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Feeding the Roman Army
the Archaeology of Production
and Supply in NW Europe

edited by

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*Front cover: Imperial period mosaic held at the Vatican Museum, Rome.
Adapted by Phillip Johns from an original photograph by Barbara McManus*

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Appetizer: preface and acknowledgements

The papers in this volume arose from two complementary sessions that were organised as part of the Theoretical Roman Archaeology (TRAC) conference held at University College London in March 2007: *Feeding the Roman army: the archaeology of supply chains and provisioning networks* (Richard Thomas) and *Food for thought: economics, natural resources and the Roman military organisation* (Sue Stallibrass).

The sessions had two interdependent aims. Firstly, they sought to draw together a growing body of new archaeological evidence in an attempt to reconsider the ways in which the Roman military organisation was provisioned with food and other natural resources (*e.g.* timber, traction and textiles), and how the production and procurement of these resources varied over time and according to circumstance (*e.g.* locality, the nature of military activity, producer/consumer identities). Secondly, these sessions sought to encourage explicit hypothesis testing in preference to routine analysis and interpretation, at the same time bringing together the multiple methodological and theoretical approaches of a variety of archaeological sub-disciplines to encourage inter-disciplinary dialogue.

One of the principal areas of research evident from the conference sessions was the way in which food was produced, procured and supplied to the Roman army, and it is this theme that is developed within this volume. It should be noted from the outset that this volume does not intend to be exhaustive in its coverage of these topics. Rather, it seeks to present a range of new evidence, consider different theoretical and methodological approaches and make suggestions regarding the possible directions of future research and improved modes of working. Consequently, this volume largely concentrates on animal husbandry, arable farming and food, particularly the north-west European staples of cereals and domestic mammals; however, several of the papers do touch upon other aspects of natural resources required by the Roman army: luxuries, non-edible raw materials and animals for transport. While we are aware that there are key aspects of food provisioning that have not been explored within the volume, such as drink (*e.g.* water, beer and wine), we hope that this series of studies will provide a platform from which future research can build.

In preparing this volume there are many people to whom we are indebted. Firstly we would like to thank our contributors, not only for their interesting research and engaging in stimulating discussion during the conference and subsequently, but also for adhering to a very tight submission schedule! We would like to extend our immense gratitude to the two reviewers Hilary Cool (Barbican Research Associates, UK) and Roel Lauwerier (Rijksdienst voor Archeologie, Cultuurlandschap en Monumenten, The Netherlands) for all their considered input. Finally, thanks to Oxbow Books, particularly Tara Evans and Clare Litt, for agreeing to publish the proceedings and all their help in producing this volume.

Richard and Sue (December 2007)

5. Food supply to the Roman army in the Rhine delta in the first century A.D.

Chiara Cavallo, Laura I. Kooistra and Monica K. Dütting

Introduction

Over a period of about 100 years, the Roman army established a sequence of different types of military installations along the lower Rhine in what is now part of The Netherlands. This paper investigates the changing nature of the production and supply of food to these sites, as evidenced by plant and animal remains.

The first Romans arrived in the Netherlands during the Augustan military campaigns. In Nijmegen, in the east, the earliest Roman fortification was built at around 19–16 B.C. and evacuated at 12 B.C. In the early first century A.D., three smaller forts were established further westward at Meinerswijk, Vechten and Velsen. Between A.D. 40 and 70, a string of about ten, quite small, fortifications was built on the southern levee of the River Rhine from Vechten down to the North Sea, covering a total distance of some 60 km (Fig. 5.1).

Opinions differ as to why these fortifications were built. Some believe that the auxiliary forts were designed to demarcate the border of the Roman Empire, whereas others are of the opinion that they were established with a different objective, and developed into actual forts only later. This debate was one of the reasons for starting a research project in 2004 entitled “A sustainable frontier? The establishment of the Roman frontier in the Rhine delta”. Within this project, data collected from excavated auxiliary forts in the study area will be compared with each other in order to develop new ideas about the Roman military presence in the Rhine delta. One key element of this research is to explore the way in which food was supplied to the Roman army, since a well-organised food supply was essential for a successful occupation (*e.g.* Groenman-van Waateringe 1980, 1989). To obtain information on questions such as:

- what were the main food products used;
- how much was needed;
- where did these products come from;
- how were these products transported to the fortifications;

both archaeobotanical and archaeozoological data are being considered and compared with other data from the archaeological record. In this paper we will discuss the preliminary results of our analysis.

