmers to their various crops from roughly the beginning of the 1st millennium BC. This can (among other things) be concluded from the fact that the cultivation procedure of pulses considerably differs from that of cereal production.

Butler noted their tolerance of relatively adverse growing conditions and their characteristic small-scale cultivation (Butler 1992). Field sizes for pulses are generally smaller than of cereals, the fields need frequent weeding and the harvesting of pulses is done by hand. Legumes are notoriously labour-intensive to harvest. From ethnographic investigations in Northern Jordan, Palmer concluded that farmers are less likely to grow pulses if family labour is scarce and that they sometimes withdraw from legume cultivation due to the high labour requirements needed to harvest them (Palmer 1998, 39). Harvesting by uprooting of the whole plant is also observed, however.

Their processing can be compared to the free-threshing cereals. In our climate, spring-cropping is assumed for pulses as they are sensitive to frost and snow. In general, we may assume that monocropping of pulses will have been the usual form, that is, if the cultivation of pulses was for human consumption. They are fit for consumption as green vegetable or as dried grain or pulse. Where animal fodder is concerned, mixed cropping is also possible. The whole plant is valuable as fodder and can be fed as hay. However, as Jones and Halstead pointed out, the distinction between animal feed and human food will not have been so strict to prehistoric farmers. Species grown as fodder (esp. as mixed crops) can have become a famine food in bad years (Jones/Halstead 1995; see also Butler 1992).

Butler's investigation of pulse agriculture in traditional farming communities demonstrated that in some regions (like the temperate areas of Asia, Europe and North Africa) a variety of alternative cropping practices of pulses has been developed. Besides monocropping of pulses, she recorded multiple cropping systems of pulses (where pulses are a second crop after a wheat or barley harvest) and mixed cropping systems of pulses combined with e.g. grain crops (Butler 1992). For the interpretation of the records of pulses in our study material I will elaborate further on this subject below.

Various authors emphasise the complementary status of pulses because of their proteins, carbohydrates and fat. I think that we should note that former farming communities were relatively unaware of or not primarily interested in the particular food value (i.e. calorific value or nutritive composition) of their crops. Stressing these aspects of these species is, in my view, incorrect when explaining the role of pulses in former society. In general, the properties of plants with regard to their environmental tolerance and adaption, and specific cultivation methods will have had more relevance to prehistoric farming communities rather than their particular properties as a nutritive calorific source (see Butler 1992, 75). In addition, the (agricultural) role which pulses might have had as green fertilizers, should be stressed (see chapter 9). And finally, the addition of pulses to the repertoire of food crops from roughly the beginning of the first millennium BC will have comprised major socio-cultural consequences related to consumption and food habits. I assume in general that pulses have played a major role in intensive agricultural regimes.

Vicia faba

Horse bean is sown in spring (February, March). For the cultivation of this species, heavy clay or peaty soils are best suited, although loamy and humus rich soils are also considered suitable. Calcareous or sandy soils are only suitable if the precipitation is high enough. In general, horse bean favours wetter regions (Butler 1992). The plants generally need much hoeing. The harvest takes place in mid-June or July (when the green legumes are harvested) or in September (when the dry beans or whole plants are harvested). Figures on the yields of horse beans vary somewhat: 1:16,5 corresponding to 4240 kg/ha in extreme, brackish conditions; up to 1:32 in less extreme conditions (Brinkkemper 1991, 128). According to Jacomet/Karg (1996, 240) the average yields of horse bean are lower: 1000-4000 kg/ha.

Pisum sativum

In general, pea is highly exacting of soil conditions. It favours loamy, humus-rich, calcareous soils and moist and well aerated fields. In brief, it requires intensive working of the soil. It does not thrive on heavy clay or sandy soils (Körber-Grohne 1987). Its sowing season is generally in spring, and it can be harvested in autumn. Like horse bean, it favours wetter regions, more than lentil does, in general (Butler 1992, 68).

