

Supplying Food to *Ulpia Noviomagus Batavorum*

Laura I. Kooistra – Maaïke Groot

Introduction

Researchers have long assumed that the economic stimulus in the Batavian area (fig. 1) was mainly caused by the recruitment of Batavian young men for the army. This was based on a text by Tacitus, in which it was mentioned that the Batavians were exempt from taxation due to their supply of troops to the Roman army.¹ Nevertheless, the agrarian countryside of the *civitas Batavorum* would also have been drawn into economic change as a result of the demand for agrarian products. That demand was not just from the Roman army, which was especially prominent with the presence of the tenth legion in Nijmegen in the first and early second century.² Already in the first century, Nijmegen had a civil centre, *Oppidum Batavorum*, which was strongly connected to the army. This capital of the Batavians was destroyed in 69 AD. After quiet had been restored, a new town was built somewhat to the west along the river Waal; this town received market rights and the name *Ulpia Noviomagus Batavorum* from Emperor Trajan in the early second century AD. The population of this town is estimated at 5,000 to 6,000 civilians. Army and civilian population together at the end of the first century consisted of ca. 10,000 consumers. How were the town and the army supplied and what role did the Batavian rural population play in this supply? These are the questions central to this paper.

Civitas Batavorum

The tribal area of the Batavians was located between the rivers Rhine and Meuse. To the west it was bordered by an extensive peat area, which was part of the territory of the Cananefatians. The eastern border was just to the east of Nijmegen. Most of the Batavian area consisted of low-lying, fertile river deposits. Active rivers with natural levees, alluvial ridges with residual channels and flood basins were the characteristic landscape elements. Only to the south of Nijmegen did high and dry sandy and loamy soils occur. The population outside the town and army camps mainly lived in small agrarian settlements, consisting of one to five wooden byres (fig. 2). Villa-like settlements were scarce;³ most of them were situated in the vicinity of Nijmegen. The *civitas Batavorum* was relatively densely populated.⁴ Vossen argued that more or less 1000 agrarian settlements were contemporaneous in the second century. The settlements were situated on alluvial ridges. Arable farming took place on the alluvial ridges, mainly just above the water level, and the animals were raised mainly in the flood basins.⁵



Fig. 1: Locations of legionary fortresses and cities (large squares) and of attested and presumed smaller forts (small squares) on the left bank of the river Rhine at about AD 100. The *civitas Batavorum* was situated in the river area.



Fig. 2: A reconstruction drawing of Tiel Passewaaij, a rural settlement in *civitas Batavorum*.

Supplying Animal Food to Nijmegen

Animal husbandry in the rural *civitas Batavorum* relied heavily on cattle. Of the three main meat-providing animals, cattle is the most common species, followed by sheep or goat and then pig (fig. 3A). When this is compared with species proportions in Nijmegen, it is clear that cattle shows the highest proportions in the urban assemblages and the lowest in the military ones (fig. 3B–C). Pig frequencies are similar for rural sites and urban Nijmegen, while they are much higher in some of the military assemblages. Since these are the earliest military sites, it seems highly unlikely that the pigs could have been supplied from the surrounding countryside, which had no strong tradition of pig keeping.

Slaughter ages of cattle show that more adult cattle are found in Nijmegen than in the countryside (fig. 4). It seems that cattle were selectively supplied to Nijmegen, with the youngest animals consumed in the countryside and older animals in town. This suggests that there was no system of specialised meat production; otherwise a selection of younger cattle would be expected for the towns.

The size of cattle increases during the Roman period (fig. 5). This would have resulted in higher output, both of traction power and meat.

The animal remains from rural sites in the *civitas Batavorum* and military and civil sites in Nijmegen not only provide information about possible supply, but also about