Time periods

For this preliminary study we have established three chronological periods:

- Period 1: 19–16 B.C. to A.D. 40: the period of the earliest Roman bases in the Netherlands;

- Period 2: A.D. 40 to A.D. 69–70: the period during which the timber auxiliary forts were established in the Rhine delta until the Batavian revolt (A.D. 69–70);
- Period 3: c. A.D. 70 to A.D. 140: a period which witnessed the rebuilding of the timber forts and the replacement of the local auxiliary troops by those from other parts of the empire until the first stone fortifications were constructed.

Landscape

Among many factors which must have influenced the food supply to the Roman army, such as food culture and the military organisation of food supply, one must also consider the relation between food supply and the surrounding landscape. In general, the Rhine delta around these fortifications was a wet area. Settlements in the eastern part of the area were concentrated on stream ridges and the levees of the River Rhine. In the west they were located on the sandy beach barriers, which were separated by salt- and fresh-water marshes. The central area was low and peaty, and the generally high water table everywhere meant that the area suitable for arable cultivation was restricted to these higher, drier areas of settlement (see Fig. 5.1). In this type of landscape there were certainly possibilities for growing cereals, but the high water table meant that the area suitable for arable fields was limited. For this reason, it is assumed that cereals for the Roman army were imported from southern Belgium, northern France and the German Rhineland.

The research

From archaeological and historical sources it is known that the main vegetable food products for the Roman army were bread, biscuits, porridge, fruits, beer, wine and olive oil. Of these, wine and olive oil were imported from the Mediterranean, whereas bread, biscuits and porridge were prepared from ingredients that were transported to the fortifications. One of the aims of the research is to locate where the ingredients came from. The main ingredients for bread, biscuits, porridge and beer are bread wheat (*Triticum aestivum*), emmer wheat (*Triticum dicoccum*), spelt wheat (*Triticum spelta*) and hulled barley (*Hordeum vulgare*). Although many more vegetable foodstuffs were used, the discussion in this paper will concentrate on the provisioning of the fortifications with staple foods, cereals in particular.

The consumption of meat by Roman soldiers has been much discussed in the past, concerning both the quantities and the range of products used. Analysis of Roman texts has stimulated debate regarding whether the Roman soldiers were vegetarians or not (e.g. Davies 1971; Stolle 1914). Zooarchaeological research has provided direct data from military contexts and shown a wide range of animals being consumed by soldiers (e.g. Junkelmann 1997; King 1984; Luff 1982). As to the amount handed out to soldiers on the move or at a base, there is no strict figure. Usually, assumptions are made based on texts, best practices, minimum amount of protein and calorific requirements *etc.* (e.g. Goldsworthy 1996; Le Roux 1994; Roth 1999).

Apart from the direct consumption of meat (and secondary products such as cheese), the army needed animals and animal products for providing them with draught, pack and riding animals, and with leather for shoes, tents, and many other items. In this paper we will not quantify the precise amounts needed by the Roman army but rather consider patterns of distribution. A discussion on the way the army's needs were met in the Rhine delta will be presented elsewhere (Kooistra *et al.* in prep.).