Lens culinaris

The sowing season of lentil is mid-April, it flowers in June/July and it can be harvested in August/September. Lentil plants prefer calcareous, marl soils with natural rock. Stony arable fields are only suitable if they contain sufficient humus. Sandy soils are also suitable to lentil cultivation, if they are calcareous and contain loam. This species does not thrive in heavy clay. Both loosening up the soil and weeding are important aspects of the cultivation of lentil. The addition of manure is unnecessary, because, if used, the plant would not develop seeds. In general, lentil is grown in dry areas, in contrast to pea and horse bean.

Gold of pleasure and flax
Gold-of-pleasure and flax (linseed), which are both cultivated for their oil containing seeds, were attested in both sub-regions. They are present in the Moselle region from 1100 BC onwards, but seem to play a more important role from the Premier Age du Fer onwards. In the MDS region, the crops are present from the Early Iron Age (800 BC) onwards.

In chapter 8, it has already been argued that the gold-of-pleasure grains in our material should not be seen as arable weeds, but rather, as crops. Gold-of-pleasure plants prefer to grow on sandy and calcareous loamy soils with sufficient nutrients, but they are also tolerant of dry sandy soils. The species is often adressed as a "risk plant" because of the short growing season of 12 to 14 weeks (like millets, see above). Körber-Grohne mentions it as an ideal substitution for (frozen) winter crops as it is insensitive to frost (1987, 390).

Archaeological evidence demonstrated that gold-of-pleasure was harvested by uprooting (Körber-Grohne 1967). The yields of this plant could be quite large, but the species competes poorly with weeds. Therefore, intensive weeding (one to three times per growing season) is necessary.

Flax could have been cultivated for its fibres as well as for its oil-containing seeds. In this study, the finds of linseed remains suggest that it was used for the human consumption of the oil. It is impossible to demonstrate whether the fibres of flax were also used by the inhabitants of our sites. Flax plants prefer fertile loams. Light soils are unsuited to the cultivation of flax, particularly in areas where the precipitation is low. Some authors suggest that flax is particularly unsuited to dry, sandy soils. This is relevant to the interpretation of its presence on the sandy soils of the MDS region. Like gold-of-pleasure, flax needs to be weeded several times during the growing season. Ethnographic information on the cultivation and processing of crops like gold-of-pleasure and flax is, as far as the writer is aware, not readily available (see also Brinkkemper 1991, 137). Brinkkemper notes the ease (i.e. labour extensiveness) of separating the seeds from the chaff of these two species, comparable to processing free-threshing cereals. Its introduction as a food oil in the Iron Age diet suggests a development towards diversity in culinary traditions.

In my opinion, the introduction of gold-of-pleasure and linseed from roughly the beginning of the first millennium BC can be related to an intensifying agricultural regime for several reasons. The new species required changes in the agricultural regime, such as increasing attention to their specific requirements, and gold-of-pleasure in particular is believed to have been grown as a risk plant (Kroll 1997). The mere introduction of (new types of) food oil in prehistoric diet is an important phenomenon as this points to a major innovation and increasing culinary diversity. Culinary diversity and agricultural intensification are only recently being considered related phenomena in archaeology.

10.4 Mixed crop assemblages

In general, the majority of botanical finds from individual contexts consists of mixed crop assemblages, i.e. a specific crop species seldom occurs in isolation. Different interpretations offering alternative "modes of arival" of the crops in the botanical material can be inferred, such as mixing during or after discard, or the combined storage of different crops. Moreover, the investigation of mixed crop assemblages (i.e. samples containing more than one crop species) can identify patterns in the composition that refer to various cultivation strategies. In particular, those interpretations of the assemblages with relation to agricultural practices are of interest to our study. First of all, they could point to simultaneous diverse cropping. This means that crops were cultivated on separate, but possibly adjacent fields. Furthermore, they could indicate multi-cropping systems, where crops were cultivated on the same field during successive seasons. And finally, we could infer mixed cropping regimes, where crops were cultivated together on the same arable fields, or maslins, a specific form of mixed cropping with the objective to reduce risks of crop failure; and by investigating mixed crop assemblages we can relate the combination of crops from one sample to a rotation system in which, in the course of successive years, different crops are cultivated on the same plot of land.