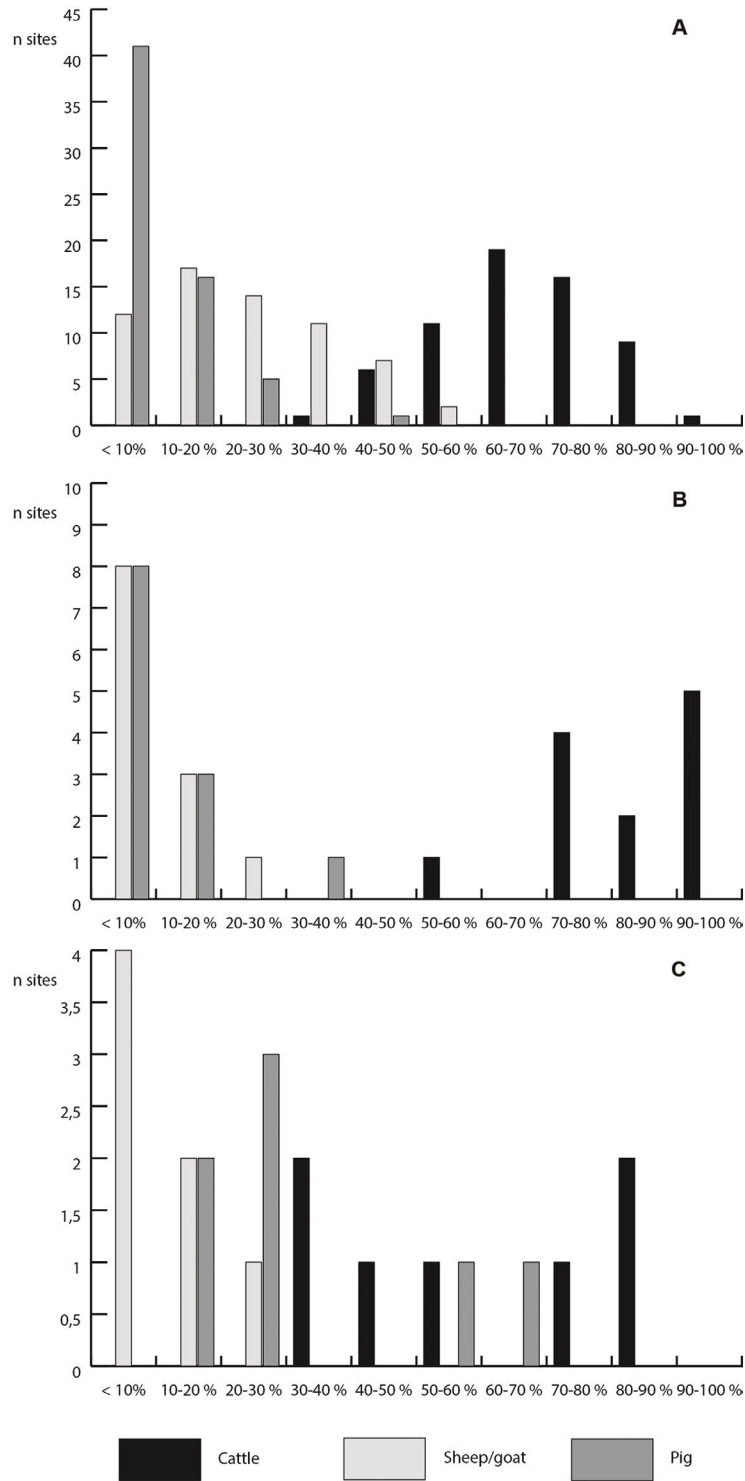


Fig. 3: Species proportions for the main meat-providing livestock species for the rural *civitas Batavorum*, military and civilian Nijmegen (all periods).

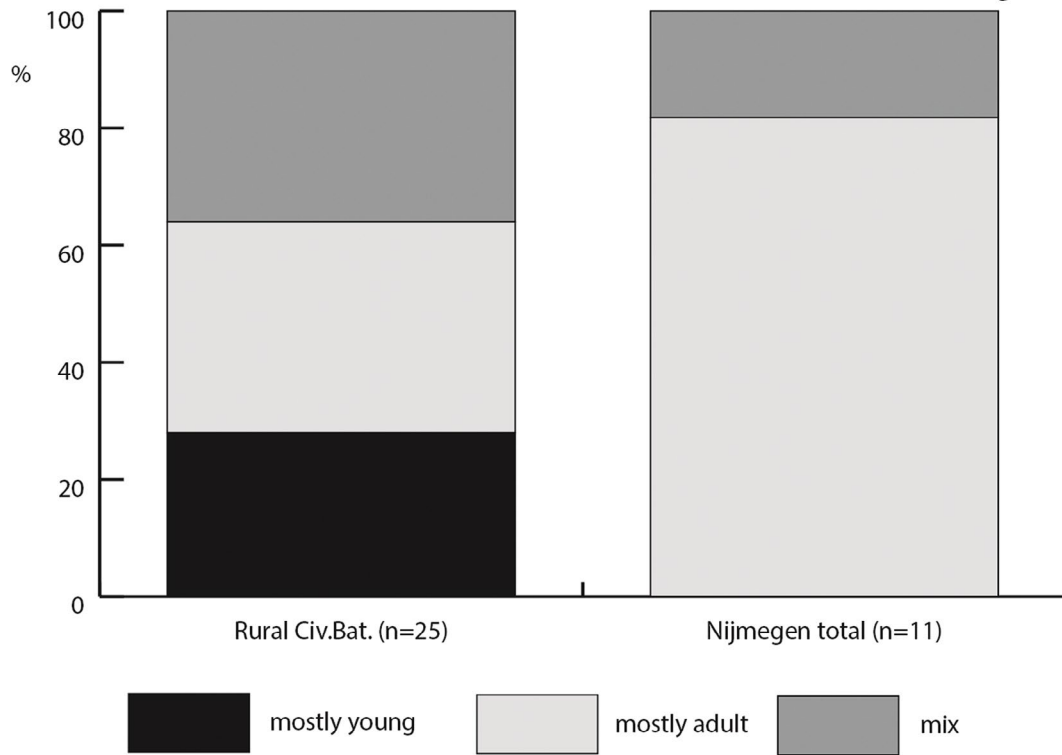


Fig. 4: Slaughter ages for cattle in the rural *civitas Batavorum* and in Nijmegen (military and civilian). For methodology, see Groot – Deschler-Erb 2015.

