Archaeological land evaluation
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Chapter 4
Ancient agriculture in Central and South Italy
Land utilisation types: land, farms, technology, people and animals
Land use requirements: crops

4.1 General introduction

Now that we are familiar with the land qualities and limitations of the reconstructed land systems of the three regions, we have to determine how prehistoric people (may) have cultivated their land. The term ‘potential land utilisation type’ is used. *A potential land utilisation type (LUT) describes in detail the way in which people may have used their land in the past.* So a LUT describes the way people (may have) managed their land, the crops they cultivated (*cropping characteristics*) and the agricultural techniques they were acquainted with. A LUT also incorporates the soil and cultivation requirements and limitations of these land use types. For each region, various LUTs are determined regarding their own specific physical characteristics. The information about these land use types is derived from the ancient literature, botanical findings and the interpretations of present-day authors of indirect evidence, such as inscriptions.

An essential part in the land evaluation method describes the agrarian development and innovations in ancient Italy (*technology*). We have to unravel the ways in which people were able to manage their land in the different periods, in order to determine the potential suitability of the various kinds of soils for prehistoric farming.

In the first place we have to know what kinds of agricultural tools were used, such as plough types, sickles and axes, and what material these tools were made of (wood, bronze, iron, or a combination of these materials). Next, the efficiency of these tools to work the soil has to be examined. Also other methods of land management have to be looked at, such as *ignicoltura* techniques (explained below), the possibilities to leave the fields fallow for a few years, rotation, manuring, and intercropping. Acquiring new land by building terraces on hill slopes or drainage of waterlogged fields was also known already in the period studied here.

To establish which technology was common in ancient Italy and at which point in time, I will combine data from different sources. These sources include data from archaeological excavations (such as agricultural tools) in Italy, literary sources transmitted by Roman and Greek writers (especially agronomers), and specialist studies executed by White (1967, 1970, 1984) and Forni (1990, 1998, 2001), terracottas, images on coins, on ancient pottery and rock art and information from present-day experimental centres. Finally, a (as detailed as possible) description of the land use requirements of (ancient) crops is given at the end of this chapter based on information from experimental agricultural farms.

To conclude, chapter 4 gives an overview of the most important LUTs in ancient Italy. Of the available data, the most logical and informative data is dealt with and will be used in the land evaluation procedures. These data are presented in Appendix B.

4.2 Four agricultural phases in ancient Italy (according to Forni 1989)

Forni (1989) distinguishes four historical agricultural phases for Bronze Age until Roman Age Italy (which has been especially deduced from the Etruscan area) based on the following criteria:
- changing socio-economic structure of the countryside
- growing influence of the city
- introduction of grapes and olive
- commercial cultivation of grapes and olive and trade
- increasing use of iron instruments, especially the ploughshare

Table 4.1 is a translation from Forni’s article. It is primarily also based on the Etruscan developments, but, in general, it provides a clear basis for the agricultural changes in Central Italy. This interpretation is not only based on information from ancient writers such as Columella, Varro, Cato and Pliny, but on the archaeological findings and inscriptions in Italy too, as shown in the next table 4.2.

<table>
<thead>
<tr>
<th>Phases</th>
<th>Socio-economic periods in Etruria</th>
<th>Instruments</th>
<th>Techniques</th>
<th>Cultivated plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>2000–1000 BC</td>
<td>Mediterranean type ploughs with convertible wooden ploughshares</td>
<td>Dominant use of soils in hilly terrain, associated with Ignicoltura (swidden) alternated with cereals. Introduction of the rotation (five to ten years) of arable fields and grassland in loose soils. Animal husbandry</td>
<td>Cereals: Triticum dicoccum, T. aestivum, T. compactum. Leguminosae: Vicia faba, Pisum arvense, Lathyrus cicer. Quercus ilex and Fagus. First evidence of olive cultivation in South Italy (Bronzo finale), domestic grapes became known</td>
</tr>
<tr>
<td>III</td>
<td>750 – 600 BC</td>
<td>Appearance of primitive iron instruments</td>
<td>Origin of fallow systems</td>
<td>Introduction of commercial grapes and olive cultivation</td>
</tr>
</tbody>
</table>

Table 4.1 Four historical agricultural phases in the context of the history of Italy (translated and modified after Forni 1989)

For the land evaluation research, I will describe three periods in detail based upon the improving and increasing knowledge about and use of agricultural techniques and cultivated crops. In the course of time, a wide variety of soils could be taken into cultivation, more crops were grown, and an ‘industry’

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1 For a more detailed discussion I refer to Forni (1990, pp. 247-250 and 257-261).
2 Forni (personal communication) prefers to use the term Ignicoltura instead of slash and burn system, because the last refers to modern techniques in which iron tools are common to fell and cut trees. But primitive people first desiccated the trees by burning the rind from the trunk. Then, the trees were set on fire. This technique probably shows more resemblance with historical techniques.
of wine and olive production emerged.

The Bronze Age (2000–1000 BC) is distinguished from the Iron Age, mainly because of the absence of iron instruments. This absence prohibited farmers to cultivate heavy soils.

Forni’s second and third periods (the period of Villanovian revolution and the period of aristocratic structure) have been joined into the Iron Age (1000–600 BC), because of their resemblance in the way farming practices were performed.

The period is marked by an urbanisation process and by the development of early states. In economic terms a shift can be observed from societies with a predominantly subsistence economy to early civilisations with more varied forms of economy due to agricultural and craft specialisation (Nijboer 1998). Agriculture diversified and its output increased. Various new crops were introduced. Only on a small-scale, iron ploughshares were used, facilitating the work on the land and hence diminishing labour.

The Archaic and Roman periods (600 BC–400 AD) were characterised by the spread of iron instruments, hydraulic structures, various farming systems and so on. Farming became more and more developed and specialised. In the sections below, every period is dealt with separately.

4.3 Description of the main land utilisation types (LUTs) in Bronze Age Central and South Italy (2000 BC till 1000 BC)

4.3.1 Detailed description of the main land utilisation types

Only few authors deal with Bronze Age agriculture in Italy. Agriculture developed (Sherratt 1980) from a system of groundwater horticulture (in which groundwater provided a continuous supply of soil moisture) to rainfed agriculture (also called dry farming compared to irrigated farming) in the third millennium BC, which continued into the Bronze Age. Wolf in his book Peasants (1966) characterises agriculture in this period as a system, relying on men and animal power, aiming to produce foodstuff for their own husbandry. Kamermans (1993) claims, that Bronze Age farming can be divided into Wolf’s five paleotechnic ecotypes (Wolf 1966: 20, 21):

a) *Ignicolatura* cultivation with long fallow (swidden system, *debbio, pascuum*)
Fields (covered by grass, bush or forest) were cleared by using fire and hoes, and cultivated until yields declined. New fields were brought in use, whereas the old ones were left abandoned or were in use for stock pasturage. After some years, the farmers returned to the first cleared fields again. Usually, no additional manuring was needed.

b) Sectorial fallowing systems (rotation)
The land was divided into two or more sectors. These sectors were cultivated for a few years, then left to fallow for three or four years. Also here, the hoe or digging stick (only in the early Bronze Age) were mainly in use.

c) Short-term fallowing systems associated with cereal cultivation (Eurasian grain farming, *a campi ed erba*)
Fields were cultivated for one or two years and left abandoned for only one year to regain fertility. More sophisticated instruments, such as animal-drawn ploughs, were used in this kind of agriculture. In this way, larger areas could be cultivated. Animal dung was collected to manure the fields.

d) Permanent cultivation of favoured plots, combined with a fringe of sporadically utilised hinterland (infield-outfield system)
Permanent cultivation is possible on favourable plots, such as fertile fluvial and marine soils.
e) Hydraulic systems

Permanent cultivation depending on permanent water supply for the growing of crops. Rivers were
tapped for irrigation.

Wolf considers types a (debbio), c (a campi ed erba) and e (hydraulic systems) as the main farming
systems in the Bronze Age period. I think that hydraulic systems were not common in the Agro Pontino,
because in this region autumn-sown crops did not experience a water deficiency. As Wolf also states,
this kind of farming occurs in the dry lands of the Old World. So maybe it is applicable to the
southern regions of Italy: Salento peninsula and Sibaritide.

For the land evaluation, it is not important to differentiate between the first two, because the tools
and fields are practically the same as well as the rotation systems of cultivation and fallow. The third
system may have been possible in the lowlands, only if the soils were not too wet or heavy. This is
also valid for the system of permanent cultivation, provided that Bronze Age people were aware of the
advantages of ploughing under organic remains to regain fertility. Kamermans (1993) adds a sixth
type: long distance transhumance, but to what extent this is important in the Bronze Age, it is not quite
clear.\footnote{In this research, transhumance is not considered to be an agricultural system, in the sense of it requiring particular soils, so it will not be incorporated. For more details about transhumance, I refer to the thesis of F.A.Veenman: \textit{Reconstructing the pasture} (2002). At the risk of labouring the obvious, unlike vegetation, wandering animals cannot be kept in categories and for land evaluation, transhumance is impossible to implement into the system (Veenman, personal communication).}

Forni (1990: 248–9) briefly refers to the traditional continuation of the system of summer meadows,
indicating that its importance diminished by increasing farming activities (Barker 1976; Radmilli
1974).

Finke et al. (1994) describe a Bronze Age land utilisation type of rainfed mixed crops of barley
(\textit{Hordeum vulgare}), emmer wheat (\textit{Triticum dicoccum}) and spelt (\textit{Triticum spelta}). Tillage was
performed by oxen and plough. Simple hand tools and light wooden ploughs required light, well-drained
soils.

\section*{4.3.2 Cultivated crops}

Forni (1990) gives a clear overview of the first evidence for cereal crops in Italy. The oldest emmer
wheat (charred seeds) was found in a cave Grotta dell’Uzzo, a large natural cave on the eastern coast
of the San Vito lo Capo promontory on Sicily, and was dated about 6000 BC (Constantini, 1989). Ein-
korn wheat was also found in the cave on Sicily (Constantini 1989; dating from the same period: 6000 BC),
together with bread wheat and club wheat (4800 BC). In Puglia durum wheat (5160 BC) and spelt wheat (4490 BC) were discovered (Follieri 1987). In the cave on Sicily, Constantini reports
charred weeds of barley from about 6000 BC.