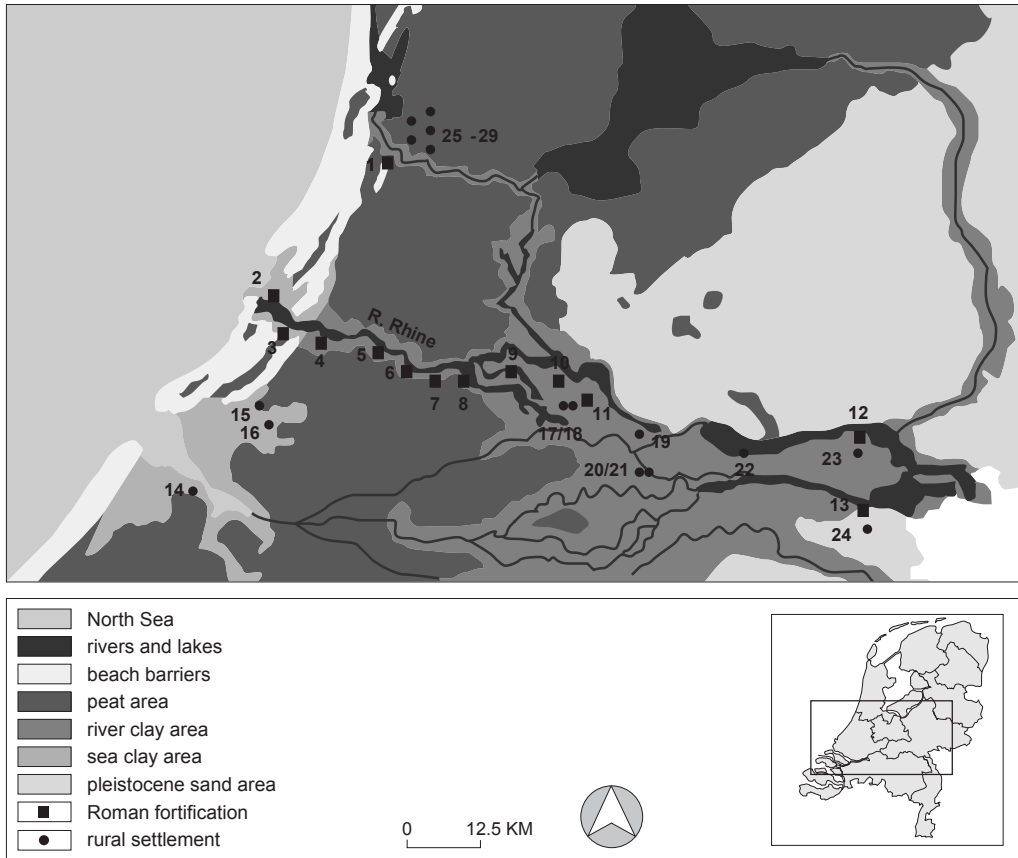


Figure 5.1: Landscape of the study area, marked with the Roman fortifications and the rural settlements mentioned in this paper. 1 Velsen, 2 Brittenburg, 3 Valkenburg, 4 Leiden-Roomburg, 5 Alphen a/d Rijn, 6 Zwammerdam, 7 Bodegraven, 8 Woerden, 9 De Meern, 10 Utrecht, 11 Vechten, 12 Meinerswijk, 13 Nijmegen, 14 Nieuwerhoorn, 15 Harnaschpolder, 16 Vlaardingen, 17/18 Houten Tiellandt/Houten Doornkade, 19 De Horden, 20/21 Tiel Passewaaij/Tiel Medel, 22 Kesteren, 23 Arnhem Schuijtgraaf, 24 Groesbeek, 25–29 Assendelft sites C, D, F, H, K. Drawing: J. Slopmsa (University of Amsterdam).

Obtaining archaeozoological data from the sites mentioned above has proved to be a complicated process. Many of the data have not been researched or published in official literature. In addition, we encountered common problems such as lack of information about recovery methods (hand-recovered, sieved *etc.*), poor contextual data, and small sample sizes. For this paper we used the well-dated and contextually secure bone material from eight military sites; the complete reference database will be published elsewhere (Cavallo *et al.* in prep.).