Indentification of maslins
Maslin cultivation refers to the practice of sowing two different cereals or other crops on the same plot of land. It represents a form of risk-reduction in a bad year. By growing two crops with different relative performances with regard to cultivation regimes and growing conditions e.g. frost, drought or rain, farmers try to reduce the risk of a total crop failure. Maslin cultivation aims at the possibility of only one of the crops sown being likely to succeed. Earlier in the text, the Greek example of growing bread wheat and macaroni wheat was given, and the possibility of a hulled and naked barley-maslin was suggested for our barley mixtures (see above). Slicher van Bath (1963) presented numerous historical records of maslin cultivations of spelt wheat and rye, wheat and barley, and oats and barley, for example. Quite frequently in archaeobotany, attempts are made to infer evidence for the cultivation of maslins from mixed crop assemblages. Van der Veen (1995) described how in most cases, the presence/absence of maslin cultivations is inferred from two factors: the presence of two or more cereal crops in one sample, and the relative proportions of the crops. With regard to the first factor, it is also mentioned

by most other authors that crops could have been mixed during discard or deposition. Therefore, this criterion does not have much value. With regard to the latter criterion, it is often assumed that a maslin is likely if the relative proportions of the two (or three) crops are similar. If the proportions are uneven, one crop is seen as the dominant crop and the other as a contaminant. Van der Veen correctly argued that the use of the latter factor in particular is inappropriate for the very reason that maslins are grown (van der Veen 1995, 336). It is precisely the uneven proportions of crops which could indicate maslin cultivation.

With the help of a principal components analysis performed on her botanical data sets, van der Veen demonstrated that the mixture of barley and wheat in her samples were not the product of maslin cultivations in later prehistoric north-east England (van der Veen 1995). Wheat and barley were grown as separate crops and not as mixtures, as both crops were clearly associated with different groups of weed species. Emmer wheat and spelt wheat appear, however, to have been cultivated as maslins or under similar cultivation regimes. When the farmer reduced the degree of soil disturbance and the amount of manuring, a shift took place from emmer to spelt wheat, with emmer flourishing under the intensive system and spelt competing better under the less intensive system (van der Veen 1995, 342). The change-over from emmer to spelt wheat in these regions (see also above) would not have been a conscious decision, but a natural development (or a "natural selection").

Mixed cropping

Various pitfalls with regard to the interpretation of mixed assemblages are imagineable. An example will illustrate this: ethnographic observations of traditional farming communities in Ethiopia offered insights in their system of mixed cultivation (Butler pers comm). Here, it was observed that three crops, i.e. legumes, cereals and flax were cultivated on the same field, but when ripe were harvested separately, per species. Other ethnographic investigations (by Jones and Halstead 1995, see above) demonstrated that in many cases, maslin cultivation was not always based on conscious decision making. Often "maslins" appeared to be plain mixed cropping regimes, with no conscious motives of deliberate risk-reduction. Our mixed naked and hulled barley assemblages could also point into this direction (see above). The phenomenon of mixed-cropping strategies with regard to pulses in prehistory is relatively unknown (see above). Butler (1992, 74-5) suggested that it is possible that the broadcasting of seeds of pulses in mixed populations of different species represents a widespread cropping strategy of risk-spreading that would probably have existed hand-in-hand with the more intense cultivation of cereals, for example. In my material, the indications of mixed cropping of pulses are rare (table 10.2). Often, only one single species of pulses was found in the assemblages. The Moselle region material presents four sites that yield examples of mixed pulses assemblages, but the numbers of remains are very low.

site	**datation**	**pulse assemblages**
Rettel	Hallstatt B1/B2	lentil, pea, horse bean
Gondreville	Hallstatt D	lentil, pea, horse bean
Yutz	Hallstatt D1/D2	lentil, horse bean
Rémerschen	Hallstatt final/ La Tène ancienne	lentil, pea, horse bean

Table 10.2 Combination of pulses in four selected assemblages

What is more striking is the find of a mono-specific assemblage consisting of a large quantity of horse beans in Frouard "Haut de Penotte" dated in the Hallstatt D period (c 600 BC). In the MDS region, only single pulse species were found in the samples.