In Italy, in the excavated Neolithic and Bronze Age sites, hulled wheat (\textit{Triticum monococcum} and
\textit{Triticum dicoccum}) wheat and naked wheat (\textit{Triticum aestivum} and \textit{Triticum compactum}) were found
(Forni 1990: 225). The naked wheat was used for the preparation of flour for bread. To prepare hulled
wheat, the seeds had to be handled first with fire, than threshed and milled. People used the flour to
make porridge, pizza, and soup with milk.

Indications for Bronze Age olive tree cultivation remain scarce in Italy (see also chapter 6: pollen
analysis), but convincing archaeological proof (described by Eleveilt 2001) was found at the site of
Broglio di Trebisacce (Sibaritide, South Italy):

\begin{itemize}
  \item 292 olive stones (Nisbet & Ventura 1994, 577–580), which mean diameter and length exceed
        those of the wild variants (Fiorentino 1995),
  \item the abundance of olive wood in the archaeological layers (probably as fire-wood and for
        construction purposes) and indications of degeneration of the original vegetation proves
        intensive anthropogenic use of the landscape and the profuse existence of olive trees in the
\end{itemize}
anthropogenic use of the landscape and the profuse existence of olive trees in the vicinity of the site; their first exploitation dating back to at least 1400 BC (Maaskant-Kleibrink 1996–1997, 83; Vanzetti 2000),

- from the late Bronze Age onwards, large olive oil storage barrels or ceramic containers (dolia) and storage accommodations were found (Levi et al. 1999, Peroni 1994).

To conclude, according to Peroni (1994, 845), intensive olive oil production emerged from the Bronzo finale (second phase of the late Bronze Age, ca. 1150–1000 BC) onwards. He states that overseas Greek contacts lead to the emergence of olive cultivation and a stratified society, in which time and means enabled ‘rich’ farmers to grow olive trees. That is, olive cultivation required long-term investigation and considerable effort before yields were obtained, and was only possible in a surplus producing agricultural economy.

### 4.3.3 Agrarian technology in Bronze Age Italy

**Ploughs**

According to Forni (1990), the plough was not invented in the first place to plough and turn over heavy soils. It was constructed to crumble the fields (which had already been opened and broken by other techniques and instruments, such as fire, pickaxe, and spade) and for the formation of furrows in which seeds could germinate. Only with the introduction of the iron ploughshare, fields could be ploughed directly.

Figure 4.1 gives an overview of the terminology of a simple ancient plough (Forni 1998: 129). This so-called skate plough was used in Central and South Italy until recently. White (1967: 130–142) discusses in detail the different parts of a simple plough. For a better understanding of the technological changes through time, each part is discussed below.

![Figure 4.1 A simple plough (the only plough used in Mediterranean Italy until recently, in: Forni 1998)](image)

**Components of a simple plough:**

*Handle and stilt:* the stilt is the vertical part of the plough to which the handle is attached in order to steer.
Sole or share-beam: the essential part of the plough, and (which) indeed can be regarded as the plough itself (White 1967). The first ploughs were constructed with a sole only, and consequently broke frequently when hitting a stone. Later, the sole was fitted with a detachable share, made of wood, bone or iron.

Plough-beam: the curved section which joins the share-beam to the yoke-beam, through which the motive power is supplied (White 1967).

Yoke-beam: most vulnerable part of the plough, that consisted either of a single length of timber, curved at one end and mortised into the sole, or of a shorter length attached to the plough-beam by means of pegs or lashings (White 1967).

Ploughshare: a soil breaking or soil turning tool attached to the sole. Pliny (18.171–2) describes different shares, which White interprets for peninsular Italy as follows: so-called ground-openers (for compact soils), common shares with beak-curved ends, and shares with a small spike at the end (for easily worked soils). Finally, he describes the shares with a double-edged blade to cleave the soil and to cut off the roots of the weeds.

Agricultural tilling implements are divided by many authors (Wolf 1966, White 1967, Spurr 1985) into two main groups: ards and ploughs, light and heavy ones. Ard is Swedish for the “breaking plough, which is symmetrical in its design and presents the same appearance when viewed from either side. When pulled through the ground, it throws up soil on both sides of the dividing ploughshare. The ard is ideal for shallow tillage (White 1967) and is an instrument adapted for ploughing light and friable soils (Wolf 1966). A plough is asymmetrical in design and turns over the soil, and is capable of deeper tillage. Wolf classifies the ard as a light, easily transported and cheap to make instrument.

Forni explains this distinction between ards and ploughs a little differently, and classifies the ploughs by the material they were made of, and by their outer appearance (personal communication):

a. Symmetrical simple ploughs completely made of wood, with or without changeable ploughshares
b. Symmetrical simple ploughs with an iron ploughshare
c. Wheeled ploughs
d. Ploughs with a cart
e. Asymmetrical ploughs with a ploughshare, usually with a cart

In his personal communication, Forni explains that the ploughs entirely made of wood were light, as well as the later ones with an iron ploughshare. Only with the introduction of the cart, the instruments appeared to be larger and consequently heavier. But, since the last ones were never present in Mediterranean Italy, all ploughs can be considered as being light in this region.

Following the work of Novikov (1970), simple symmetrical ploughs can be divided into two groups according to the position of the share-beam and the ploughshare (this subdivision resembles the ard and plough difference of White and Wolf):

a. Simple ploughs with a vertical or oblique position of the share-beam and the ploughshare
This type of ploughs was less stable then type b. and steering was only possible with great difficulty, requiring a lot of effort. However, when hitting an obstacle, the ploughs could be lifted up easily. Suitable fields for working with this kind of ploughs were humid clayey soils, fields, which had been recently cultivated or deforested terrains full of roots and branches.

b. Simple ploughs with a horizontal position of the share-beam and the ploughshare
Except for the plough of Arezzo (4.5.3), all Etruscan and Italian known ploughs are of this second type. The ploughs, also called skate ploughs, only scratched the soil. They had a larger stability than type a. ploughs and could be manoeuvred easily during the ploughing. These ploughs were character-
istic of the dry Mediterranean environment with low yields. Ploughing humid clayey soils had to be avoided.

Asymmetrical ploughs were designed to turn over the clods of earth. But until Roman times, in peninsular Italy, people used the symmetrical ploughs only.

![Figure 4.2 Two types of the simple symmetrical plough (Forni 1990: 182)]

In the current research, the subdivision mentioned above is followed. Generally speaking, in Bronze Age Italy, simple ploughs (and other agricultural instruments) made of wood were common, whereas in Iron, Etruscan and Roman Age Italy simple ploughs with an iron ploughshare were used.

In his book Gli albori dell’Agricultura (1990), Forni shows a broad overview of the ploughs or parts of ploughs, and other agricultural instruments found in Italy, together with their dates and characteristics. A modified table after Forni is given below (table 4.2).

According to Forni (in prep.), Italy is one of the best countries for the study of tools and prehistoric and protohistoric agricultural techniques. For the Bronze Age, he provides an additional list of the main discoveries in Italy (quotation):

a. Hundreds of agricultural rock-cut images. Most of them depict ploughing scenes. Forty-five are located in the central-Alps, in Valcamonica (Forni 1997a), dating from the Late-Neolithic period to the Iron Age. Five-hundred-seventy-one were found in the Monte Bego region near the Italian-French border (Forni 1996a, Lumley de 1995). These date from the Bronze Age and related epochs.

b. Most precious discoveries are the fossil furrows of the crossed type in Grigioni area from the Bronze Age (Forni 1997a).

c. A rich documentation of real tools comes from the Terramare culture: hoes, ploughshares and other ploughing components, cutting instruments completely made of wood, bone or horn dating from the Bronze age (Forni 1997b).

d. Also belonging to the Early Bronze Age are the finds of ploughs in the Gardesana area (Lavagnone, Ledro and Fiavê-Carera; Perini 1987, Forni 1990: 185–188).

e. Especially important for southern Italy is the recent discovery in several areas with volcanic soils in Campania, related to the Vesuvius, of traces of land division into plots and cultivation of the soil. Fossil ploughing furrows of the early Bronze Age (Marzocchella 1998, 2000) were also found.