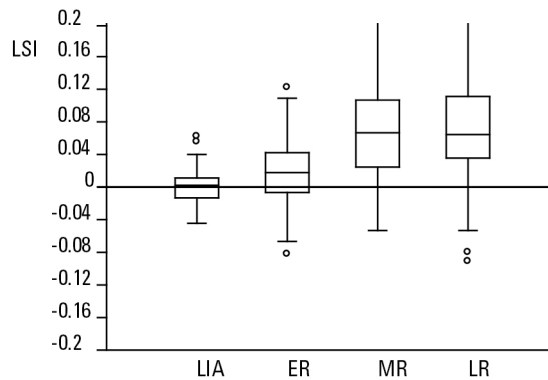


Fig. 5: Logarithmic Scale Index for width measurements for cattle for rural sites from the *civitas Batavorum*, per period. LIA: Late Iron Age, n=63; ER: Early Roman period, n=98; MR: Middle Roman period, n=215; LR: Late Roman period, n=152.

the kind of interaction between the producers and consumers. We find similar species proportions (although with small differences) in producer and consumer sites. In the consumer sites, both young and older animals are represented, and all body parts are present. These are all indicators for direct distribution.⁶ Typical for direct distribution is that the farmer is in control of supply, and herd security will always be the farmer's main priority. The distance between farmer and consumer is small, and it is unlikely that there were middlemen operating. Small-scale transactions directly between farmer and consumer are to be expected.

Using the estimated population of Nijmegen around 100 AD, we can reconstruct the amount of meat needed to feed the town. This will help us understand the magnitude of meat production that was required to feed the town and army and conclude whether this was feasible for the rural *civitas Batavorum*. Two different ways of estimating the number of cattle required are used. First, the assumption that people on average consumed about 10% meat in their diet. Second, the assumption that people consumed about 200 grams of meat per day. In the first approach, using the figures from Groot et al. 2009, and assuming that all meat came from cattle to simplify matters, 2735 animals would have been needed per year to feed a military and urban population of Nijmegen consisting of 10,000 people. In the second approach, assuming a meat yield of 200 kg per cattle, and again assuming all meat came from cattle, 3650 cattle were needed per year.⁷ The two methods give different results but are of the same order of magnitude. Earlier research suggested that the settlement of Tiel-Passewaaij was able to produce a surplus of 7–40 cattle per year (depending on the period).⁸ Although the lowest number does not sound like very much, if we take into account the large number of Roman settlements known for the *civitas Batavorum* (1000), together the settlements could easily have produced enough meat to feed Nijmegen without the need for imported animals or preserved meat. Each settlement would only have needed to supply 3 or 4 cattle per year, which means perhaps 1 animal per family. The animals were probably taken to the market in Nijmegen by their owners or a representative from the village; periodic livestock sales were held in the large structure adjacent to the *canabae legionis*.⁹

Although local supply of meat was possible, this does not mean that there would not have been any non-local supply of meat to Nijmegen. Considering the low proportions of pig in the rural sites, pigs were perhaps either raised in the town or supplied from further away, as live animals or as joints of meat. For the early Roman military occupation on the Kops Plateau, zooarchaeological data suggest that at least some of the cattle consumed there were not local. Measurements of cattle bones indicate that the cattle on the Kops Plateau were larger than those in contemporary rural sites and urban Nijmegen (fig. 6). There is no evidence suggesting different male to female ratios among the cattle in the different sites, so it seems the size difference represents two different populations, with cattle from outside the region represented in the Kops Plateau population.