Another example of possible mixed cultivation in the material from the Moselle region could be the combined cropping of millet species. The constantly observed occurrence of the combination of Italian and common millet could suggest that the two cereals were cultivated as mixed crops (see above).

Crop rotation, multi-course-cultivation or multiple cropping?

The agricultural practice of crop rotation, in which the cultivation of different crops and fallow period take their turns, is well-known from historical tradition. The alternation of crops during successive growing seasons and fallow periods on the same field obviously had its advantages (Karg 1996a, 79).

1. The nutrients of the arable soils regenerate during fallow periods.
2. Ploughing of the fallow represses the growing of weeds.
3. Cattle may be left on fields to graze during the fallow period.
4. The risk of total crop failure is considerably reduced.
5. There is a more efficient division of labour.

The classical method of identifying crop rotation was developed and applied for the first time by Jäger (1966; see also Herrmann 1981). Prerequisites for this method are closed storage finds. The main assumption is that a minor admixture of one crop species within a stock of another dominating crop reflects the harvest of the previous year (s). Numerical analysis results in the reconstruction of rotation schemes. Attempts to infer crop rotation from archaeological seed assemblages are still undertaken, but have often proven problematic. Quite often, archaeobotanists suggest that crop samples with minor contaminations by other crops are indicative of prehistoric crop rotation (see e.g. Dennell

1974; Matterne 2000). Karg and Jacomet (1996) for example, demonstrated the practice of crop rotation in Late Bronze Age Zug Sumpf (Switzerland) on the basis of the analysis of stored cereal assemblages. In this case, spelt stocks were generally cleaner than barley stocks. Barley stocks almost always contained small quantities of spelt. Therefore, they established a rotation of fallow, followed by spelt wheat, followed by barley (Jacomet/Karg 1996, 250). Karg could likewise demonstrate a three year rotation regime consisting of spelt wheat followed by fallow, followed by oats in Late Medieval Laufen, on the basis of the relative proportions of the cereal crops (Karg 1996a, 77-82).
A problematic aspect of establishing crop rotation was put forward by Jones and Halstead (1995). Their ethnographical observations on the Greek island of Amorgos demonstrated that most crop contamination is predominantly introduced with the seed corn, and does not derive from a previously grown crop (see also Palmer 1998). Therefore, if crop X is found as a minor admixture or contamination in a stock of crop Y, this does not offer any indications on the sequence in which these crops were cultivated. Naturally, such an observation does give evidence that more than one crop was cultivated within a relatively short period of time.

Indications in the study material
Generally speaking, botanical assemblages from single contexts virtually always consist of more than one crop species. This, however, is not sufficient as a departure point for reconstructing former agricultural strategies. For a similar investigation, genuine closed storage finds are prerequisite.
For our material, only few finds suit a similar investigation because of the low numbers of seeds per context (table 10.3; see also chapter 8). For those samples containing higher quantities of material, a preliminary attempt was made to trace former cropping strategies. To a certain extent, these finds all present storage contexts, like silos and storage pits. They were never recovered as closed or sealed features however, so it is quite possible that stray finds have "polluted" the evidence. Therefore, a profound analysis of the majority of these samples had to be omitted as we could not be sure that these plant remains ended up in their contexts simultaneously or by the same action.