f. Small bidental hoes (zappette a bidente), axes and foraterra (implement to make holes in the ground for planting seedlings or driving poles) appear in the engravings of Monte Bego (Final Bronze age, Early Iron age; Forni 1996a).
<table>
<thead>
<tr>
<th>Chronology</th>
<th>Dating method</th>
<th>Period</th>
<th>Location</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>2500 y. BC</td>
<td>Sti</td>
<td>Chalcolithic</td>
<td>Dos Cuì (Brescia) –</td>
<td>Horizontal wooden part attached to the ploughshare (useful in terrain which has already been cultivated before)</td>
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<tr>
<td></td>
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<td>Northern Italy</td>
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<tr>
<td>2000 y. BC</td>
<td>Str</td>
<td>Bronze Age</td>
<td>Lavagnone (Brescia) –</td>
<td>1. Horizontal wooden part attached to the ploughshare, with a connection to the stilt similar to the Tritolome model</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Northern Italy</td>
<td>2. Convertible ploughshare</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3. The depth of the furrow is regulated by a hinged helm. This plough is the oldest real plough documented in the world.</td>
</tr>
<tr>
<td>800 y. BC</td>
<td>Sti</td>
<td>Iron Age</td>
<td>Seradina (Brescia) –</td>
<td>Pulling horse (first documentation of the use of horses with ploughs)</td>
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<td>Northern Italy</td>
<td></td>
</tr>
<tr>
<td>700 y. BC</td>
<td>V</td>
<td>Late Villanovan</td>
<td>Bisenzio (Viterbo) –</td>
<td>First documentation of the use of a plough in the Italian peninsula by the discovery of fossilised furrows in Campanian area (plough model in a bronze (little) cart)</td>
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<td></td>
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<td></td>
<td>Central Italy</td>
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<tr>
<td>550 y. BC</td>
<td>V</td>
<td>Greek-Sicilian</td>
<td>Betlem (Caltanissetta) –</td>
<td>First ploughshares found in Sicily</td>
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<td></td>
<td></td>
<td></td>
<td>Sicily</td>
<td></td>
</tr>
<tr>
<td>500 y. BC</td>
<td>V</td>
<td>Iron Age</td>
<td>Montebelluna (Treviso) –</td>
<td>Plough illustrated on a ciste. Has a convertible ploughshare. Depth of furrow can be regulated.</td>
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<td></td>
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<td></td>
<td>Northern Italy</td>
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</tr>
<tr>
<td>500 y. BC</td>
<td>V</td>
<td>Etruscan</td>
<td>Gravisca (Lazio) –</td>
<td>First iron ploughshare found in the Italian peninsula</td>
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<td></td>
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<td>Central Italy</td>
<td></td>
</tr>
<tr>
<td>500 y. BC</td>
<td>V</td>
<td>Etruscan</td>
<td>Certosa (Bologna) –</td>
<td>Plough illustrated on a situla of Certosa di Bologna. Presence of an iron ploughshare is obvious.</td>
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<td></td>
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<td>Northern Italy</td>
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</tr>
<tr>
<td>500 y. BC</td>
<td>V</td>
<td>Etruscan</td>
<td>Orvieto –</td>
<td>Bronze model appears at the private collection of Castiglioni. Is considered as an ancestor of the traditional Po-plough. The oblique wooden part attached to the ploughshare is capable for working in humid clayey terrain.</td>
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<td>Northern Central Italy</td>
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<tr>
<td>400 y. BC</td>
<td>V</td>
<td>Etruscan</td>
<td>Arezzo –</td>
<td>Bronze model of a ploughman with a couple of yoked oxen; oblique share-beam attached to the ploughshare (soil turning plough).</td>
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<td>Central Italy</td>
<td></td>
</tr>
<tr>
<td>200 y. BC</td>
<td>V</td>
<td>Roman period,</td>
<td>Talamone (Grosseto) –</td>
<td>Depth of the furrow is regulated by a changeable angle of the wedge of the ploughshare: bronze model.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>but of Etruscan</td>
<td>Northern Central Italy</td>
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<tr>
<td></td>
<td></td>
<td>tradition</td>
<td></td>
<td></td>
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<tr>
<td>0</td>
<td>L</td>
<td>Roman period</td>
<td>Virgil, Pliny, Varro</td>
<td>With ‘aures’ or ‘tablæae’ to widen the furrow</td>
</tr>
<tr>
<td>0</td>
<td>V</td>
<td>Roman period</td>
<td>Brading and Folkstone</td>
<td>Asymmetrical ploughshare (turns over the soil)</td>
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<td></td>
<td>Venezia Giulia, Pannonia</td>
<td></td>
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<tr>
<td>0</td>
<td>L</td>
<td>Roman period</td>
<td>Padania Rhaeto-Etruscan</td>
<td>Plough with (little) cart. Is a Rhaeto-Etruscan invention, which indicates the name of ‘plumamaturum’ (of ‘plogstrum’ = little cart). The cart facilitates the regulation of the depth of the furrow and furthermore the cultivation of heavier soils.</td>
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<td></td>
<td></td>
<td></td>
<td>Pliny</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>Str, V</td>
<td>Roman period</td>
<td>Venezia Giulia, Pannonia</td>
<td>Presents the coulter, which cuts the crust of the soil vertically, in this way complementation of the ploughshare, which cuts the soil horizontally.</td>
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<td></td>
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<td>Inghilterra</td>
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</tr>
<tr>
<td>200 – 400 y.</td>
<td>L</td>
<td>Roman period,</td>
<td></td>
<td>Possibly the beginning of the fabrication of ploughshares in ‘aciarium’.</td>
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<td></td>
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<td>Imperial period</td>
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</table>

Table 4.2  Overview of ancient ploughs or parts of ancient ploughs found in Italy (modified after Forni 1990). Legend: Str = stratigraphically (excavated contexts); V = variable (other sources); Sti = stylistic analysis; L = literary documents

The plough of Lavagnone (2000 BC)

In Italy, the first plough found intact is the very famous plough of Lavagnone (Brescia), excavated by R. Perini during his campaign in 1974 till 1979 (Perini 1982). The plough is made of oak-wood and has a replaceable ploughshare. This must be seen as a remarkable innovation, because when the ploughshare broke, only this part had to be changed, instead of the whole tool, common in the previous periods. This meant a saving of time, and more fields could be worked. The plough probably was
manoeuvrable and plough depth could be regulated, together with a slight inversion of the soil. A yoke was found in the neighbourhood, indicating that a pair of oxen may have drawn the plough.

As we can see from tables 4.1 and 4.2, ploughs were already in use in Bronze Age Italy. The ploughs have been modified in time to facilitate the work and to till heavier soils. Oxen, horses, mules and donkeys were used to pull the equipment.

We must bear in mind, that most of the early archaeological findings of ploughs are located in the northern part of the country, not in the rest of the peninsula, due to a shortage of sites with favourable conservation conditions, such as lacustrine sediments (Forni 1990). However, this does not mean explicitly that no such tools were used. In this respect, according to Forni (2001, in prep.): ‘we have to take account of an important fact of a general ethnological character and thus also with a palaeontological value. From the detailed analysis of traditional agricultural tools all over Africa – carried out by Bauman (1944) – one may deduce that, with diverse populations and cultures, but at equal technological levels, the typologies of tools are similar, especially regarding their function. This seems valid, even if they are situated in geographically diverse environments that are distant from each other. But the resemblance also holds for their morphology, in so far as their functionality is generally connected to their morphology.’

In other words, we can assume that the tools used in the central and southern part of Italy resemble those found in the North, both in outer appearance as in functionality.

### 4.3.4 Favourable cultivation areas

Section 4.5.4 describes Roman soil perception deduced from ancient agronomers such as Pliny and Columella. However, it is impossible to get a grip upon Bronze and Iron Age soil perception because of lack of written sources. Understandingly therefore, Roman soil perception has been used for determining the suitability of soils for Bronze and Iron Age farmers, because it is the best we have.

We can assume that Bronze Age agriculture is a continuation of early Neolithic farming. According to Sherrat (1980), early agriculture in the Old World (including the Mediterranean area) can be described as a form of fixed plot horticulture dependent on ground- and surface-water, which differentiated in succeeding millennia into various forms of dry farming (rainfed) and irrigated agriculture (as we have seen before). Favourable cultivation areas were alluvial plains, lake-edges and other locations with high groundwater levels (Allan 1972, Sherratt 1973). Early sites have been found concentrated near springs, by stream confluences, or on lower terraces by rivers and seasonally-enlarged lakes in Greece and the Balkans (Sherratt 1980).

In the Bronze Age, in which techniques such as drainage were not common, people also preferred moderately sloping areas for crop cultivation, which were free of wet areas and swamps (Forni 1990). Volcanic plains and flat parts alongside hills, sandy and calcareous hills were favoured too.

But it does not mean that people used these soils only. According to Forni (in prep.), despite the general opinion in the literature (White 1967), there is no direct relationship between heavy soils and plough-type. In fact, it is a question of labour and time. For example, in the period before the Iron Age, the fields had to be treated by ignicoltura methods first to loosen the soil. Next, to break the
heavy clayey soil, other tools were used. Only after that labour, the ground could be ploughed with a wooden ploughshare.

However, with the introduction of the iron ploughshare, it was not necessary anymore to treat the ground before ploughing. The strength of the material diminished it to break when pulled through unprepared land. So, working with iron ploughshares, farmers could double or triple the amount of land that had to be cultivated in less time.

But, since one of the main assumptions in this thesis starts with the least-effort theory, we may assume that in Bronze Age agriculture, heavy clayey areas were avoided as much as possible, because it required a lot of effort and time to prepare heavy soils, before it could be ploughed with an iron ploughshare.

4.3.5 Summary and concluding remarks concerning Bronze Age agriculture

Bronze Age agriculture can predominantly be characterised as a self-subsistence farming system, relying on manual labour and occasionally on ploughs and animal traction power.

Three land utilisation types can be distinguished: self-subsistence farming with prolonged or sectorial fallowing (using ignicoltura techniques to cultivate new land); permanent cultivation of favoured plots; and medium-sized, rotational farming systems (aiming at cereal cropping). The most important cultivated crops in this period were wheat and barley, which preferably were cultivated on plots with favourable ground- and surface water levels, on moderately sloping areas, on volcanic plains, on flat parts alongside hills and finally, on sandy and calcareous hills.

In the three farming systems, the use of the hoe and the digging stick for cultivating the fields was well known (regarding the discoveries of many real tools), whereas the larger farms may have also incorporated the simple, symmetric plough and oxen too. The discovery of the almost intact plough of Lavagnone, and the fossil furrows in the Grigioni region and Campania, proved that people were indeed familiar with the use of the instrument in this period. According to Forni (1990), all ploughshares were made of wood in the Bronze Age. Bronze ploughshares (found in ceremonial and ritual contexts, Peruzzi 1981, 118) probably were rarely used in agriculture, because of the brittleness of the metal and the relatively high production costs (Liverani 1979: 62). None of the ancient excavated ploughs were fitted with a stone ploughshare (Forni 1990: 189). Although most ancient agricultural tools were found in Northern Italy, we may assume that they were used in Central and South Italy too (Bauman 1944, Forni 2001). Unless indicated differently (for example on changing ploughshares), it is assumed that the overall morphology of the ploughs mentioned above did not change significantly during the following archaeological periods in Italy.

4.4 Description of the main land utilisation types (LUTs) in Iron Age Italy (1000–600 BC)

4.4.1 Introduction

Society changed significantly in Iron Age Italy: increasing demographic growth and development both in the city (that emerged in the 7th/6th century BC) and in the countryside, emergence of various activities besides farming (such as handicraft, trade and navigation). In agriculture, the typical Mediterranean polyculture (cultivation of cereals together with olives and grapes) became established during the late 8th and 7th centuries BC, and signals an expansion in agricultural production because it supplemented the traditional agronomies (Nijboer 1998). One of the activities formed the preparation of olive oil and wine from domesticated plants. But, although production increased both in quality and quantity, it cannot have been on a large-scale basis (Forni 1990), because maintenance of olive and
vineyards requires intensive care and investment in time before any yield is produced (Nijboer 1998),
despite the fact that at some particular places olive production was already well-known (5.3.2). A con-
sequence of the demographic increase and agricultural expansion resulted in a growing exploitation of
the rural hinterland.

The situla of Certosa (Bologna) shows the use of a metal ploughshare in agriculture. The introduction
of the iron ploughshare led to a general increase in robustness of the plough, but in peninsular Italy the
light plough remained in use until the modern industrial revolution (Forni 1999a).

4.4.2 Cultivated crops

The Iron Age is characterised by an increase of cereal production and a significant cultivation of
leguminoses. Cultivation of emmer wheat (*Triticum dicoccum*) and naked wheat (Helbaek 1967, Jar-
man 1976) was still favoured. In this period, grapes and olive cultivation increased in importance.

4.4.3 Development of iron technology

According to Snodgrass (1980, 336–7), the development of iron technology can be divided into three
stages: the production of iron ornaments, the introduction of iron tools with sharp cutting edges and
finally the prevalence of iron tools over copper alloy tools.