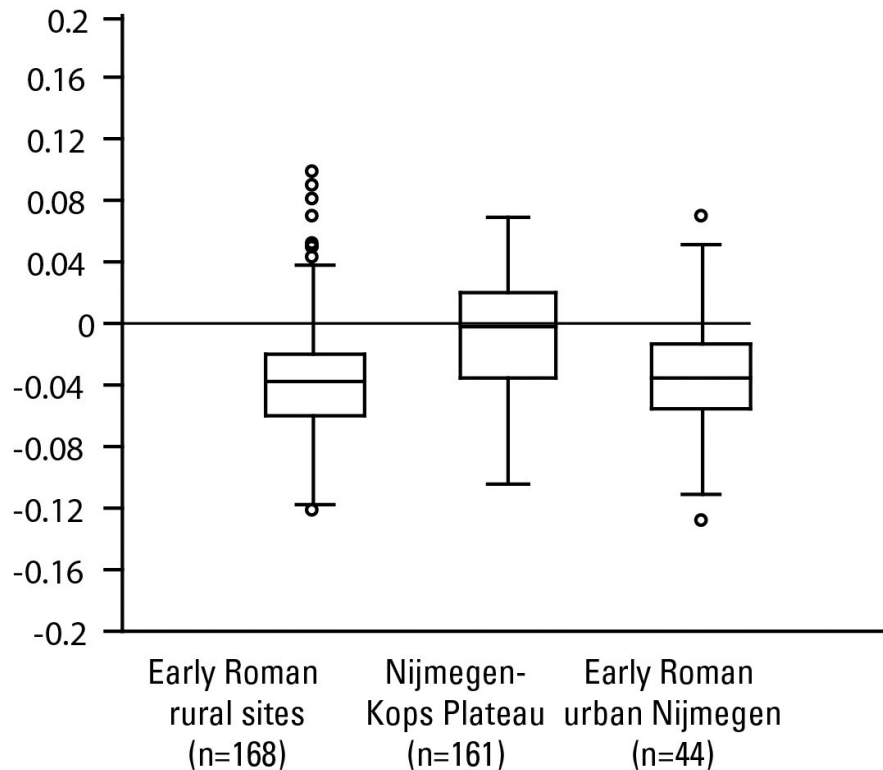


Fig. 6: Logarithmic Scale Index for cattle measurements from Early Roman rural sites in the Central Netherlands, Nijmegen-Kops Plateau and urban Nijmegen.

Supplying Plant Food to Nijmegen

The archaeobotanical data for Nijmegen are mainly derived from military sites (table 1).¹⁰ In addition, soil samples for archaeobotanical research have been taken during several excavations in the town *Ulpia Noviomagus*. These are accessed but not yet analysed.¹¹ The Romans liked to eat bread, and small pieces of bread were found at Nijmegen (fig. 7). The wheat species bread wheat, spelt wheat and emmer wheat are the species suitable for making bread. Besides these bread-making cereals 50% of the cereals found could be added to flour, but these species do not make bread on their own. These species are barley, millet, oat and rye. Cereal production must have taken place outside the capital and military sites of Nijmegen. Pulses like Celtic bean, lentil and pea, herbs like dill and collected fruit and nuts like bramble, elder, sloe and hazelnut, could have been cultivated in gardens or orchards inside *Ulpia Noviomagus*. There is evidence for orchards, because pruned wood from probably apple or pear, cherry or plum, hazel, peach and raspberry is found in a depression behind houses in *Ulpia Noviomagus* dated in the second century AD.¹² If there are orchards, why not also gardens for products like herbs, vegetables and pulses?

	Augustan base Hunerberg	Oppidum Batavorum	Castra & cannabae legionis	Ulpia Noviomagus houses	Ulpia Noviomagus temples	Civitas Batavorum rural settlements
	19–16/12 BC	before AD 69	end 1 st – early 2 nd	end 1 st – 2 nd	end 1 st – 2 nd	1 st – 2 nd
	6 samples	inventory (1 site)	37 samples	inventory (5 sites)	2 temples	22 settlements
Cereals						
Barley	4	.	15	2×	1×	21
(Cultivated) Oat	2	1×	10	.	1×	20
Millet	1	.	4	.	.	11
Rye	.	1×	1	.	.	2
Bread Wheat	.	.	7	2×	.	.
Emmer Wheat	1	.	7	.	.	21
Spelt Wheat	.	.	5	.	.	1(ER)
Wheat, not identified	1	1×	10	1×	1×	.
Bread fragments	.	.	3	.	.	.
Food fragments	.	.	2	.	.	.
Pulses						
Celtic Bean	.	.	2	1×	.	7
Lentil	1	1×	3	2×	.	1
Pea	.	.	5	1×	1×	1
Pea/Celtic Bean	1	.	.	.	.	.
Herbs and vegetables						
Aniseed	.	.	1	.	.	.
Beet	.	.	.	.	.	5
Coriander	.	.	1	.	.	5
Dill	.	.	2	.	.	4
cf. Summer Savory	.	.	1	.	.	.

Table 1: The presence of food plants in military and civil sites in Nijmegen and in rural settlements in the *civitas Batavorum*. ER = Early Roman period (1st century AD), cf. = identification not sure.

	Augustan base Hunerberg	Oppidum Batavorum	Castra & cannabae legionis	Ulpia Noviomagus houses	Ulpia Noviomagus temples		Civitas Batavorum rural settlements
Cultivated fruit and nuts							
Apple	.	.	2	.	.		.
Apple/Pear	.	.	1	2×	.		.
Cherry/Plum	.	.	.	1×	.		.
Date	.	.	.	.	1×		.
Fig	.	1×	2	2×	1×		.
Grape	.	.	3	2×	.		.
Hazelnut	1	.	1	.	1×		5
Olive	2	.	1	.	.		.
Peach	.	.	.	1×	.		.
Pear	.	.	2	.	.		.
Plum	.	.	2	1×	.		4
Raspberry	.	.	.	1×	.		2
Stone pine	.	.	.	.	1×		.
Walnut	.	.	1	.	.		2
Wild Cherry/ Sour Cherry	.	.	1	1×	.		.
Collected nuts and fruit							
Blackberry	.	.	.	2×	.		.
Bramble	.	.	1	.	.		3
Dewberry	.	.	1	.	.		2
Elder	.	.	1(cf.)	1×(cf.)	.		11
Sloe	.	.	3	.	.		2
Oil-rich seeds							
Cabbage/ Mustard	.	.	1	.	.		13
Cultivated Flax	1	.	1	.	.		12
Gold-of- pleasure	1	.	1	.	.		8

Table 1 (*continued*).