Two of the storage samples presented point to monocropping or the separate harvesting of horse bean, respectively emmer wheat (Frouard-2035 and Ay-356). The most common combinations of crops appear to be: naked and hulled barley in varying proportions (see above for the interpretation), spelt wheat and barley, and emmer wheat and barley. Sometimes these mixtures are found together with millet, or combined with pulses. In other cases (Riethoven) millet was the dominant crop, combined with emmer wheat and barley.
Only the data of Gondreville (Hallstatt D-silos) lend themselves to the classical method of identifying crop rotation. In one of the silos of Gondreville (4214), large quantities of cereal grains were observed during the excavation and consequently carefully sampled. The assemblage is dominated by — presumably hulled — barley and consists further of spelt wheat and einkorn. The relative proportions are approximately 94 : 6 : 6. The sample is not clean, as chaff remains of emmer and einkorn, and grains of millet, lentil and pea were also found. In another silo of Gondreville (4219) the seed assemblage is dominated by barley, complemented by spelt wheat and einkorn. The relative proportions are comparable to those of sample 4214, i.e. approximately 90 : 9 : 1. Pollution was practically absent in this assemblage. This would support the idea that a system of successive cultivations of different crops or a rotative crop cultivation was applied in Gondreville. Spelt wheat would have been the first crop (after a period of short fallow?) and barley would have been the second crop. The weed spectrum supports the hypothesis. The weed taxa in the barley stock are relatively abundant which could point to the cultivation of barley following a preceding crop (i.e. spelt). This assumption can only be confirmed if, in the future, spelt stocks from the same site become available for analysis.

10.5 Conclusion

The conclusion with regard to the presence of crops should be, by definition, relatively prudent because of two restrictive factors. One restriction is the relatively small number of samples taken into account, especially for the MDS region. For both regions, especially the small amounts of samples from the early periods could result in a powerful bias in the results. The other factor is the occasionally insecure identifications, of wheat grains in particular, which can, at times, cause major problems. Taking these obtrusive effects into account, we should be able to draw some (preliminary) conclusions on the crops.
To some extent, the data from the Moselle region and the MDS region demonstrate comparable developments with regard to crop cultivation.
The earliest periods (before 1250 BC) are characterized by the presence of exclusively cereals. Both in the Moselle region and the MDS region, the regular occurrence of barley, millet, emmer wheat, (possibly) spelt wheat and minor occurrences of einkorn and bread wheat were assessed. We may assume that agriculture was completely based on the cultivation of these cereal species. We saw in the previous chapter that it is not implausible to suggest that these crops were part of an intensive "garden" cultivation in which the cereals were, among other things, rigorously hoed, manured

Table 10.3 A selection of storage finds assemblages

Geldrop			**Crevechamps**			**Frouard "Haut de Penotte"**			**Ay-sur-Moselle (F)**	
			Zone B							
feature	**112**		feature	**2625**		feature	2091		feature	356
context	pit		context	silo		context	silo		context	silo?
datation	mba		datation	BM?		datation	HaA2/B1		datation	HaB1?
volume (litres)	15		volume (litres)	1.5		volume (litres)			volume (litres)	6
crops			**crops**			**crops**			**crops**	
Hordeum vulgare vulgare (grain)	153		Hordeum vulgare	15		Hordeum vulgare nudum	XXXX		Triticum dicoccum (grain)	79
Triticum aestivum (grain)	4		Hordeum vulgare nudum	71		Hordeum vulgare vulgare	XXXX		Triticum dicoccum (glume base)	462
Triticum dicoccum (grain)	551		Hordeum vulgare vulgare	231		Triticum dicoccum (grain)	3		**arable weeds**	
Triticum dicoccum (glume base)	18		Triticum aestivum (rachis internode)	8		Cerealia	XXX		Bromus secalinus-type	85
Triticum monococcum (grain)	2cf		Triticum dicoccum (glume base)	4		**arable weeds**			Bromus spec.	603
Hordeum/Triticum spec. (grain)	212		Triticum monococcum (rachis internode)	1		Bromus spec.	1		Bromus sterilis/tectorum	67
Cerealia (fragment)	xxx		Triticum spelta (glume base)	28		Bromus sterilis/tectorum	1		Chenopodium album	3
arable weeds			Trit. spec. (glume base)	24		Bromus secalinus-type	1		Galium aparine	2
Capsella bursa-pastoris	1					Chenopodium album	1		Galium spec.	3
Chenopodium album	6					Galium aparine	1		Lapsana communis	148
Chenopodium ficifolium	3					Gramineae	1		Plantago major	1
Chenopodium spec.	1					Sambucus ebulus	1		Fallopia convolvulus	179
Fallopia convolvulus	56								Persicaria lapathifolia	1
Gramineae spec.	3								Rumex acetosella	13
Lolium/Festuca spec.	21								Stachys arvensis	2cf
Persicaria hydropiper	1								Vicia hirsuta	1
Persicaria lapathifolia	42									
Persicaria lapathifolia/maculosa	18f									
Persicaria maculosa	5									
Spergula arvensis	2									
Vicia hirsuta/tetrasperma	3									
cf = tentative identification										