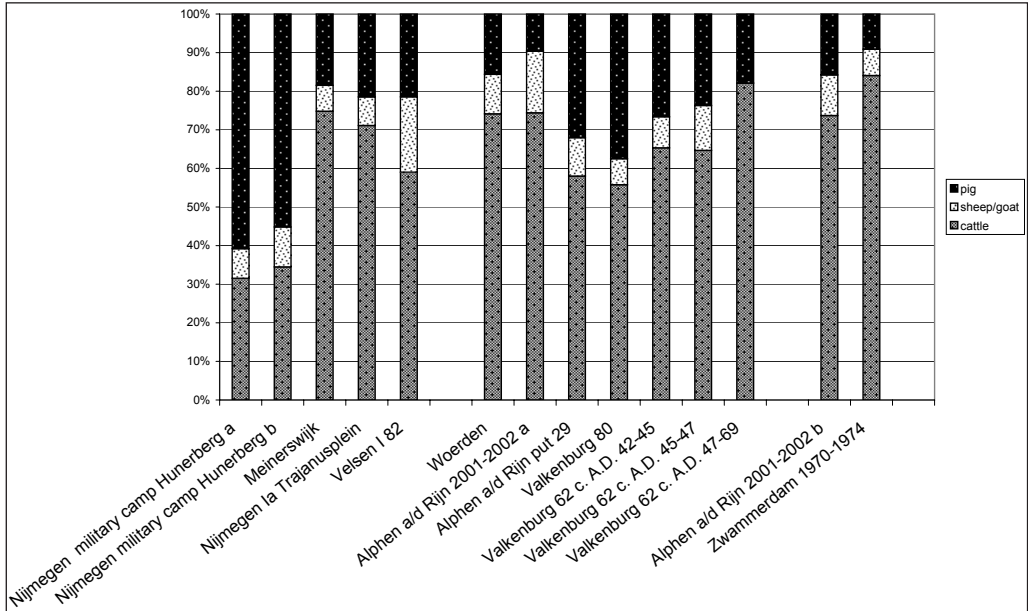


Figure 5.2: Relative frequencies of identified bones of cattle, sheep/goats and pigs from stratified deposits at eight Roman sites in the Rhine delta (see Table 5.1 for site details and bibliographic references).

Period 1: 19/16 B.C.–A.D. 40: the period of the earliest Roman bases in the Netherlands

At around 19–16 B.C. the Roman army built a huge military camp at the Hunerberg in Nijmegen. This camp housed two legions and was in use till around 12 B.C (Kemmers 2005: 44–57, esp. 48–49; Polak forthcoming). Part of the bone material studied shows a relatively high percentage of pig comprising up to 55% of the main (staple) domesticated species (Thijssen 1988: Fig. 5.2). A little later, a fortification at the nearby Trajanusplein was erected. The bone material there showed a different picture with cattle bones dominating the zooarchaeological assemblage (Lauwerier 1988). It can be argued that this difference may have been the result of the way in which the material was retrieved (hand-collected and not sieved) and that the data should be corrected for a relatively higher percentage of pig compared to cattle. However, an alternate explanation for the higher amount of pigs is that it relates to the more offensive character of the first phase of the military camp at the Hunerberg. This is confirmed by the results of other bone assemblages from the Augustan period from the military camp, studied by Koopmans (1996), which show a percentage of pigs of around 60% (Fig. 5.2 and Table 5.1). Unfortunately, no archaeozoological data from contemporary indigenous sites from the immediate area surrounding the military fortification at the Hunerberg currently exist for comparison.

With respect to the botanical data, only six samples have been analysed from the military levels at the Hunerberg to date, and these were unfortunately poor in botanical remains (de Hingh and Kooistra 1995). The main cereal crop is hulled barley, but emmer wheat, oat (not definitely cultivated oat) and common millet are also found. These cereals could be cultivated locally but

<i>Time period</i>	<i>Site</i>	<i>Cattle</i>	<i>Sheep/goat</i>	<i>Pig</i>	<i>Total</i>	<i>% pig</i>
Period 1: pre A.D. 40						
19–16 B.C. to 12 B.C.	Nijmegen: Hunerberg a	197	48	380	625	61%
19–16 B.C. to 12 B.C.	Nijmegen: Hunerberg b	60	18	96	174	55%
A.D. 20–250	Meinerswijk	89	8	22	119	18%
10 B.C.–A.D. 25	Nijmegen Ia Trajanusplein	192	20	58	270	21%
A.D. 15–30	Velsen I 82	4228	1398	1538	7164	21%
Period 2: A.D. 40–A.D. 70						
Woerden I, II, III: c. A.D. 40–70	Woerden	275	38	58	371	16%
period 1: A.D. 41/42–69/70	Alphen a/d Rijn 2001–2002	93	20	12	125	10%
A.D. 41/42–A.D. 69/70	Alphen a/d Rijn put 29	228	39	126	393	32%
werkput VI: A.D. 39–47	Valkenburg 80	58	7	39	104	37%
period 1: c. A.D. 42–45	Valkenburg 62	81	10	33	124	27%
period 2: c. A.D. 45–47	Valkenburg 62	150	27	55	232	24%
period 3: c. A.D. 47–69	Valkenburg 62	156		34	190	18%
Period 3: A.D. 70–A.D. 140						
period 2: wooden fort after A.D. 70	Alphen a/d Rijn 2001–2002	14	2	3	19	16%
A.D. 80–A.D. 175	Zwammerdam 1970–1974	443	36	48	527	9%

Table 5.1: Absolute numbers of identified bones of the main domestic species and the relative proportion of pig bones found in the Roman forts. See Appendix for site details.

in this period the local farms seem to have only been self supporting (Kooistra 1996). Apart from the cereals, one olive stone was also found. This species must have been imported from the Mediterranean.