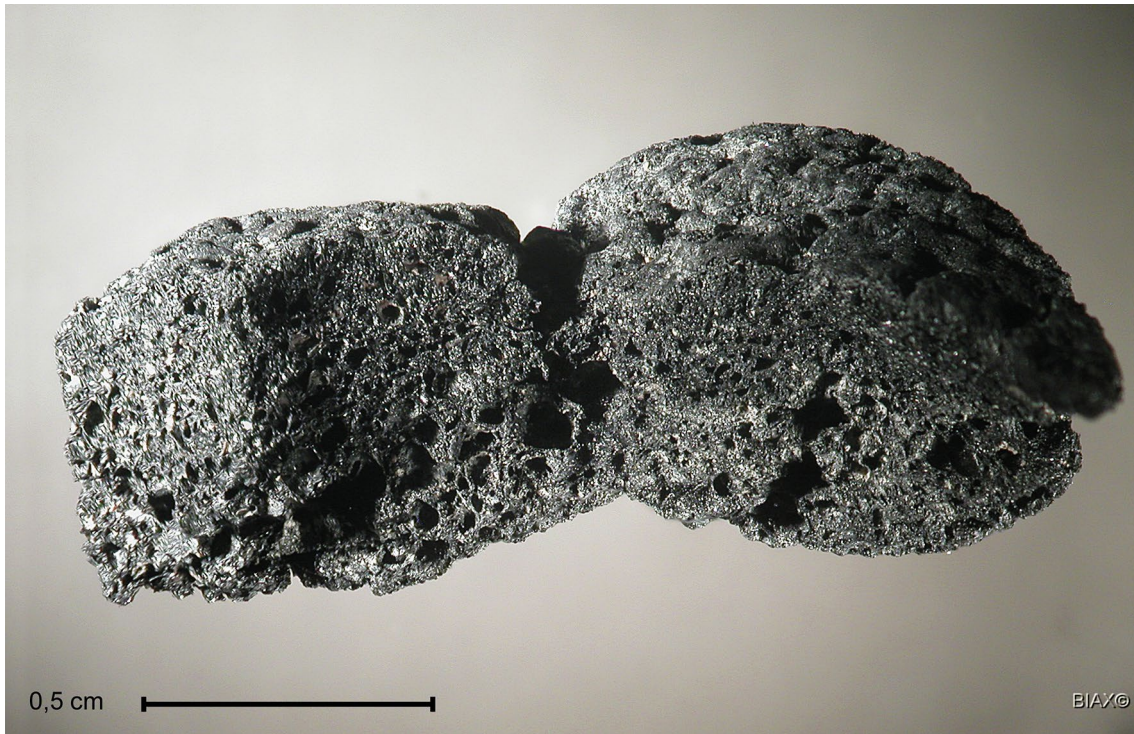


Fig. 7: Charred piece of bread found in a water well of a Flavian military site at Nijmegen.

When we compare the food products found at 22 agrarian sites situated in the *civitas Batavorum* with those in Nijmegen, the following remarks can be made. Of the bread-making cereals only emmer wheat could have been supplied by the farmers of *civitas Batavorum*, together with the non-bread cereals as barley, millet and oat. These species were found in the rural settlements and it is likely that these cereals were supplied by the local farmers. For the other plant products found in rural sites of the *civitas Batavorum*, such as pulses – mainly Celtic bean is found – herbs and vegetables, collected and cultivated fruit and nuts, it is not clear (yet) if these products were supplied by the Batavian farmers. There is no doubt that plant foods were delivered from other parts of the Roman Empire. The loess area in the south of *Germania inferior* produced tons of spelt wheat.¹³ It is possible that the lentil and pea found in Nijmegen were delivered by the farmers of the loess area, although these species were found just a couple of years ago in a rural settlement on the other side of the river Waal in features dated to the Iron Age (500 to 12 BC, pea) and the first century AD (lentil).¹⁴ There is one more agrarian settlement with pea, dated in the first and second century AD.¹⁵ Bread wheat did not occur in the area of the Batavians and hardly existed in the loess area. This cereal must have been imported from other provinces of the Roman Empire, most likely Gaul. These long-distance cereals were probably brought in by traders, as testified by an inscription found at Nijmegen referring to the Nervian grain trader M. Liberius Victor.¹⁶