Gondreville "site 4"			Frouard "Haut de Penotte"		Betting "Galgenberg"		Heesmortel bij Riethoven	
feature	4214	4219	feature	2035	feature	1	feature	154
context	silo	silo	context	silo	context	silo	context	pit
datation	HaD	HaD	datation	HaD	datation	Ha fin./LT anc.	datation	eia
volume (litres)			volume (litres)		volume (litres)	unknown	volume (liters)	30
crops			**crops**		**crops**		**crops**	
Hordeum vulgare (grain)	XXXXXX	XXXXXXX	Hordeum vulgare vulgare	1	Hordeum vulgare vulgare	45	Hordeum vulgare (grain)	7263
Hordeum vulgare nudum (grain)	-	XXcf	Triticum monococcum (grain)	1cf	Hordeum vulgare	50	Hordeum vulgare (internode)	1
Hordeum vulgare vulgare (grain)	XXXXXX	XXX	Triticum monococcum (base)	1cf	Triticum spelta	21	Triticum dicoccum (grain)	3459
Hordeum vulgare (rachis internode)	1	-	Triticum spelta (grain)	1	Triticum/Hordeum spec.	40	Triticum dicoccum (base)	191
Triticum dicoccum (base)	20cf	-	Cerealia	XX	**arable weeds**		Triticum/Hordeum	7892
Triticum monococcum (grain)	1120	XXX	Vicia faba	XXX	Avena spec.	4	Panicum miliaceum (grain)	489
Triticum monococcum (base)	10cf	-			Vicia spec.	1	**arable weeds**	
Triticum spelta (grain)	XXXcf	XXXX					Bromus cf. secalinus	2
Triticum spelta (base)	XXXcf	-					Carex spec.	4
Triticum spec. (grain)	1078	-					Chenopodium album	93
Triticum spec. (base)	XX	4					Digitaria spec.	3
Panicum miliaceum	1	1					Galeopsis spec.	1
Linum usitatissimum	-	1					Gramineae	30
Lens culinaris	4	-					Fallopia convolvulus	51
Pisum sativum	1	-					Persicaria hydropiper	167
Vicia faba	-	1cf					Persicaria lapathifolia	39
arable weeds							Persicaria maculosa	22
Adonis spec.	4	-					P. lapathifolia/maculosa	55
Agrostemma githago	50	1					Persicaria spec.	128
Agrostis spec.	1cf	-					Rumex acetosella	26
Avena spec.	17	1cf					Solanum nigrum	10
Avena spec. (base)	1	-					Spergula arvensis	30
Avena spec. (awn)	1	-					Stachys arvensis	36
Bromus secalinus-type	1	-					Veronica cf. arvensis	1
Bromus sterilis/tectorum	3	-					Vicia spec	1
Bromus spec.	1	-						
Buglossoides arvensis	8cf	-						
Convolvulus arvensis	-	4						
Galium aparine	9	32						
Galium spurium	15	4						
Lapsana communis	12	6						
Malva sylvestris	9	-						
Orlaya grandiflora/Pastinaca sativa	-	25						
Papillionaceae	-	-						
Rumex spec.	15	2						
Veronica hederifolia	-	3						
Vicia hirsuta/tetrasperma	22	8						
Vicia spec.	5	7						

Table 10.3 continued

and weeded (G. Jones 1992, 141). Concluding from the evidence of the former chapter, it is not likely that the cereals can be related to large-scale, extensive winter cereal cropping (as was suggested by Kroll 1997, for the einkorn cultivation in Central Europe).