During Period 1 a further three Roman forts were built: Vechten (around A.D. 4–5), Meinerswijk (around A.D. 10–20) and Velsen (around A.D. 15–16 and in use until A.D. 29; Fig. 5.1, Table 5.1 and Appendix). From Vechten no well-dated archaeobotanical remains were recovered and the bone material has yet to be studied.

The pollen information obtained through archaeological research of the fort at Meinerswijk shows that both the northern and the southern bank of the River Rhine were in use (Teunissen *et al.* 1987). The pollen records also show high amounts of cereal. The authors suggested that this might point to local production of cereals. However, it is known from experimental research that most of the pollen of cereals reaches the soil not by growing on arable fields but when the cereals are threshed to isolate the kernels from the chaff (Diot 1992). Thus, it is even possible that the high amounts of cereal pollen at Meinerswijk came from imported hulled cereals which were threshed just before consumption. Much of the pollen indicates grasslands around the fortification.

The zooarchaeological data from Meinerswijk, although not so sharply dated as the palynological material, show a relatively high percentage of pig amounting to around 18% of the bones from domesticated animals, while cattle dominates with a high percentage of 68% (Lauwerier 1988: 86; Table 5.1).

The finds from the fort at Velsen demonstrate that luxury food products such as peach and olives were present (Pals 1997). On the subject of staple plant foods, no data are available yet. The bone material from Velsen also shows the presence of luxury goods, including peacock, chicken, chub mackerel and a broad spectrum of wild birds and game (Prummel 1987, 1993). The

presence of relatively large numbers of chicken bones is seen as evidence of Roman influence (Lauwerier 1988: 142). In the fort at Velsen we see that up to 80% of the avifaunal assemblage consists of chicken, from the earliest occupation levels at the fort onwards (Prummel 1987, 1993).

Pig bones form a substantial part of the faunal assemblage from the first phase of occupation at the fort at Velsen (Table 5.1). The surrounding area of the Assendelver Polders was intensively surveyed, excavated and studied by the University of Amsterdam in the 1970's and 1980's, but pig bones from this period are either totally absent or, if present, comprise up to maximally 1% (Laarman 1983; Meffert 1998; Van Wijngaarden-Bakker 1988). The landscape of this area lacks the characteristics that are usually attributed to an area suitable for keeping pigs, namely more sandy ground with preferably oak woods. Although Meinerswijk also lies in a landscape less suitable for keeping pigs, Lauwerier thinks that like heather sods, pigs were transported from the sandy regions on the other side of the Rhine. He specifically links the occurrence of a high percentage of pigs to the military presence in the area (Lauwerier 1988: 127).

Looking at the relatively high percentage of pig in the collected bone material from these early Roman military sites (Fig. 5.2), we suggest as a possible explanation that these early forts relied on pig as a fast and reliable source of animal protein in times of offensive campaigns and in territories that were still relatively recently under Roman control, a phenomenon attested elsewhere in the empire (Thomas this volume). In the case of Velsen, there are clear indications that not just pig but also chicken were brought with the army to the fort as there are no indications in the faunal remains from sites in the surrounding area in this period that could point to local sources for these animals, and the exotic peacock, peaches and olives must have been brought from elsewhere (Prummel 1987).

Period 2: A.D. 40–A.D. 69/70: from the first timber auxiliary forts until the Batavian revolt

Towards the middle of the first century a series of auxiliary forts was constructed on the south bank of the Rhine, between Vechten and the North Sea. Traditionally, Valkenburg is assumed to have been built in A.D. 39–40, the others between A.D. 40 and 50 (Polak forthcoming). These forts are thought to have been largely occupied by troops that were recruited locally. It is still not clear how the local troops that were stationed along the Rhine were provisioned. It is generally assumed that the troops were stationed inside the forts and that provisioning of the forts was part of the routine of the Roman army. However, de Weerd (2006) recently suggested that these forts were not permanently manned which would raise the question whether a standard supply line would have been set up.

It remains unclear whether at this time the River Rhine was already the northern border of the Roman Empire. Archaeobotanical evidence is available from four military sites and from ten rural settlements of which three were situated northwest of the Rhine delta (Fig. 5.1 and Appendix). Table 5.2 summarises the different groups of plant foods found at military locations and in rural settlements.