The excavations at Nijmegen also revealed some interesting exotic products that must have been imported from the Mediterranean. The most exciting ones are the concentrations of dates, figs and stone pine nuts found in second-century offering pits adjacent to the temple dedicated to the goddess Fortuna.¹⁷

The provenance of plant food in military sites and *Ulpia Noviomagus* is rather complex and the connections between farmer and citizen/soldier are not clear yet. What we do know is that several of the plant food species found in rural sites and in Nijmegen are the same (see table 1). This suggests that these products were supplied to Nijmegen by the Batavians. The second strand of evidence, which points to local surplus production of cereals is the increase in storage capacity at some, but not at all, rural sites from the first century until the end of the second century. It is suggested that cereals were stored in central places before transport to Nijmegen or the Roman forts along the Rhine.¹⁸ The third type of evidence to prove surplus production of cereals are calculations based on the availability of arable fields per rural settlement in combination with the labour availability.

To get an idea about the theoretical production capacity of cereals of the Batavian farmers some rough calculations were done, starting from the consumers at Nijmegen. At the end of the first century AD the urban and military population is estimated at ca. 10,000 people, of which 5000 soldiers. Calculations are based on the assumptions that diet contained 70% cereals and that only 50% of the required cereals (only emmer wheat and the non-bread cereals) came from the *civitas Batavorum*.¹⁹ That means that over 1.2×10^6 kilo cereals per year were needed to feed the Nijmegen population.²⁰ Calculations based on available arable fields, the total of rural settlements and labour in harvest time suggest that theoretically, 7.5×10^6 kilo cereals per year could have been produced as a surplus by the farmers of the *civitas Batavorum*.²¹

All in all, it seems likely that the production capacity was dependent on the population density of the Batavian countryside. Many small-scale producers were theoretically very well able to deliver half of the cereal demand of the civilian and military population.

Conclusion

The conclusions of our study are that the Batavian farmers were able to produce a considerable surplus of cattle and cereals. The surplus production per rural settlement was small, but the amount of settlements was high, which could have ended in a considerable supply of food to the civilian and military population of Nijmegen. The animal food consisted of small-scale transactions between farmers and consumers rather than merchants and traders operating at a large scale. In case of food plants, there could have been a centralisation of cereal storage at the somewhat larger rural sites. It is still unknown if the farmers or the military were responsible for cereal transport to the city or that traders were active in the *civitas Batavorum* as was the case for the long-distance cereal transport.

Notes

¹ Tacitus *Germania* 29; *Historiae* IV.12, 17.

² Willems 1990, 71; Willems – Van Enckevort 2009, 74.

³ Vos 2009.

⁴ Vossen 2003.

⁵ Groot – Kooistra 2009.

⁶ Zeder 1991, 36–43.

⁷ Based on the highest figure Lepetz uses to calculate meat consumption in Arras (50–200 g per person per day) but adjusting the meat yield per animal, since cattle in the *civitas Batavorum* were considerably smaller than the cattle in Gaul. Lepetz 1996, 137–138. See also Groot 2016, 224–225.

⁸ Groot et al. 2009.

⁹ Driessen 2018.

¹⁰ Augustan camp Hunerberg (5 samples) De Hing – Kooistra 1995; Mid-first century camp Kops Plateau (1 sample) Buurman 1988; Flavian *castra* and *canabae legionaris* location Canisiuscollege (37 samples) Buurman 1984 (1 sample); De Hingh – Kooistra 1995 & unpublished data (35 samples); Kooistra 1989 (1 sample).

¹¹ Hänninen – Vermeeren 1995.

¹² Van Rijn 1998; context information and dating from Harry van Enckevort.

¹³ Kooistra 1996; Schamuhn – Zerl 2009.

¹⁴ Kooistra – Kubiak-Martens 2016.

¹⁵ Lange 1990.

¹⁶ Driessen 2007, 161. 177–178 fig. 85.

¹⁷ Hänninen – Vermeeren 1997.

¹⁸ Groot et al. 2009.

¹⁹ Groot et al. 2009; Kooistra 2012; Van Dinter et al. 2014. We calculated with 10% meat, 70% cereals and 20% other food products.

²⁰ Based on 5000 soldiers (3000 kcal/person), and a civil population of 833 men, 833 women (2200 kcal/person), 833 subadult men (10–14 years old, 2750 kcal), 833 subadult women (same age, 2420 kcal/person), 833 children (1–4 years old, 1360 kcal/person) and 833 small children (0–1 years old, 550 kcal/person). The energy needs mentioned after Gregg 1988, 143. It is assumed that 1 kg cereals provides 3100 kcal of energy (Bloemers 1978, 70; Bakels 1982, 10).