In Latium, a range of iron artefacts were found dating to the late 8th and 7th centuries BC, in which
the combined use of both tools and ornaments was common (Nijboer 1998). Examples include iron
weapons (swords, spits, spearheads, and daggers) and other tools (knives, horse bits and fibulae). Ni-
jboer claims local manufacturing of these iron tools.

4.4.4 Agrarian technology in Iron Age Italy

**Ploughs**

Below, the list summarises important discoveries concerning Italian Iron Age agriculture (Forni in
prep.):

a. In the Cisalpine mountain range we note the ploughing scenes found on situlae and cists of si-
tula art (those of Certosa di Bologna, Sanzeno d’Anaunia-Trento, Montebelluna-Treviso, Ne-
sazio-Trieste). Among them, the situla of Certosa shows a plough with a metal ploughshare,
therefore presumably made of iron (Forni 1990: 263–9).

*The situla of Certosa (Bologna; 6th century BC)*

This situla, Forni (1990) claims, can be considered the most beautiful ever discovered. It forms part of
the burial gifts for a particular ruler or prince, and probably shows a symbolic scene of proto-urbane
agrarian life, death and resurrection, and fertility. We see images of agriculture, hunting people and
feast banquets.

The situla represents one of the first ploughs with a recognisable metal ploughshare, and can be
considered as the horizontal plough type (see 4.4.3). The ploughshare is attached to the sole by means
of two rings. A farmer is depicted behind two oxen, which pull the instrument.

b. A lot of votive models of ploughs. Some are technologically advanced in as far as they show
an iron ploughshare. We may note also the bronze cart model of Bisenzio (8th –7th cent. BC.),
that has, among its ornaments, also a pair of oxen with a plough (Forni 1990: 250–310).
The plough and ploughman of Bisenzio (late 8th century BC)

In the necropolis dell’ Olmo Bello (Bisenzio), a model of a plough with a ploughman was found (Forni 1990). The model is the oldest evidence of the existence of this kind of ploughs in peninsular Italy. The plough is constructed with a horizontal ploughshare-sole (share-beam), and resembles the plough of Lavagnone.

c. Hoes, pitchforks and rakes appear on the rock-engraved images of Valcamonica and Valtellina (Forni 1990: 152–153, 265). A number of images with the plough of Valcamonica clearly show an iron ploughshare (Forni, in prep.)

4.4.5 Favourable cultivation areas

Forni (1990) claims, that in the Iron Age, arable land had to be expanded due to population increase. Because of this demographic change, production had to be increased, both in qualitative and quantitative terms. Arts and crafts, mining and commerce emerged. Forests with oak and beech were brought into cultivation (an intensification of the a campi ed erba-system), as well as the fertile alluvial plains (despite the fact that cultivation of these soils required more effort). Soil fertility increased by spreading animal dung and ashes of burned wood on the fields. Coastal swamps and high mountains were still avoided for cultivation.

4.4.6 Summary and concluding remarks concerning Iron Age agriculture

In Iron Age agriculture (although assumed to be a continuation of Bronze Age farming), important evolutionary changes can be witnessed (Forni 1981a and b, 1990). These include the change from wooden to iron ploughshares (as can be deduced from the situla of Certosa, from votive models of ploughs and the rock-engraved images of Valcamonica) and the accompanying increasing efficiency of ploughing. With the use of the iron ploughshare, soils could be worked more easily, requiring less time (Forni, in prep.). Before the introduction of the iron ploughshare, compact clayey soils could be ploughed only after the vegetation was burned and the fields were left abandoned for many years. However, with the use of the iron ploughshare the amount of arable fields increased drastically, and the years of fallow could be reduced radically. Complementary handwork and burning of grasslands became less important in time.

The situla’s from San Zeno d’Anaunia, Montebelluna and Nesazio show ploughs with convertible wooden ploughshares, resembling the plough found in Lavagnone (Bronze Age). The plough of Montebelluna evidently shows that the instruments were designed with a further developed facility: regulation of plough-depth. The metal (probably iron) ploughshare on the situla of Certosa is attached to the plough by means of two rings.

Farmers increasingly cultivated cereals, but from this period onwards also (although in relatively small quantities) grapes and olives. A growing demand for arable land resulted in deforestation, together with the cultivation of the heavy soils of alluvial plains. Application of animal dung and ashes of burned wood enlarged soil fertility.

A final remark must be made: although iron ploughshares were known in this period, and consequently heavier soils could be cultivated, we cannot consider the instrument and farming techniques to be very common in all farmsteads and its importance must not be exaggerated (Forni: personal communication). The metal emerged in the Iron Age, but only in Roman times, the iron ploughshare would become commonly used.
4.5 Description of the main land utilisation types (LUTs) in Archaic and Roman Age Italy (600 to 0 BC)

4.5.1 Introduction

Forni (1990) claims, that society changed further into an urban society, in which handicraft and trading became progressively more important. A social hierarchical structure emerged. In *The Etruscans* (1998), Barker and Rasmussen explain the expansion of rural sites (compared to the previous periods) to be one of the factors of an increased grapes cultivation. The very rapid development of viti-olive culture in the 6th century BC can be related to Greek immigration. Olive as well as grapes cultivation became an important component of Etruria’s crop husbandry only at this time and not earlier. Besides using wine in domestic circumstances, the liquid was traded or given away as a gift. Grapes cultivation had a significant environmental impact: increased levels of forest clearances were the results of the urge to reclaim (fertile) fields, together with many adverse consequences such as soil erosion (Barker and Rasmussen 1998).

Also life in the countryside changed. Farmers increasingly participated both in power and in wealth. However, urban landowners had a firm grip on rural population. For example, the land had to be geometrically divided (centuriation) and a leasing-system emerged. The use and consistent spread of iron ploughs led to the cultivation of new terrain, such as compact clayey soils, or areas, which were recently used as pasture. In this period, also yields increased on the reclaimed grounds. At the same time, manpower could decrease.

Another important change in agriculture relates to the building of cunicoli (Ravelli and Howarth 1988): a system of canals to drain waterlogged clay soils, so an increasing area could be used to grow crops. Section 4.5.3 shows a more detailed view of the functions of these cunicoli. In trade, Etruria expanded her maritime influence even more, whereas southern Italy experienced a strong Greek influence.

4.5.2 Land utilisation types

*A. LUTs in Central Italy*

The best information so far about the Archaic land utilisation types is described by Barker and Rasmussen (1998) and Forni (1990). According to Attema (personal communication), we are allowed to compare the information about Etruscan agriculture with the agriculture practised in Lattium Vetus (that is the Pontine region including the Colli Albani) at that time (chapter 1).

Etruscan crop husbandry depended on an increasing (but probably not on the Roman scale) number of cereals, together with legumes and cultivation of tree crops such as olives, grapes and figs. There is no clear evidence of the system of polyculture or coltura promiscua (= olive trees with grapes between them and cereals below), which was certainly practised in Roman times. But it cannot be excluded in the Etruscan period (Barker and Rasmussen, 1998).

Emmer wheat (*Triticum dicoccum*), einkorn wheat (*Triticum monococcum*), and bread wheat (*Triticum aestivum*) were the most important cereals, next to barley (*Hordeum vulgare*), millet (*Panicum miliaceum*), and oats (*Avena sativa*). Olive stones and grape pips have been found. A bronze vessel containing olives was found at Cerveteri (dating 575–550 BC).

The authors of *The Etruscans* assume an intensification of agricultural production, based on increased dental caries in the teeth of the people found. This probably proves a change in diet from meat to vegetables and cereals. These crops grew in rotation systems, to provide enough food and sustain soil fertility.

For the Roman period, Spurr (1986) claims in his dissertation that there can be no doubt that grain (wheat) was the most extensively cultivated crop, and it is important to realise therefore it would usually have been grown alone in separate fields. But also the arbustum (intercultivation of both grapes and olives) system was highly praised, because of the high yields and surplus. Cereals were planted in
rich soils; then grapes and olive trees were placed there also but far enough apart so as not to damage the cereal production. But Romans recognised that cultivation of olives requires a lot of organisation and treatment (Barker 1985). He agrees with Spurr, that cultivation of olives could not have been on a large-scale base. However, at the end of the Roman period, specialisation in olive cultures was common (Columella).

According to Spurr (1986), various LUTs of cereal production existed in Roman Italy (he acquires evidence from the Roman agricultural writers, direct practical knowledge gained from fieldwork and evidence from archaeological investigations), which can be divided into three farm types (small, moderately large and large farms) and three farming systems:

Farms:

a) Small farms growing cereals for self-subsistence
On these small farms a polyculture of cereals was cultivated for domestic purposes. Probably millet took an important place in the farming system, because of its low cultivation requirements compared to the other cereals (4.7: land use requirements). Varro describes a cultivation system *vervactum* common on small farms. Fields were sometimes left abandoned after crops were taken from the fields and before sowing in new crops, to regain fertility. Duration and frequency depended on the kind of crops (and their associated soil influences) and the urgency to feed the population. Spurr assumes that these farms could afford only one plough, which was used in all soil types of relatively small fields.

b) Larger farms growing cereals for self-subsistence, while perhaps specialising in other crops
According to Spurr, mixed farming was more common on larger farms. This system provided work and food for the workforce all year round, and prevented a significant economic risk, by not relying on one crop only. Larger farms also owned more fields with a variety of soil types, suitable for various crops. This can be noted as another benefit of mixed farming, suitable for isolated farms (Spurr 1986). Brunt (1971) claims that these estates raised cultivated grains, produced wine and olive oil, grew vegetables and fruits, usually in mixed husbandry. Ampolo (1980) suggests that emmer wheat and barley were often grown as a mixed crop to assure reasonable yields, both in dry and wet summers. Millet and fodder crops were commonly cultivated in a rotation system without fallow to feed the animals and enrich the soil (Spurr 1986).

c) Large farms producing cereals for sale
In Spurr’s opinion, because of the growing urban society and different socio-economic levels with its own food requirements, large farms with cereal specialisation appeared. A polyculture of cereals was grown. Such probably ‘rich’ farms could have cultivated the best soils, manured their land well, and paid close attention to ploughing (to increase the cereal yields, deep, occasional working with a spade (*vanga*) of arable land occurred on intensively-run estates during the Late Republic and early Empire). Maybe these farms had areas under woodland, which were brought under cultivation by slash and burn techniques, so they could enlarge their area. The soils were probably dug instead of ploughed (Spurr 1986).