In the first century before A.D. 70 all of the cereals needed to prepare bread were found inside the fortifications, including spelt wheat and bread wheat. Not all of these cereals were available from the rural settlements nearby. Hulled barley and emmer wheat were grown at all investigated rural settlements south of the River Rhine. On a smaller scale, millet and oat were also produced. Northwest of the River Rhine, hulled barley was the main crop, probably due

<i>Settlement type</i>	<i>Period 2 A.D. 40 – A.D. 70</i>			<i>Period 3 A.D. 70 – A.D. 140</i>		
	Military	Rural (south of Rhine)	Rural (north of Rhine)	Military	Rural (south of Rhine)	Rural (north of Rhine)
<i>Number of sites</i>	4	7	3	4	8	2
Cereals						
Hulled barley	4	7	3	3	7	2
Millet	1	4	-	-	3	1
Oat	2	5	1	-	4	2
Rye	2	-	-	-	1	-
Bread wheat	2	-	-	2	(1)	-
Emmer wheat	4	7	-	4	5	2
Spelt wheat	3	-	-	4	(1)	-
Pulses						
Celtic bean	2	3	-	1	4	-
Vegetables and kitchen herbs						
	3	1*	-	3	5	-
Exotic foodstuffs						
	4	-	-	1	1	-

Table 5.2: Presence data for cereals, pulses, vegetables and exotic food products found in military and rural settlements. Numbers in brackets indicates uncertain identifications; the asterisk indicates uncertainty as to whether the vegetable/kitchen herb mentioned here (celery) was wild or cultivated.

to the rather brackish conditions here. Bread wheat and spelt wheat did not occur in any of the rural settlements, either north or south of the River Rhine. Further, no vegetables, Mediterranean kitchen herbs and exotic food plants (for example fig, olive, walnut and grape) have been encountered in the local rural settlements. Yet, these food products did occur at the military sites (Table 5.2). This could indicate that the rural population and the Roman army did not engage much in the exchange of imported food products.

The evidence available concerning the structure of rural settlements in the delta of the Rhine shows that these habitations consisted of quite small, mixed farms without substantial or structural surplus production (Kooistra 1996: 50–55; Meffert 1998: 101–113). Given the structure of these farms, it is most likely that local production of food was quite meagre and that the only way for the Roman army to obtain cereals was to import them. The main possibility for importing cereals is clearly by ship, either over sea and sailing up the river, or by navigating downstream on the rivers Rhine or Meuse. Historical support for this idea is provided by Tacitus (*Historiae* IV, 26) who mentions that in A.D. 69 food could not be imported, because of the low water levels of the River Rhine.

The archaeozoological data for this period reveal a relatively substantial quantity of pig bones from the very start of the occupation (Table 5.1). Although the amount of pig is significantly less than that seen in the earliest military forts discussed above, it constitutes a much higher percentage than the majority of contemporary rural settlements in the region (Ewijk – Lauwerier 1988; Heteren – Lauwerier 1988; and Leiden-Pomona – Kemerink 2006), where the percentage

of pig amounts at the most to 5% of the main staple species. An exception is Katwijk-de Zanderij where the percentage of pig bones reaches 18% (Heiden *et al.* in prep.).

The relatively high percentage of pig bones in the forts slowly decreases over time, as we can see in the case of Valkenburg where the bone material could be ascribed to well-defined and short phases (Table 5.1). Due to the long occupation of the forts, the picture of meat supply is slightly blurred. We still think that pig may have been a reliable ‘start-up’ resource for troops stationed in these forts but that the importance of this food source diminishes through time.

Although there is little evidence of Roman dependence on local settlements for their cereals, it is unlikely that the Roman army would continue to import cattle and other animals from further away to supply the forts if this could be avoided, as this would involve huge transport problems, if importing live animals. Importing preserved meat products from far away would incur the major problems of long-term storage and keeping the food edible, on top of that of transport. A discussion of transport is presented elsewhere (*e.g.* Dütting *et al.* forthcoming).

If the forts were not permanently manned, we would expect a much higher and more stable amount of pig bones representing an easy and reliable meat source. An argument against this could be that the locally recruited troops were taking their supplies from home, thus representing a picture more consistent with neighbouring local settlements.