²¹ Based on 1000 rural settlements (Vossen – Groot 2008; Vos 2009, 209–216) with 2.5 families per settlement in average (Vos 2009, 215), 5–8 persons per family (Bloemers 1978, 55; Willems 1984, 236) and the same proportions of adults and children as the civil population. It is assumed that each settlement had 30–40 ha of arable fields (Groot et al. 2009). With the assumption of 70% cereal needs the rural population needed 3×10^6 kg cereals per year. Therefore almost 10,000 ha arable fields were in use (assumed yield 1000 kg cereals/ha, 200 kg of sowing-seed, and 200 kg in reserve, and a two-course rotation system). The calculation of surplus is based on labour capacity in harvest time (14 days a year and each man could harvest 0.25 ha/day). The calculated 4062.50 men are theoretically able to harvest cereals from more than 14,000 ha/year, from which ca. 5000 ha for own purpose and 9000 ha for surplus. With 800 kg cereals/ha (200 kept aside for sowing-seed) a theoretical surplus of 7.5×10^6 kg cereals/year is possible.

Image Credits

Fig. 1: after Polak and Kooistra 2015, fig. 1. – Fig. 2: Mikko Kriek. – Fig. 3–4: Maaïke Groot. – Fig. 5: Groot 2016, fig. 5.49. – Fig. 6: Groot 2018, fig. 6. – Fig. 7: BIAX *Consult*.

References

Bakels 1982

C.C. Bakels, Zum wirtschaftlichen Nutzungsraum einer bandkeramischen Siedlung, in: *Siedlungen der Kultur mit Linearkeramik in Europa* (Nitra 1982) 9–16.

Bloemers 1978

J.H.F. Bloemers, Rijswijk (Z.H.), ‘De Bult’: Eine Siedlung der Cananefaten, *Nederlandse Oudheden* 8 (Amersfoort 1978).

Buurman 1984

J. Buurman, Botanisch laboratorium, Jaarverslag Rijksdienst voor het Oudheidkundig Bodemonderzoek 1982, 1984, 91–94.

Buurman 1988

J. Buurman, Botanisch laboratorium, Jaarverslag Rijksdienst voor het Oudheidkundig Bodemonderzoek 1987, 1988, 86–89.

Van Dinter et al. 2014

M. van Dinter – L. I. Kooistra – M. K. Dütting – P. van Rijn – C. Cavallo, Could the Local Population of the Lower Rhine Delta Supply the Roman Army? Part 2: Modelling the Carrying Capacity of the Delta Using Archaeological, Palaeo-Ecological and Geomorphological Data, *Journal of Archaeology in the Low Countries* 5, 2014, 5–50.

Driessen 2007

M.J. Driessen, Bouwen om te blijven: De topografie, bewonings–continuïteit en monumentaliteit van Romeins Nijmegen, *Rapportage Archeologische Monumentenzorg* 151 (Amersfoort 2007).

Driessen 2018

M. Driessen, Nice Meating: The canabae legionis Livestock Market at Nijmegen Revisited, in: T. Ivleva – J. de Bruin – M. Driessen (eds), *Embracing the Provinces. Society and Material Culture of the Roman Frontier Regions. Essays in Honour of Dr Carol van Driel-Murray* (Oxford 2018) 121–132.

Gregg 1988

S.A. Gregg, *Foragers and Farmers: Population Interaction and Agricultural Expansion in Prehistoric Europe* (Chicago 1988).

Groot 2016

M. Groot, *Livestock for Sale. Animal Husbandry in a Roman Frontier Zone*, Amsterdam *Archaeological Studies* 24 (Amsterdam 2016).

Groot 2018

M. Groot, How to Feed a Roman Camp, in: S. Matesic – C.S. Sommer (eds), *Limes XXIII: Proceedings*

of the 23rd International Limes Congress Ingolstadt 2015, Beiträge zum Welterbe Limes Sonderband 4 (Mainz 2018) 971–977.

Groot – Deschler-Erb 2015

M. Groot – E. Deschler-Erb, Market Strategies in the Roman Provinces: Different Animal Husbandry Systems Explored by a Comparative Regional Approach, *JASc: Reports* 4, 2015, 447–460.

Groot et al. 2009

M. Groot – S. Heeren – L.I. Kooistra – W. Vos, Surplus Production for the Market? The Agrarian Economy in the non-villa landscapes of Germania Inferior, *Journal of Roman Archaeology* 22, 2009, 231–252.

Groot – Kooistra 2009

M. Groot – L.I. Kooistra, Land Use and the Agrarian Economy in the Roman Dutch River Area, *Internet Archaeology* 27, 2009, 1–53.

Hänninen – Vermeeren 1995

K. Hänninen – C. Vermeeren, Het karakter van Nijmegen. Een overzicht van de karakterisering van zadenmonsters van de Biezenstraat, Gerard Noodtstraat, Hessenberg, Kruisweg, Maasplein, Piersonstraat en Rivierstraat en het onderzoek aan hout van de opgravingen Hessenberg, Gerard Noodtstraat, Maasplein, Rivierstraat en Weurtse weg, *BLAXrapport* 10 (Amsterdam 1995).

Hänninen – Vermeeren 1997

K. Hänninen – C. Vermeeren, Exotische offers. Botanisch onderzoek aan kuilen uit de Romeinse Fortuna-tempel op het Maasplein in Nijmegen, *BLAXiaal* 51 (Amsterdam 1997).