The later periods demonstrate an extensive widening of the range of crops in both areas. In the Moselle region this development takes place from the Bronze Moyen onward (1500 BC) with its climax in the Early Iron Age (from 750 BC onward). In the MDS region, it appears to start in the Early Iron Age (800 BC onward) and to have its peak in the Middle Iron Age (from 500 BC). In the earliest periods (Chalcolithic and Early Bronze Age), the total number of crop species for the Moselle region is four and this number threefolds to twelve different crop species in the Early Iron Age. In the MDS region, the number of different crop species in the Middle Bronze Age is six which increases to eleven in the Early Iron Age and twelve in the Middle and Late Iron Age. The numbers of different crops apparently increased by the introduction of various new food crop species.

Diversity in the range of crop species

The observation that the second half of the 2nd millennium and especially the beginning of the 1st millennium BC are characterised by an increase in the number of species is not new. As early as 1952, Helbaek observed the same development for the Iron Age in Britain, and many more authors have concluded that throughout Europe this period was marked by a widening of the crop assortment (Helbaek 1952, M.Jones 1984, Bakels 1999, Harding 1989, Kroll 1997).

The increase of the range of crops appears to imply a diversification or differentiation in the agrarian regime and the co-occurrence of different cultivation regimes next to each other. The individual crops all have their specific demands, with regard to cultivation regimes and environmental conditions. As the various crops all have their specific demands with regard to soils, soil working and manuring (see above) their introduction must be associated with an increase of different agricultural practices (preparing and working of the soil, sowing, weeding, harvest methods), crop processing and food preparation activities.

A broader spectrum of species also requires an elaborate and more accurate agenda of sowing, harvesting and the various activities in-between. This requires organisation, time management and labour specialisation, co-ordination and possibly, co-operation. In brief, it gives rise to a totally different (agri-)cultural mentality. Some of the crop plants, like lentil, pea, horse bean, millets, gold-of-pleasure and flax, of which the presence was attested in our material, doubtlessly require a horticulture-like care and small-scale, intensive cultivation. The increase and increasing variability of these activities could be interpreted in terms of specialisation of labour. Although this is suggested by the study of *contemporary* traditional agriculture, we might also assume that certain elements of crop cultivation were divided between the sexes (see above, millet and pulses harvested by women). The implications for a possible social differentiation in relation to specialisation, labour and decision-making, will be described in chapter 12.

The intensification of agriculture (i.e. of the care and attention for the specific demands of the various crop species and the field in which they grow) could also imply a more far-reaching modification of the agricultural landscape. This could be related to an increasing appropriation and, at the same time, a justification of the appropriation of nature. In chapter 12, these new developments towards ownership of arable land will also be elaborated upon.

The introduction of new species, moreover, reveals a great deal about the attitude of farmers to their crops. The range of crops and their accompanying cropping systems represent responses to various environmental, agricultural and socio-cultural conditions, and differing attitudes of the farmers towards their crops. This contradicts the traditional image archaeologists have developed on prehistoric farming. The traditional image of farmers — as agriculturalists — is of people sowing their seed and harvesting it *en masse* in a collective approach (Leach 1997, see also Bronson 1975; Johnson 1989), but this is not consistent with what we find in our material. From the end of the 2nd millennium or the beginning of the 1st in particular, we may assume that the farmers' close familiarity with their plants encouraged their interest in new varieties and/or new species. [18] Farmers — as horticulturalists — handle their crops with closer and more purposeful intention and can risk experimentation with new cultigens. The presence of almost ten different new food plants does point in this direction.

In my view, agricultural intensification and culinary diversity are two inter-related developments or linked processes. In our model of change with regard to agricultural change, the latter should be interpreted merely as a social or cultural change. The spread of new crops is a social process (see Sherratt 1991; 1999; Meadows 1994; Bakels/van Amen/Wesselingh 1996). A model of food choice imposes itself, where certain new foodstuffs as well as the accompanying preparation and habits of consumption were adopted for social reasons. Although this is not the primary objective of this study, it was suggested above that the introduction of millet bread formed a major transformation in the first half of the 1st millennium BC (Behre 1998). The reason for a shift towards crop and food diversity might have been necessary for social and prestige display. It could also have been symbolic, in terms of the establishment of a (new) cultural identity (see Viklund 1998, 174).