This is disputable however. Although provisions for the core of the Roman army, the legionaries, were probably more a matter of concern to the Roman general staff than providing for the auxiliary troops, it seems unlikely that they were wholly left to cater for themselves as this would seriously have hampered army routine and law and order. In this period and area, we have no indication for *villae* supplying the military. Although in this period some of the cereals were imported from the south, we must assume that the meat supplies were either provided by ways of taxation, trade with the locals or requisition (although requisition is more often used by armies as incidental practice, not during longer periods).

In A.D. 69–70 the Batavian revolt sees most of the timber forts destroyed and marks the start of a new phase in the Roman presence in the Rhine delta.

Period 3: from A.D. 70–140: the rebuilding of the timber forts and the replacement of the local auxiliary troops, until the first stone fortifications were constructed.

In the 80s of the first century the Lower German military district was reshaped into a proper Roman province. At least from that time on it seems legitimate to consider the Rhine as the actual border of the Roman Empire.

Within three fortifications and at the *vicus* of Leiden-Roomburg, the same range of cereals as for the first century have been found, although there is a growing preference for spelt wheat (see Fig. 5.1, Table 5.1 and Appendix). Archaeobotanical evidence is available from eight rural settlements south of the River Rhine and two rural settlements northwest of the river. The main crops on the farms situated immediately to the south of the Rhine are still hulled barley and emmer wheat. It seems that to some extent millet, oat and rye were also produced. At the rural settlement at Kesteren, bread wheat and spelt wheat may have been present, but their identification is uncertain. In this area, rural settlements also grew kitchen herbs and vegetables. Exotic products did occur, but were rare. In the two rural settlements northwest of the River Rhine, hulled barley continued to be the main crop, followed by oat, emmer wheat and millet.

No kitchen herbs, vegetables or exotic food products have been found here (Table 5.2).

It seems that the farms south of the border had undergone a change. They remained mixed farms, but grew bigger and arable farming became more important (Kooistra 1996: 50–55). The situation north of the River Rhine remained unchanged in comparison with the period A.D. 40–70. The rural settlements were still the same size and practised the same agrarian economy as during the previous period.

In this period only hulled barley, spelt wheat, emmer wheat and bread wheat are found at military sites, including the *vicus* of Leiden-Roomburg. There is an indication that the rural settlements south of the River Rhine attempted to produce a surplus of emmer wheat and hulled barley. It is possible that these crops of local origin did reach the military sites, but the increase in the rural population, which consumed the cereals at its source, may have frustrated any surplus production for the Roman army. If this was the case, hulled barley and emmer wheat may also have been imported from elsewhere. It is certain that spelt wheat and bread wheat were imported to the military sites from the loess areas of Germania Inferior. In the loess regions of the German Rhineland, southern Netherlands, Belgium, and northern France there was a surplus production of mainly spelt wheat (Kooistra 1996: 102–104, 111–113, 125–127).

Looking at the archaeozoological record, we see little difference for this period when compared to the data from Period 1 (Table 5.1). One of the assumptions made is that after the Batavian revolt the locally recruited and stationed auxiliaries were ordered to other parts of the Roman Empire (such as Britain as is well attested by several Roman sources and the archaeological record). En lieu of these, other troops were stationed along the Rhine who, concluding from evidence such as military diplomas, came from such remote areas as Hispania and Pannonia (Polak forthcoming).

When considering the idea that the earlier forts were not permanently manned or that the troops were (partly) locally catered for by their relatives, it would be fair to assume that the new troops, lacking ties with the local population in the Rhine delta, would for their daily food be completely dependent on the provisions supplied to them by the Roman army. This would imply a different troop provisioning system, one that required increased imports or enhanced local military meat production, for example. In that case a fast and reliable supply of meat could have been found by an old and proven army routine: chicken and pigs. However, when looking at archaeozoological data, we see no such clear indication (Table 5.1). Although chicken and pig still appear in the bone assemblage, the amount of pig further declines with an increase in the percentage of cattle for the sites on the western part of the Rhine delta. This can clearly be seen in the data collection from the fortifications at Valkenburg, Alphen and Zwammerdam. In our view this points to an already well established system of local or regional meat production geared to supply and sustain the Roman army for this area. However, this view is challenged by the persistent relatively high percentage of pigs found in the Nijmegen *castra*. Whether this is a matter of sample size or a difference in economic systems might be answered with a more expanded study in the future.