To suppress the fallow, broad beans were grown, and used as fodder crop to feed the cattle and to enrich the soil (by ploughing under their organic remains, such as roots).

These and the larger farms under b) probably had a variety of ploughs so various soil types could be cultivated, even the most heavy ones (instead of the farmers in previous periods such as the Bronze and Iron Age). To complete their diet, farmers of these large estates must have bought food other than cereals from different farms in the neighbourhood. So probably farms of type b) and c) stood in the vicinity of each other.

Farming systems:

1) Grazing of natural and improved pastures
Pastures were improved by manuring. Usually sheep were left to graze on these fields to collect their
dung and urine to increase fertility.

In Italy, permanent (natural) pastures were situated in areas having high groundwater levels, such as swampy coastal belts, deltaic flats and mountain-blocked lake-basins (Semple 1932).

2) Slash and burn systems (ignicoltura) in mountainous and remote areas

In the ashes of the burned fields, cereals were grown. After a few years, the land was abandoned to a long fallow. Use of animal drawn ploughs could not have been possible on steep hills in the mountains, so probably only small-scale, manual tillage was practised in these areas.

3) Short distance transhumance

The livestock was kept on the farm all year round. Cattle moved to the nearby hills and river courses only for three months a year (when the meadows were open after the hay had been cut: Cato 149. 1). So loss of manure on the farm was kept to a minimum in this manner (Spurr 1986).

B. Land Utilisation Types in South Italy

As compared with the data known from Central Italy (from, for example, Forni, Spurr, and White), there is no corresponding treatment of Greek farming, let alone of agriculture in Calabria and Puglia. This lack of information is due to several causes (Isager and Skydsgaard 1992): most implements were made of transient wood and/or iron, and the depiction of agriculture in arts is not always clear (is real life shown or are we dealing with a ritual picture?). Furthermore, information from the literature (if South Italy is mentioned at all) is difficult to decipher, because one word could be used for various tools or various words for one tool. Palaeobotanical studies are difficult, for the absence of many suitable conservation conditions. Therefore, we have to gather all pieces of information available in order to obtain a picture of ancient farming in southern Italy. If possible, the literary evidence must be compared with archaeological sources.

Archaic/Classical period (6th –4th century BC)

Only very little is known from the LUTs in the Archaic/Classical period. Burgers (1998) suggests in farming a partial shift in emphasis on agriculture at the expense of pastoralism, a mobilisation of a surplus beyond subsistence and a increased sedentarization.

From Greece, more indirect information is available, written down by the poets Homer and Hesiod, by the botanist Theophrastus and Xenophon (Isager and Skydsgaard 1992). They describe various active land utilisation types:

- a two-field system or dry-field system with biennial fallow: one year crop cultivation followed by one year’s fallowing; main crops are autumn-sown emmer wheat (Triticum dicoccum) and Triticum vulgare, and barley (Hordeum vulgare),
- intercultivation of grapes and barley or beans in good soils,
- cultivation of olives,
- cultivation of other crops such as millet,
- important evidence concerning technology is achieved from different sources:
  - from the poets Hesiod and Homer, who describe the parts of the contemporary plough in detail. According to Isager and Skydsgaard, it is archaeologically attested in bronze and iron,
  - from vase paintings and coins,
  - from statues, such as the terracotta plough with ploughman of Boeotia, and
  - from an attic black-figure kylix with agricultural activities, such as ploughing scenes with oxen and mules.

4 For the same reasons mentioned before (foot note 3), issues concerning pasturalism will not be included into this research. Only for the sake of completeness, the LUTs are described here.
The pollen evidence of Metapontum (Sullivan 1985) shows that agriculture was diversified and grazing was important. Fallow or waste fields were numerous.

**Hellenistic period (4th–3rd century BC)**

In early Hellenistic southern Italy, one of the main activities probably was sheep rearing, as could be concluded from the discoveries of loom-weights (processing of products of wool) on the investigated sites. According to Burgers (1998), *it can be assumed that most households would have kept some sheep for subsistence.*

The survey data in the Brindisino (discoveries of large amounts of Hellenistic amphora fragments, basically used for storage and transportation of wine and/or olive oil) show an increase and establishment of arboreal cultivation (horticulture), next to the crop growing of cereals (Burgers 1998). We can witness a typical Mediterranean polycultural system.

The surveys in the Brindisino support the thesis of an intensification and expansion of agriculture and rural settlements. Small farmsteads were built on or in the vicinity of previously cultivated land. In this way, the fields could be worked more intensively, the time required to travel from the settlement to the fields being strongly reduced. Also, previously unutilled lands and even marginal soils were increasingly brought under cultivation. Burgers (1998) doubts that the total region was cultivated in the early Hellenistic period, but in later times farm sites covered the entire survey area (Boersma et al. 1991: 127).

For this period, the survey data near Metapontum, aiming to discover the original density of ancient settlement, executed by a team from the Texas University, showed similar results (Carter 1990). The team found a very high density of farm sites, especially from 350 BC onwards. The most common type of site encountered was the isolated farmstead, and at each farm site amphore fragments, many loom-weights, mortars and grinding stones were found.

The excavation of sites near Sant’Angelo Grieco (thirteen kilometres from Metapontum) revealed again a large amount of loom-weights, suggesting that sheep-raising and wool-industry were important activities. A palaeobotanical study of organic material at Pantanello (also in the Metapontum neighbourhood) shows the presence of seeds of olive, barley, grape and fig. Three kinds of cereals were found: emmer wheat (*Triticum dicoccum*), bread wheat (*Tr. compactum*) and barley (*Hordeum vulgare*).

The pollen evidence (Sullivan 1985) indicates that the importance of animal husbandry decreased (pastoralism was virtually eliminated). The maquis rejuvenates. But the pollen record also shows an increase of olives, legumes and especially cereals.

According to Carter (1990: 412), in this period, *it is clear that the isolated, independent farmstead was a major fact of Greek colonial life along the Ionian coast of Southern Italy.* The society made maximum use of the land and brought it to peak production on small- or medium-sized farms. There are no signs of an “aristocracy” or gross social inequalities, as Carter concludes in this article.

**Roman period (3rd–1st century BC)**

In the Roman period, the land utilisation types changed through further agrarian intensification, but also by a decline of peasantry. Large slave-run specialised farms of native elite families emerged, aiming at an increased surplus cultivation and centralisation of the workforce (Burgers 1998). According to de Neeve (1984–1, 1984–2), Roman expansion resulted in a large availability of slaves. Small farmsteads disappeared, as a consequence of a disturbance of the labour balance (large estates now used slaves instead of peasants), and the unfeasibility to effectively intensify production (because no more land could be hired).

In the Metapontum territory, the farmsteads were abandoned after 275 BC. Carter (1990) adds some possible other causes than those posed above: political instability, over-reliance on one crop and progressive soil exhaustion.
4.5.3 Roman, Etruscan and Greek agricultural technology

A. Ploughs

The introduction, spread and use of the iron ploughshare in agriculture had been a real revolution in history, as stated earlier. In antiquity, new reclaimed land had to be cleared first, then burned and left to fallow for several years. Next, the soil had to be opened by using pick-axes, shovels and hoes. Only after a relatively long and labour-intensive period, the plough could be used to smooth the soil and create furrows for sowing. During ploughing, the wooden ploughshare could break fairly easily and had to be repaired or replaced repeatedly.

When the iron ploughshare was introduced, more fields could be cultivated without using fire, fallow (this holds for very fertile soils only) or manual labour. The efficiency of the plough increased (regulation of the depth of the furrow, cutting open of grasslands) and several connecting pieces could be eliminated, because the instrument existed of fewer components than before. The iron ploughshare and the other constituting parts had to be changed less frequently and more easily. This new technology resulted in a significant reduction of time required to prepare the fields.

According to Reynolds (personal communication), the ease of ploughing a field depends upon a number of variables. These are, for example, soil humidity, the abundance of roots in the soil, the time that the field was last cultivated and the crop it bore. Also, a field under regular cultivation is more easily ploughed than a field, which is cultivated for the first time.. Ploughing can be made easier by using more than one cattle span in order to increase the traction power. The addition of a metal sock on the plough tip makes a marginal difference for the better. Stoniness can be considered a mixed blessing: stones can play a role in preserving humidity in the soil. Forni supplements (personal communication) that stones facilitate precipitation to penetrate into the soil. But, at the contrary, stones also improve soil drainage and destroy capillarity of loose soils, actually decreasing soil humidity. So stoniness reveals a complex relationship between the benefits and the disadvantages.

Important discoveries

Forni summarises the following innovations in Roman Age agricultural instruments (in prep.):

a. Models of hoes, bidental hoes and foraterra were found among the Etruscan votive bronzes of Talamone (2nd cent. BC), in Pompeii and near Magna Grecia (Forni 1990, pp.319–23, Giulierini 1999).

b. In this Roman period, the first iron ploughshares were found in the area, which were influenced by the Greeks (Gela in Sicily, and Gravisca near Tarquinia; Forni 1990: 298–300).

Iron ploughshares of Gravisca (Tarquinia) and Gela (Sicily) (6th century BC)
The originally Greek iron ploughshares of Gravisca were found in a Greek grave (Torelli 1978, 401). They were probably attached to the sole by a kind of nail. They measure 24 cm and 18 cm in length.

Orlandini (1965) also describes two originally Greek iron ploughshares found in Betlem near Gela (Sicily). Probably, these shares, measuring 26 cm and 20 cm in length, were bent over the sole and attached to it by means of nails. Interesting is the fact that the longest share could also be used for harvesting or mowing activities, whereas the second one provides a little shovel to clean the ploughshare from caked clayey material.

Though these ploughshares are considered to be the oldest iron shares, it is evident from the scene on the situla of Certosa that metal ploughshares were already in use in the previous period (Forni 1990: 300).

c. Precious are also the bas-reliefs found on the Etruscan cinerary of the last centuries BC, that show the fight between farmers armed with an archaic plough (with a wooden ploughshare), from which the handle is taken off to use it as a weapon (Forni 1990: 307–308)
Plough model of Cornaggia Castiglioni (6th–5th century BC)
Using the knowledge from different disciplines (especially from iconography and archaeology) a model of a plough was reconstructed (Forni 1990: 309), which had probably been used to cultivate humid clayey soils in Tyrrenian Etruria. It closely resembles the ploughshares found in Gravisca and Betlem, the ploughshare of Talamone (below) and also the representation on the situla of Certosa.
Again, the ploughshare is attached to the sole by means of two rings. Furthermore, attention has to be paid to the position of the sole and the ploughshare: the ploughshare’s oblique position enabled the farmer to cultivate the colluvial plains in the area (Forni 1990: 300–301).