De Hingh – Kooistra 1995

A.E. de Hingh – L.I. Kooistra, Reste von Getreide und anderen Pflanzen, in: J. K. Haalebos (Hrsg.): *Castra und Canabae; Ausgrabungen auf dem Hunerberg in Nijmegen 1987–1994*, *Libelli Noviomagenses* 3 (Nijmegen 1995) 103–109.

Kooistra 1989

L.I. Kooistra, Botanische resten uit een kuil, bijlage bij, in: J.E. Bogaers – J.K. Haalebos (eds.), *Opgravingen op het terrein van het voormalige Canisiuscollege, 1988*, *Numaga* 36 (Nijmegen 1989) 58–60.

Kooistra 1996

L.I. Kooistra, Borderland Farming. Possibilities and Limitations of Farming in the Roman Period and the Early Middle Ages between the Rhine and Meuse (Assen 1996).

Kooistra 2012

L.I. Kooistra, Die pflanzlichen Grundnahrungsmittel der Rheinarmee vor und nach der Gründung der Germania inferior, in: A. Stobbe – U. Tegtmeier (Hrsg.), *Verzweigungen. Eine Würdigung* (Bonn 2012) 171–187.

Kooistra – Kubiak-Martens 2016

L.I. Kooistra – L. Kubiak-Martens, Botanisch onderzoek, in: E.N.A. Heirbaut – C.W. Koot (red.), *Archeologische monumentenzorg in het plangebied van de dijkteruglegging bij Lent 4. Archeologisch onderzoek naar vindplaats 9/57 en de bewoningsgeschiedenis van de ijzertijd en de Romeinse tijd deel II*, *Archeologische Berichten Nijmegen – Rapport* 61 (Nijmegen 2016) 841–856.

Lange 1990

A.G. Lange, De Horden near Wijk bij Duurstede. Plant Remains from a Native Settlement at the Roman Frontier: a Numerical Approach, *Nederlandse Oudheden* 13 (Amersfoort 1990).

Lepetz 1996

S. Lepetz, L`animal dans la société Gallo-romaine de la France du Nord (Amiens 1996).

Polak – Kooistra 2015

M. Polak – L.I. Kooistra, A Sustainable Frontier? The Establishment of the Roman Frontier in the Rhine Delta. Part 1: From the End of the Iron Age to the Death of Tiberius (c. 50 BC–AD 37), *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 60. Jahrgang 2013, 2015, 355–458.

Van Rijn et al. 1998.

P. van Rijn – K. Hänninen – C. Vermeeren, Hout van Nijmegen gebundeld. Houtonderzoek van Nijmegen van de Romeinse vindplaats Weurtse Weg en de post-middeleeuwse opgravingen van Hessenberg, Hezelstraat en Waalkade, *Blaxiaal* 70 (Amsterdam 1998).

Schamuhn – Zerl 2009

S. Schamuhn – T. Zerl, Zur Landwirtschaft der Kelten, Römer und Germanen im Gebiet von Nordrhein-Westfalen. Kontinuität oder Wandel?, in: S. Zimmer (ed.), *Kelten am Rhein. Akten des Dreizehnten Internationalen Keltologiekongresses / Proceedings of the Thirteenth International Congress of Celtic Studies*, 23. bis 27. Juli 2007 in Bonn. 1. Archäologie – Ethnizität und Romanisierung, *BjB Beih.* 58,1 (Mainz 2009) 239–250.

Vos 2009

W.K. Vos, Bataafs platteland: Het Romeinse nederzettingslandschap in het Nederlandse Kromme-Rijng gebied, *Nederlandse Archeologische Rapporten* 35 (Amersfoort 2009).

Vossen 2003

I.M.J. Vossen, The Possibilities and Limitations of Demographic Calculations in the Batavian Area, in: Th. Grünewald – S. Seibel (Hrsg.), *Kontinuität und Diskontinuität. Germania inferior am Beginn und am Ende der römischen Herrschaft*, *Reallexikon der Germanischen Altertumskunde Ergänzungsband* 35 (Berlin 2003) 414–435.

Willems 1984

W.J.H. Willems, Romans and Batavians: A Regional Study in the Dutch Eastern River Area, II, *Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek* 34, 1984, 39–331.

Willems 1990

W.J.H. Willems, Romeins Nijmegen. Vier eeuwen stad en centrum aan de Waal (Utrecht 1990).

Willems – Van Enckevort 2009

W.J.H. Willems – H. van Enckevort (eds), *Ulpia Noviomagus, Roman Nijmegen: The Batavian capital at the imperial frontier*, *Portsmouth, JRA Suppl.* 73 (Rhode Island 2009).

Zeder 1991

M.A. Zeder, Feeding Cities: Specialized Animal Economy in the Ancient Near East, *Smithsonian Series in Archaeological Inquiry* (Washington 1991).