Conclusions

From the first Roman presence during the Augustan campaigns, into the middle of the first century A.D., the Roman army in the Rhine delta relied heavily on food supplies from external sources. Both the earliest military camps and the first phases of the wooden forts that marked the beginning of the consolidation of Roman occupation, show that cereals and luxury goods were

imported from outside the Rhine delta. In particular, the exploitation of pigs and chickens seems to be strongly influenced by the appearance of the Roman troops. This may be an indication that the Roman army used these animals as a reliable, easily transportable, rather undemanding and fast reproductive protein resource, in times of campaigns or in unfavourable circumstances such as lack of local resources.

During the following consolidation period, Period 2, up until the Batavian revolt in A.D. 69–70, most of the cereals needed by the army still were imported from outside the Rhine delta as the present farms show little evidence of surplus production. In contrast, the region seems to have stepped up animal production to meet the army's demand for cattle and possibly, but to a much lesser extent, sheep. This system clearly worked well as it persisted into Period 3. Once the forts were established, the army looked around for other sources for meat supply and found them either in the local or in the regional farms. For the Rhine delta, from around A.D. 70 this picture remains a constant one and in our view this points to an already well-established local or regional pattern of production. This is in stark contrast to the picture for cereal production: spelt wheat and bread wheat continued to be imported from more southerly regions and from the end of the first century A.D. the rural settlements in the (eastern) river area supplied a certain amount of surplus of barley and emmer wheat.

It remains a matter of research and debate as to what causes these differences in food provisioning. Were they the result of the limitations of the landscape and production, the storage requirements, the seasonal availability, or were they due to the logistics of transport?

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Appendix: site details for Table 5.1

<i>Site name</i>	<i>Status</i>	<i>Site No.</i> <i>(Fig. 5.1)</i>	<i>Reference</i>
Velsen	fortification	1	Schnitger (1988); Pals (1997)
Valkenburg	fortification	3	Brinkkemper unpublished data; van Zeist (1968); Noordam and Pals (1987); Pals <i>et al.</i> (1989)
Valkenburg 62	fortification	3	Prummel (1974)
Valkenburg 80	fortification	3	Verhagen (1988)
Leiden Roomburg	vicus	4	Kooistra (2006a)
Alphen aan den Rijn	fortification	5	Kuijper and Turner (1992); Kooistra (2004)
Alphen aan den Rijn 2001–2002 a and b	fortification	5	Shuman (2006)
Alphen aan den Rijn put 29	fortification	5	Fischer (2004)
Zwammerdam	fortification	6	van Mensch (1974)
Woerden	fortification	8	Brinkkemper and de Man (1999); van Dijk (2007); van Beurden in prep.
De Meern	watch tower	9	van Haaster (2004)
Meinerswijk	fortification	12	Teunissen <i>et al.</i> (1987); Lauwerier (1988)
Nijmegen	fortification	13	de Hingh and Kooistra (1995); Kooistra unpublished data
Nijmegen: Hunerberg a	fortification	13	Koopmans (1996)
Nijmegen: Hunerberg b	fortification	13	Thijssen (1988)
Nijmegen la Trajanusplein	fortification	13	Lauwerier (1988)
Nieuwerhoorn	rural settlement	14	Brinkkemper (1993: 80–94)
Harnaspolder	rural settlement	15	Kooistra (2006b)
Vlaardingen	rural settlement	16	Brinkkemper and de Ridder (2000)
Houten Tiellandt	rural settlement	17	Kooistra (1996: 300–306)
Houten Doornkade	rural settlement	18	Hogestijn (1984)
De Horden	rural settlement	19	Lange (1990)
Tiel-Passewaaij	rural settlement	20	Fokma (2005); Kooistra and Heeren (2007)
Tiel-Medel	rural settlement	21	van Beurden (2004)
Kesteren	rural settlement	22	Kooistra and van Haaster (2001)
Arnhem Schuytgraaf	rural settlement	23	Hänninen <i>et al.</i> (2004)
Groesbeek	rural settlement	24	van Beurden (1998)
Assendelft site C	rural settlement	25	Pals (1987); Meffert (1998)
Assendelft site D	rural settlement	26	Pals (1987); Meffert (1998)
Assendelft site F	rural settlement	27	Pals (1987); Meffert (1998)
Assendelft site H	rural settlement	28	Pals (1987); Meffert (1998)
Assendelft site K	rural settlement	29	Pals (1987); Meffert (1998)