Votive model of Arezzo: plough with ploughman (4th century BC)
This famous model represents a unique documentation of a plough with a sole and ploughshare in oblique position. The instrument is very suitable for the cultivation of stony soils, soils with abundant roots (just after a recent deforestation), or for just reclaimed fields (Forni 1981a; Forni 1990: 303–305). The ploughshare has been attached to the sole in the same way as the plough mentioned before.

Despite intensive observations and the obviously accurate Etruscan depiction of reality, no proof exists that the ploughshare was made of iron, not even in a symbolic way. Perhaps this kind of plough had been supplied with a convertible wooden ploughshare.

Votive model of a plough of Civita Castellana (Viterbo; 3rd–2nd century BC)
The model of Civita Castellana represents two oxen pulling a plough. In this model, the presence of an iron ploughshare is obvious. It is attached to the sole by means of rings. One piece of wood is used to construct the sole and the plough-beam. Two wooden pins secure the yoke-beam to the plough-beam (Forni 1990: 297, 305–306).

B. Soil fertility methods
To avoid or overcome soil exhaustion by overcultivation, ancient farmers relied on (1) manuring of their land (White 1970, Barker, 1985; Spurr, 1986) and/or on (2) fallowing the fields in combination with crop rotation (White 1970, Humphrey et al., 1998).

Improving soil fertility by using fertilisers
White (1970) provides a list of fertilisers used by the Romans: farmyard manure, poultry and other animal’s manure, compost, wood ash and fresh seaweed. The most important fertilisers are discussed below (for the others, I refer to White 1970: 137–45).
Fernyard manure includes dung from animals and litter (usually straw or other crop residues, Spurr, 1986). Litter had the essential effect of absorbing the valuable urine which contained nitrogen, potassium and a portion of all other elements essential for plant growth, which had been present in the original food of the animal and in the straw itself. In addition, manure also enhances the formation of humus in the soil, improves the fertility and the texture, rendering heavy, clayey soils more friable and aerated and giving cohesion and water-retaining power to thinner, sandy soils.
Poultry manure was also favoured, especially because of its high contents of nitrogen, phosphorus and potassium (White 1970).
But those farmers, who lack this kind of manure could use, according to Cato (37.2) and Columella (2.14.6,8), common farmyard compost (a mixture of animal and plant materials) and even human excrements. White (1970) stresses that both Greek and Roman farmers were well aware of this method of supplying organic fertilisers to enrich the soils.
In September, manure was ploughed in the soil immediately after a rainfall, and thus before the cereals were sown (Columella II.15.1, Pliny XVIII.193). When manure was not available, wheat could be better cultivated than barley (White 1970).
An other well known method (Cato, Varro, Columella, and Pliny) was green manuring: ploughing in grasses, lupine and beans to provide humus and create a better soil structure.
C. Hydraulic engineering

The management of water is related to various processes, such as control, storage and distribution of water from a higher source to a lower, but also to technology (White 1984). An excellent example of such technology is the cunicole or qanat (long distance water tunnel).

Cunicoli (Etrusco-Latin water-collecting tunnels)

Cunicoli are man-made, subsoil tunnels and can be found parallel to the Tyrrhenian coastline north and south of Rome (Judson and Kahane 1963, Scullard 1977, Ampolo 1980, Moscati 1985, Potter 1985, Quilici-Gigli 1987, Ravelli & Howard 1988, Forni 1990). The exact ages of these cunicoli are disputed: Ravelli & Howard (1988) claim them to be created between 800 and 400 BC, Forni (1990) postulates their construction in the 6th to 4th century BC. A further discussion concerning the age of cunicoli can be found in Attema (1993: 69–70).

The Etruscans excavated the tunnels in volcanic rock. The volcanic material is especially favoured, probably because its fertility and relative softness to work. The rectangular, sloping tunnels measure, on average, 1.5 m in height and 65 cm in width (Ravelli & Howard 1988, Attema 1993). South-west of the Colli Albani (Lazio), cunicoli of 45 km long have been found (Forni 1990).

The function of cunicoli can only be guessed at, but next to purposes such as sewer-pipes, hiding places for animals, catacombs or aqueducts, the tunnels were more likely excavated for the following functions:

- to capture rainfall in the form of percolating water for drinking-water (especially in Latium: Forni 1990),
- to drain humid soils or superfluous water from lakes (for example Lago di Albano: Forni 1990),
- to regulate water from perennial springs,
- to conduct water for irrigation purposes.

According to Forni (1990), this Etruscan technology is highly influenced by Greek technological science, which reached its zenith in the Hellenistic period (4th–3rd century BC). In Greece, the oldest tunnel dates back to Mycenaean times and drained the waters of Lake Copais in Thessaly (White 1984).

Other water devices

White (1984) describes additional water conveying techniques in the Roman Age, such as aqueducts and earthenware or lead pipelines. But it is not clear whether such devices existed in the three research areas. However, we know for certain, that Roman people were capable of regulating water for various purposes, as we have seen above.

Amphore drainage

Mattioli and others (1998) describe the ways amphores were used for (among other functions, such as to prevent groundwater to rise and to capture precipitation) drainage. At some depth, they were buried horizontally like a chain. Percolating precipitation could enter the porous amphores and the water was consequently drained away.

Drainage and irrigation techniques

Spurr (1986) lists a number of circumstances when drainage practices were applicable for improving land:

- cultivation of new land, which might be heavy and wet,
- to avoid the collection of stagnant water,
- to check and divert excessive rainfall,
- to remove stagnant water on grasslands to avoid parasites.
Drainage is especially important at the beginning of the autumn and in the growing season (Cato, On agriculture 155). Columella (2.2.9–11) describes two types of drainage-ditches (fossae): the open and the blind ones. *Open ditches* were constructed in compact and chalky soils. ‘... it will be best to make open drains wider at the top, and sloping and narrowing together at the bottom...’ to avoid erosion.

*Blind ditches* were used in soils with a loose structure. These fossae were filled with brushwood or fine gravel to a depth of about one meter, then covered with earth.

Also, irrigation techniques were well known in Roman Italy. As White indicates: *the geological structure of the hills made it possible to combine drainage of higher grounds with irrigation on the plains* (1970: 151). Irrigation water was taken out of channels, originating in natural springs or from subterranean wells, but also from man-made furrows running downhill from higher locations. From a well, water was drawn up by means of a wheel, a pump or a swipe (Pliny XIX.60.f). According to White, Roman farmers irrigated their pastures, gardens, orchards and grapesyards, and grain-crops and legumes.

### 4.5.4 Roman soil perception

Researchers, who worked in the Archaeomedes project in the Rhone Valley (France) analysed the works of Columella and Pliny the Elder regarding their perception of the soil (Audouce et al. 1998). The results were remarkable: the Romans argued that many crops (such as olives and three kinds of wheat) need fertile soils to thrive, whereas nowadays opinions differ on this subject.

*Fertile soils were those well suited for a) cereal cultivation and b) cultivation of olives and grapes:*

- **a)** chalky soils, black or grey soils, clayey limestones and clayey silicate soils, all with considerable water retention
- **b)** thin, light rather dry soils that are generally warm, calcareous, sandy or even gravelly and have a ‘terra rossa’ fine fraction (Audouce et al. 1998).

When large tools or heavy equipment was not available, light and rather dry soils were preferred, rather than heavy and humid soils.

Next, they categorised soils according to the relationship between soils and technology. The soils thus were divided into four classes:

1. **the soils naturally suitable for the grapes, whether they are now occupied by garrigue, by forest or by wasteland, and which were for most of the past covered by mixed oak forest (erosion soils, fersiallitic soils, redzinas, brown calcareous soils, and brown calcareous soils),**
2. **soils which need to be drained and irrigated because they are too compact, contain a large fraction of very fine clay, or overlie a marly substrate,**
3. **sandy soils, alluvial soils, hydromorphic soils and saline soils on which one may cultivate vegetables and cereals if one is willing to battle continuously with water and salt,**
4. **all the soils on which cultivation is impossible (Audouce et al. 1998).**

Although for land evaluation purposes the list is not specific enough, it provides a basis for judging the land systems in chapter 3 from a Roman farmer’s view. As we will see in section 4.6, more LURs and management requirements of the different crops are shown. But this overview definitely receives proper attention in chapter 5, in which the results of chapter 3 (land qualities) and 4 (LUTs and LURs) are compared. In the factor rating process, Roman perception of soils is an important part of the archaeological land evaluation.
4.5.5 Summary and concluding remarks on Roman agriculture

An impression of Roman farming in Central and South Italy has been given in the sections above. Early Roman farming is characterised by a significant intensification (Barker and Rasmussen 1998) of, especially, cereal cultivation. Emmer, einkorn and bread wheat, barley, millet and oats were highly praised. Greek immigration led to the rapid development of viti-olive cultures, claiming more and more terrain by burning large areas of forests, causing instability of soils and consequently serious erosion.

Cereal production also prevailed on Roman farms, ranging from the small self-subsistence farms to the large specialised market-orientated estates (Spurr 1986). Distance and accessibility to the market, ownership of certain areas with its specific soil properties, and wealth of the farmer resulted in the various farming systems.

Cereals were preferably grown alone in separate fields, usually next to olive trees and grapesyards. Both Barker (1985) and Spurr (1986) conclude that olive production could not have been on a large-scale basis.

Below, the land utilisation types of Central Roman Italy are described:

- Small self-subsistence farms, managed by a farmer and his family, cultivating cereals for their own domestic purposes and using one simple plough in all kinds of soils (Spurr 1986),
- Isolated, larger farms, growing various crops in a mixed farming system: cereals (emmer wheat and barley), grapes, olives, vegetables and fruits, both for their own husbandry and for the market. Millet and fodder crops provided food for the livestock. A variety of soils belonged to these farmsteads (Brunt 1971, Ampolo 1980, Spurr 1986), which were worked with a variety of plough types,
- *Latifundia*: large estates, cultivating a polyculture of cereals for sale. These large estates probably cultivated the best and all kinds of soils, used sophisticated soil fertility techniques and various kinds of ploughs. Next to cereals, beans were cultivated to shorten the fallow and to feed the cattle (Spurr 1986),
- Slash and burn systems in remote areas.