The poor composition of the assemblages excludes a thorough analysis of possible mixed cropping, the assessment of maslin cultivation or crop rotation (see above). The examples of mixed assemblages do not offer convincing indications for the presence of maslins or mixed cropping. This lack of evidence is mainly due to the poor quality of the assemblages. Mixed or multiple cropping as agricultural strategy however, might well be assumed, not only for the so-called storage finds but virtually for all sites producing samples containing several different crop species. Based on the fact that the majority of the settlement sites under study were inhabited for no more than a single generation (c 30 years), it may be assumed that the variety of crops found on the sites were grown within this time span. That is to say that one generation of inhabitants of a Hallstatt settlement could theoretically have had c. 13 different crops under cultivation — either simultaneously or one after the other. The expansion of the range of crop species from approximately around the beginning of the 1st millennium BC onwards, could be indicative in our argumentation on a possible agricultural intensification.

Rise of spelt?

A rise of spelt wheat cultivation at the expense of growing emmer wheat, as is frequently observed in Britain and in many parts of Europe (Rhineland, Alpine zones) in the 1st millennium BC, could not be securely assessed in our study regions (see above). The shift from the cultivation of emmer to that of spelt wheat is often related to the expansion of agriculture onto marginal soils and the extensification (i.e. disintensification) of agriculture (M. Jones 1984; van der Veen/O'Connor 1998). This assumption is based primarily on the association of spelt wheat and weeds indicative of poorer soils in seed assemblages (van der Veen 1992), and on the relative performance of spelt in more extreme conditions such as low nutrients and low temperatures (van der Veen/Palmer 1997, but see above information by Enklaar 1850). Notably, these observations do not however, exclude *per se* the possibility of growing spelt on more fertile soils and in more favourable circumstances.

We must emphasise that the switch to spelt was not universal across Europe and this may imply that the need for agricultural expansion was not uniform across Europe or that all farmers did not choose spelt wheat as the method through which to expand their production (regional differences were noted in Britain as well, see van der Veen/O'Connor 1998, 131). In addition to this, the choice of crop was more complex than simply choosing a new crop for its yield, its hardiness or soil tolerance, as there may have been any number of cultural (or culinary) and social connotations as well (see above).

As described above, van der Veen pointed to another explanation for the shift to spelt wheat cultivation (van der Veen/O'Connor 1998, 133; 1995, 342). She assumed that emmer wheat and spelt wheat were initially grown as mixed crops on the same fields or at least under the same cultivation regime. Any change in this cultivation regime (had it been it expansion, decreasing manure, soil disturbance or labour effort, i.e. a dis-intensification) might have resulted in the increase of the proportion of spelt within the field at the expense of emmer wheat. In that case, the decision would not have concerned the specific change of crop but rather the specific change of cultivation regime.

A shift (from emmer?) to spelt wheat cultivation in our regions could be assessed with some caution for the late Hallstatt (C/D) and Early La Tène period in the Moselle region. The sites of Jouy (Hallstatt C), Gondreville (Hallstatt D), Betting (Hallstatt final-La Tène ancienne), Rémerschen (Hallstatt final-La Tène ancienne) and Woippy (La Tène C/D) yielded what were mostly small numbers of spelt grains and chaff remains. Additional research should be carried out to see if these data represent a drastic changeover from emmer wheat to spelt wheat in the Late Iron Age. Although the evidence really is insufficient for an accurate assessment of the situation, a transition to spelt wheat cultivation appears never to have occurred in the MDS region. In this region, we do have some indications for spelt cultivation (in the Early and Middle Iron Age as well as in previous periods), but these were only represented by very small numbers of seeds. On the other hand, emmer wheat remains the dominant wheat crop during the Iron Age in this region. Therefore, for the time being, we might conclude that no drastic changes in cultivation regimes took place in this area.