Land utilisation types in South Italy:

- Small- and medium-sized, isolated farming systems, producing crops in a polycultural system both for the own husbandry and for sale (Burgers 1998). Cultivation of especially emmer wheat and barley, next to grapes, olives and other crops, such as beans and millet. Fields were worked using ploughs, pulled by oxen and mules (Isager and Skydsgaard 1992),
- Large, slave-run estates (latifundia), producing crops for sale.

It is evident, that all Etruscan and Roman ploughs were of the horizontal (skate) type, except for the model of Arezzo (Forni 1990). Ploughs with iron shares (found in Gravisca and Gela: Forni 1990) were used now for turning over and cultivating all kinds of soils.

From about the start of the Roman period practically all kinds of soils could be cultivated, provided that the fields were not too stony and/or rocky (class 3 or higher FAO 1977) and did not have an impermeable layer in the subsoil (for example Planosols or Vertisols).

With the help of drainage techniques (fossae and cunicoli), wet soils could be taken into cultivation. This also counts for infertile soils (such as for example beach ridges):

- by addition of manure and compost,
- by leaving the field fallow for a year or longer, or
- by growing fodder crops and plough the unused remains (stubble) under (Barker, 1985; Spurr, 1986).
4.5.6 Introduction to land use requirements (LURs)

A land use requirement is defined as ‘a condition of the land necessary for successful and sustainable implementation of a specific LUT’ (FAO 1976). In other words, we have to know the soil and cultivation requirements of ancient crops, in order to determine the suitability of the soil for these domesticated plants.

A few other definitions have to be made, before going further. I agree with Harlan (1975) that a crop specifies certain kinds of plants that are grown on purpose for later harvest. Harlan also clarifies the difference between domestication and cultivation. Domesticated plants have been altered genetically from their wild state, and changed in their ecological adaptation. To cultivate means to conduct those activities, involved in caring for a plant, such as tilling the soil, preparing a seedbed, weeding, pruning, and manuring.

When we want to unravel the soil and cultivation requirements of ancient crops, we first have to know which crops were cultivated in the past. Information from botanical findings in general in Central and South Italy have been used here. If not available, information from ancient writers forms another starting point. To prevent the danger of circular reasoning, palynological data from the three research areas (Pontine region, Salento peninsula and Sibaritide) are not used here. Subsequently, the requirements are described. The LUTs, accompanied with the LURs, have been compared at a later stage with the land qualities. These results are then compared with the information of pollen diagrams from the specific research areas.

Description of LURs of ancient crops

This part describes the soil and cultivation requirements of ancient crops in Central and South Italy. These requirements cannot always be obtained easily, because many of the present-day crops have been genetically changed in order to increase yields and to adapt the crops to less favourable site conditions and through this to enlarge the possible cultivation areas. Examples of ancient crops are emmer wheat, einkorn wheat, millet, barley, olives and grapes.

Emmer wheat and olive trees have not been changed (much), so the present-day soil and cultivation requirements represent those of their ancestors (personal communication D’Antuono²). Nowadays, the ancient requirements of the other crops are less known. We must therefore rely on the recommendations given by ancient writers such as Columella, Pliny and Cato, concerning growing conditions of these crops. Unfortunately, these recommendations cannot be tested in the field, but it is the best we have.

Below, each crop variety will be discussed in detail concerning its LURs, divided into soil requirements and cultivation requirements. Suitability classification is based on yields; suitable for the highest yields, marginally suitable for the medium yields (supplementation with another crop is recommended), and not suitable for low or no yields (other crops have to be cultivated or the land has to be abandoned).

Introduction on wheat (Triticum species)

One of the most important and probably the most important crop for preparing traditional food in ancient Italy is wheat.

Six varieties of wheat were certainly cultivated in Central and South Italy, that is einkorn wheat (Triticum monococcum), emmer wheat (Triticum dicoccum), durum wheat (Triticum durum), spelt wheat (Triticum spelta), bread wheat (Triticum aestivum) and club wheat (Triticum compactum). Below, each variety will be discussed.

Emmer wheat (Triticum dicoccum)

Next to the discovery of emmer wheat on Sicily, seeds of the crop have also been found in Puglia, dating back to 5000 BC (Follieri, 1987). So at a very early stage of agriculture, emmer wheat already was

² Professor D’Antuono, university of Bologna, faculty of agronomy
an important crop. Later, for reasons that are not relevant here, emmer wheat lost its prominent role.

Thirty years ago, in 1970, emmer wheat (figure 4.5) has been re-introduced sporadically in Northern and Central Italy, after a long period of neglectance. This wheat especially proofs to be very healthy for both man and animal. Another benefit of emmer wheat is its tolerance for cultivation in marginal areas, where other crops do not flourish very well. In Italy, emmer wheat is called farro, after the Latin word far (which means flour). Two types of farro exist: autumn-sown winter wheat and spring-sown spring wheat. The first type needs a period of low temperatures to develop the buds and gives highest yields. The spring wheat, despite being less favourable, was probably cultivated as an emergency crop, when cultivation of winter wheat failed.

As stated above, emmer wheat has not been genetically changed during the last two millennia. Therefore, a visit was paid to two farmers, who still cultivate emmer wheat, in Garfagnana (Northern Italy) and Monteleone di Spoleto (Central Italy), in order to examine the soil and cultivation requirements of the plants. In the Garfagnana area, Giovanni Bravi (figure 4.6), a winter wheat producing farmer, invited us. In Monteleone di Spoleto, Renato Cicchetti cultivates spring wheat.
The soil and cultivation requirements of winter wheat and spring wheat do not differ significantly. Highest yields of emmer wheat in general are received when sowed in non-calcareous, moderately fertile, clayey or sandy clayey soils, with a minimum thickness of 30 cm (in fertile soils, emmer wheat is prone to lodging: bending of the plants). Because emmer wheat withdraws nutrients (especially nitrogen) from the soil, the crop should be cultivated in a rotation system with other crops or the soil must lie fallow for two or three years (depending on soil fertility), covered with grass, lucerne or clover. Irrigation, weeding or manuring is not necessary for high yields in these Italian landscapes. Depending on local winter temperatures, emmer wheat thrives well at elevation levels till 1100 m above sea level.

Yields of winter emmer wheat in Garfagnana amount to 1 to 2 tonnes per hectare per year, while yields of spring emmer wheat comprise 0.75 to 1.3 tonnes per hectare per year.

An interesting fact for excavating archaeologists may be that the seeds of winter emmer wheat differ in weight from the seeds of spring emmer wheat. Winter emmer wheat weighs between 45 and 55 mg per kernel, spring-sown emmer wheat weighs between 30 and 35 mg per kernel (personal communication D’Antuono). A detailed description is provided in Van Joolen and Woldring (2000).

Columella (II.9.3) advises to grow emmer in ‘soil that is heavy, clayey and wet’. This I interpret as soils, having a heavy texture (clay), a firm structure and moderately to poorly drained. ‘Moderately clayey or marshy land is less favourable’ (Columella II.9.5), and ‘brackish or bitter soils’ (Columella II.9.8). Moderately clayey soils can refer to soils, such as loamy sand, sandy loam, loam, and clay loam; brackish refers to soils with medium salinity.

Weeds in a field can give a clue about the kind of emmer wheat being cultivated at that time. The weeds in the winter emmer wheat field at the end of June 1999 were wild oat (Avena fatua) and rests of cultivated oat (Avena sativa) from the previous year, (Lagurus ovatus), (Convolvulus arvensis), (Ranunculus arvensis), pimpernel (Anagallis arvensis), knotgrass (Polygonum aviculare), five-finger potentilla (cinquefoil) (Potentilla reptans), wild geranium (Geranium rotundifolium), camomile (Matricaria chamomilla), cornflower (Centaurea cyanus), (Viola arvensis) and (Legousia speculum-veneris).

Weeds in the fields with spring-sown emmer wheat consisted of (Hordeum murinum), lucerne (Medicago sativa), comamile (Matricaria chamomilla), poppy (Papaver rhoeas), knotgrass (Polygonum aviculare), dandelion (Taraxacum officinale), (Convolvulus arvensis), couch grass (Triticum repens), wild delphinium (Consolida regalis) and (corn) cockle (Agrostemma githago).

<table>
<thead>
<tr>
<th>Emmer wheat</th>
<th>Suitable</th>
<th>Marginally suitable</th>
<th>Not suitable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil requirements</td>
<td>At least 30 cm thick</td>
<td>Thin (less than 30 cm thick)</td>
<td></td>
</tr>
<tr>
<td>Clay or sandy clay</td>
<td>Loamy soils</td>
<td>Sandy soils</td>
<td></td>
</tr>
<tr>
<td>Moderately to poorly drained (wet)</td>
<td>Marshy</td>
<td>Excessively drained (dry)</td>
<td></td>
</tr>
<tr>
<td>Firmly structured</td>
<td></td>
<td>Loose</td>
<td></td>
</tr>
<tr>
<td>Marginally fertile</td>
<td>Fertile</td>
<td>Very fertile</td>
<td></td>
</tr>
<tr>
<td>Non-calcareous</td>
<td>Calcareous</td>
<td>Very calcareous</td>
<td></td>
</tr>
<tr>
<td>Medium salinity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cultivation requirements</td>
<td>Rotation system of two years with grass, clover or lucerne</td>
<td>No manuring</td>
<td>No irrigation</td>
</tr>
</tbody>
</table>

Table 4.3 Suitability classification of emmer wheat

The other five wheat varieties

In the ancient literature, hardly any distinction is made between the soil and cultivation requirements of einkorn wheat, durum wheat, spelt wheat, bread wheat and club wheat. All together they represent...
one group opposed to emmer wheat regarding these requirements. However, some authors do make this distinction, but their requirements are generally based on present-day (possibly genetically changed) varieties and will not be incorporated in this research.

According to Spurr (1985) and Barker (1985) einkorn was less important during the Roman period. Spelt wheat tended to replace the leading role of emmer wheat later (Barker 1985).

White (1970) gives an excellent overview of the recommendations for the soil and cultivation requirements by ancient writers. According to Cato, wheat should be sown in dense, fertile soil, or in ‘dry land, that is free from grass and not full of shade’. These soils can be interpreted as clayey, fertile, firmly structured, and lying at the south facing slopes of a hill. ‘Common and other naked wheat (such as durum and club wheat) are to be sown in an open and elevated situation, that is exposed to the sun’s heat for as long as possible’. Varro recommends fat soils, relatively rich and relatively compact, of medium quality and of moderate temperature. Common wheat (siligo) tolerates chalky and wetter soils. We can interpretate Varro’s writings about the best soils to cultivate wheat as soils, which are fertile, moderately firm structured, clayey, calcareous and poorly to moderately drained.

<table>
<thead>
<tr>
<th>Wheat varieties</th>
<th>Suitable</th>
<th>Marginally suitable</th>
<th>Not suitable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil requirements</td>
<td>Deeper soils</td>
<td>Thin soils</td>
<td></td>
</tr>
<tr>
<td>Clotey soils</td>
<td>Loamy soils</td>
<td>Sandy soils</td>
<td></td>
</tr>
<tr>
<td>(Moderately) firm(ly) structured</td>
<td>Loose</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertile</td>
<td>Unfertile</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderately to well-drained</td>
<td>Wetter</td>
<td>Poorly drained</td>
<td></td>
</tr>
<tr>
<td>Open and elevated situations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plains</td>
<td>Hill slopes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcareous (marls)</td>
<td>Calcareous</td>
<td>Non-calcareous</td>
<td></td>
</tr>
<tr>
<td>Relatively warm</td>
<td></td>
<td>Cold</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.4 Suitability classification of other wheat varieties than emmer wheat

Barley (Hordeum vulgare)

Six- and two-rowed

According to Forni (personal communication), in Magna Grecia, in Greek Sicily and in the eastern Mediterranean, barley formed the alimentary basis. However, in Roman Italy, barley was not highly appreciated and therefore the crop was cultivated for animal fodder. But, especially in times of scarcity, humans (Columella II.9.14) also used it. Two-rowed barley (Hordeum vulgare subsp. distichum), when mixed with wheat, is an excellent food for the household (Columella II.9.16). Columella also distinguishes six-rowed barley (Hordeum vulgare subsp. hexastichum) barley. The last variety has to be sown in loose, dry ground, either very rich or poor (only when nothing else is entrusted). It is best [after the crop has been taken of the land] to let the ground lie fallow for a year or...saturate it with manure. Two-rowed barley thrives best in very rich soils (Columella II.9.16). Pliny (HN XVIII.79) also advises sowing barley in dry, loose, and fertile soil. Cato recommends fallow land, and land that can be made to bear a crop two years running (the authors probably mean to make the land more fertile by adding manure). Thin soils will be allocated to barley, since its roots need less nourishment. It prefers soils of medium richness and of loose structure (Varro RRI.23).

To summarise, barley thrives well when cultivated both on thin and deeper soils, which preferably are dry, loose and fertile. Therefore, most suitable soils are dry sands containing a large percentage of humous.
Millet (Panicum miliaceum)

Millet could be used for making bread and porridge with milk (Columella II.9.19). The crop requires light, loose soils and thrives not only in gravelly ground, but also in sand, if only the climate is moist or the ground well watered, for [millet] has a great dread of dry and chalky ground. The crop is fond of warm weather (Columella II.9.18). Marginally suitable are those soils, which are dense and fertile, and liable to fog (Cato).

How can we interpretate these requirements? Light, loose soils refer probably to sandy soils. Chalky ground refers to calcareous soils and dense soils (as stated before) to firmly structured soils.

Grapes (Vitis vinifera)

Columella (III.1.1) informs us about the cultivation of grapes in his period. They were planted for eating or for drinking juice. Only when the grape yards lay close to the village, trading became profitable.

In his third book on Agriculture, Columella presents a clear overview of the LURs of grapes, according to the prevailing opinions of his time. Grapes thrives well on plain, as well on hillside, in compact soil no less than in loose, often also on thin land, in fat and lean ground, in dry and wet ground (Columella III.1.4). He adds that the suitability of grapes depends on which variety you want to use in a specific region with its own characteristic soils. A calm and clear-skied region does not refuse to omit any kind of grapes, though most suitable one whose clusters or berries fall quickly (Columella III.1.7). But, on average, grapes yards can be located best on rather loose soils, rather fertile, on slightly elevated plain-land, moderately moist soils, which are neither bitter nor brackish. It is not such as icy cold or burning hot (Columella III.1.8–10). Besides, he strongly advises not to use very fertile land for grapes cultivation, but a medium fertile one, because the cutting quickly take root and shoot up..., yet if transferred to poorer soil when they become quicksets, they wither and cannot grow to maturity (Columella III.2.5).

The interpretation of these recommendations is as follows: suitable are sandy soils, marginally suitable are loamy soils. Moderately moist soils can be those, which are moderately drained.

<table>
<thead>
<tr>
<th>Barley</th>
<th>Suitable</th>
<th>Marginally suitable</th>
<th>Not suitable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil requirements</td>
<td>Thin and deeper</td>
<td>Very fertile (very rich)</td>
<td>Excessively drained (dry)</td>
</tr>
<tr>
<td></td>
<td>Lean; when replenished with nutrients</td>
<td>Well-drained</td>
<td>Poorly drained (wet)</td>
</tr>
<tr>
<td>Cultivation requirements</td>
<td>Leave the soil fallow for one year, or replenish it with nutrients</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.5 Suitability classification of ancient barley

<table>
<thead>
<tr>
<th>Millet</th>
<th>Suitable</th>
<th>Marginally suitable</th>
<th>Not suitable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil requirements</td>
<td>Irrigated sand</td>
<td>Well-drained</td>
<td>Loose</td>
</tr>
<tr>
<td></td>
<td>Loamy soils</td>
<td>Fertile</td>
<td>Firmly structured</td>
</tr>
<tr>
<td></td>
<td>Clayey soils</td>
<td>Excessively drained (dry)</td>
<td>Firmly structured</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fertile</td>
<td>Liable to fog</td>
</tr>
</tbody>
</table>

Table 4.6 Suitability classification of ancient millet

Grapes (Vitis vinifera)

Columella (III.2.1) informs us about the cultivation of grapes in his period. They were planted for eating or for drinking juice. Only when the grape yards lay close to the village, trading became profitable.

In his third book on Agriculture, Columella presents a clear overview of the LURs of grapes, according to the prevailing opinions of his time. Grapes thrives well on plain, as well on hillside, in compact soil no less than in loose, often also on thin land, in fat and lean ground, in dry and wet ground (Columella III.1.4). He adds that the suitability of grapes depends on which variety you want to use in a specific region with its own characteristic soils. A calm and clear-skied region does not refuse to omit any kind of grapes, though most suitable one whose clusters or berries fall quickly (Columella III.1.7). But, on average, grapes yards can be located best on rather loose soils, rather fertile, on slightly elevated plain-land, moderately moist soils, which are neither bitter nor brackish. It is not such as icy cold or burning hot (Columella III.1.8–10). Besides, he strongly advises not to use very fertile land for grapes cultivation, but a medium fertile one, because the cutting quickly take root and shoot up..., yet if transferred to poorer soil when they become quicksets, they wither and cannot grow to maturity (Columella III.2.5).

The interpretation of these recommendations is as follows: suitable are sandy soils, marginally suitable are loamy soils. Moderately moist soils can be those, which are moderately drained.
### Table 4.7 Suitability classification (on average) of ancient grapes

<table>
<thead>
<tr>
<th>Grapes</th>
<th>Suitable</th>
<th>Marginally suitable</th>
<th>Not suitable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil requirements</td>
<td>Deeper</td>
<td>Thin</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sandy soils</td>
<td>Loamy soils Compact or loose</td>
<td>Clayey soils</td>
</tr>
<tr>
<td></td>
<td>Moderately drained</td>
<td>Poorly drained</td>
<td>Excessively drained (dry)</td>
</tr>
<tr>
<td></td>
<td>Rather fertile</td>
<td>Fat or unfertile</td>
<td>Very fertile</td>
</tr>
<tr>
<td></td>
<td>Slightly elevated plain-land</td>
<td>Plain or hillside</td>
<td></td>
</tr>
<tr>
<td>Temperature requirements</td>
<td>Relatively warm</td>
<td>Icy cold or burning hot</td>
<td></td>
</tr>
</tbody>
</table>

### Table 4.8 Suitability classification (on average) of ancient olive trees

<table>
<thead>
<tr>
<th>Olive trees</th>
<th>Suitable</th>
<th>Marginally suitable</th>
<th>Not suitable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil requirements</td>
<td>Thin and deeper soils</td>
<td>Steep slopes with thin soils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Loamy soils</td>
<td>Clayey soils</td>
<td>Sandy soils</td>
</tr>
<tr>
<td></td>
<td>Well-drained (moist)</td>
<td>Excessively drained (dry)</td>
<td>Poorly drained (wet); Muddy or marshy</td>
</tr>
<tr>
<td></td>
<td>Chalk mixed with coarse sand</td>
<td>Gravelly soils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fertile</td>
<td>Fertile</td>
<td>Unfertile (lean)</td>
</tr>
<tr>
<td></td>
<td>Moderately inclined</td>
<td>Rocky terrain</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Calcareous</td>
<td>Calcareous</td>
<td>Non-calcareous</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bare</td>
</tr>
<tr>
<td>Temperature requirements</td>
<td>Warm</td>
<td></td>
<td>Very warm or very cold</td>
</tr>
</tbody>
</table>

### 4.7 Concluding remarks

This chapter described the main land utilisation types, which were common in Central and South Italian farming during the last two millennia BC. An overview has been given of the various cultivated crops, together with their land use and management requirements, the agricultural techniques and the evolution of farming equipment. Also, the most favourable and unsuitable cultivation areas in each period were explained.

The main conclusions that can be drawn from the chapter are:

- From the Bronze Age till the Roman Age, a development can be seen in agricultural instruments and techniques. For example, iron ploughshares replaced wooden ploughshares and the ploughs themselves became increasingly robust during time. Heavy soils could be cultivated...
more easily. Also, the use of drainage systems and fertilisers enabled Romans to cultivate wet or unfertile areas, which had been useless in the periods before. Deforestation was facilitated with the use of iron sickels and axes.

- Evidence shows that in South Italy olive cultivation already emerged in the Bronze Age, whereas Central Italy faced the development of olive (and grapes) production from the 6th century BC only.
- Workability must be considered as an important land quality in archaeological land evaluation.
- Research has shown that many present-day crops have different land use requirements than their ancestors (except for, for instance, emmer wheat). So these requirements must be investigated carefully before using them in archaeological land evaluation.

In the next part of this book, all data from chapter 3 (land systems, land qualities) and chapter 4 (land utilisation types) are incorporated in ALES to decide on the degree of suitability of certain LUTs for certain land systems. The results are visualised with GIS in maps.

Appendix B and C1 shows the data from this chapter in ALES format.