

The emergence of mixed farming in eastern Norway*

by Axel Mjærum

Abstract

Farming societies in large parts of northern Europe until the last century were founded on a close integration between livestock breeding and the cultivation of arable land. The emergence of this mixed farming economy represented a fundamental change in the history of the region. The main aim of this paper is to study this process of transformation in greater detail by using statistical modelling of radiocarbon dates and results from excavations in eastern Norway. The article discusses the details of a clear shift in farming traditions 1000–500 BC, including a large-scale expansion of farming land into areas of stone-rich moraine. It concludes that this represents the emergence of farming systems practised until recently in eastern Norway and that this change was an important part of the social and cultural developments that took place in the last part of the Bronze Age in Northern Europe.

Few issues are more important in farming societies than soil fertility. Historically farmers in large parts of northern Europe have ensured this by closely integrating livestock breeding and arable cultivation to prevent soil depletion.¹ In such a mixed farming system, the livestock is fed on crops grown on the farm, as well as grass and leaf fodder from pastures and forests. In return, the animals' manure helps to sustain agricultural plant growth. The balance between crops and livestock is critical and offers an opportunity to involve the whole family in the production and even out farm labour during the annual cycle.

It has long been argued that this form of mixed farming emerged in northern Europe in the first millennium BC.² In the last few decades the process of transformation to this economy has been discussed in further detail, and it has been held up as one of the most significant changes in agricultural history, especially on the basis of excavations and research projects in

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¹ R. Jones, 'Why manure matters: Historical, archaeological and ethnographical perspectives', in R. Jones (ed.), *Manure matters* (2012), pp. 1–11; R. Shiel, 'Science and practice: The ecology of manure in historical retrospect', in *Manure matters*, pp. 13–23. See also C. Dyer, 'The housing of peasant livestock in England, 1200–1520', *AgHR* 67 (2019), I, pp. 29–50 for a discussion

of these perspectives.

² D. B. Grigg, *The agricultural systems of the world: An evolutionary approach* (1974), pp. 152–86; on dating, see Myrdal, 'Elisenhof och järnålderns boskapskötsel i Nordvästeuropa [Elisenhof and Iron Age cattle farming in north-western Europe]', *Fornvännen* 79 (1984), pp. 73–92.

Sweden. Our knowledge of the emergence of mixed farming, however, has only partly been based on wider systematic analysis of larger datasets from multiple sites.³

Surveys and excavations in eastern Norway in the past three decades have, however, generated close to 600 radiocarbon dates, a record that provides new possibilities to study the emergence of mixed farming by quantitative approaches. Based on the new data, combined with contextual information and other parts of the archaeological record in the region, I will address three research questions related to the introduction of a new way of farming in the first millennium BC. First, when was the concept of mixed farming introduced in eastern Norway? Secondly, to what extent was the system transformed to a mixed farming economy, and, finally, how can such a transformation to a new way of farming be explained?

I

According to the agrarian historian Janken Myrdal the agricultural histories of pre-modern societies were characterized by a small number of large-scale transformations separated by periods of relative stability when only parts of the system were adjusted.⁴ He identified the last parts of the Bronze Age (c.1100–500 BC) and the transition between the Early and Late Iron Age (AD 500–600) as such moments of transformation in prehistory. Myrdal based his model on archaeological and historical records from Sweden, but his ideas are also applicable to other parts of northern Europe. The model is grounded on the fact that agricultural production was a pervasive part of most European societies until the nineteenth century, and that farming was also entangled with almost every other task and goal in these societies.⁵ It is clear, however, that there was room in these systems for the individual farmer's choices, adaptations and innovations, and that such innovative practices were most likely to be incorporated more generally when they fitted the existing technological system.⁶ In essence, widespread changes in the technology of livestock breeding and arable farming also required proportional transformations in farming societies as a whole. Agricultural history is consequently often intertwined with major societal changes, climatic events, and pandemics.⁷

³ 716 radiocarbon dates on charcoal found beneath clearance cairns are analysed in a study of demography in the Swedish region of Upland. See P. Lagerås, 'Agrara fluktuationer och befolkningsutveckling på sydsvenska höglandet tolkade utifrån röjningsrösen [Agricultural and population dynamics in the South-Swedish Upland interpreted from radiocarbon-dated clearance cairns]', *Fornvännen* 108 (2013), pp. 263–77, and Figure 2 in this article. Dates from arable land without such cairns have not been analysed in the same way. A broader discussion of the date of this development can however be found in E. A. Pedersen and M. Widgren, 'Agriculture in Sweden: 800 BC–AD 1000', in J. Myrdal and M. Morell (eds), *The agrarian history of Sweden, 4000 BC to AD 2000* [hereafter *AHS*] (2011), pp. 46–71 and L. Häggström, *Landskapsutnyttjande, bete och odling på sydsvenska höglandet under äldre järnålder*:

Exemplet Öggestorp [Land-use, grazing and cultivation in the south Swedish uplands: The Öggestorp case] (Gotarc, series B, 2005).

⁴ J. Myrdal, 'Swedish agrarian history – the wider view', in Myrdal and Morell (eds), *AHS*, pp. 257–70; and see Grigg, *Agricultural systems*.

⁵ I. Hodder, *Entangled: An archaeology of the relationships between humans and things* (2012).

⁶ See P. C. Anderson, A. L. van Gijn, J. C. Whittaker, and F. Sigaut, 'The dimension of tools, skills and processes: exploring diversity', in A. L. van Gijn, J. C. Whittaker, and P. C. Anderson (eds), *Explaining and exploring diversity in agricultural technology*, II (2014), pp. 3–11.

⁷ J. Myrdal, 'Swedish agrarian history', in Myrdal and Morell (eds), *AHS*, pp. 257–70.

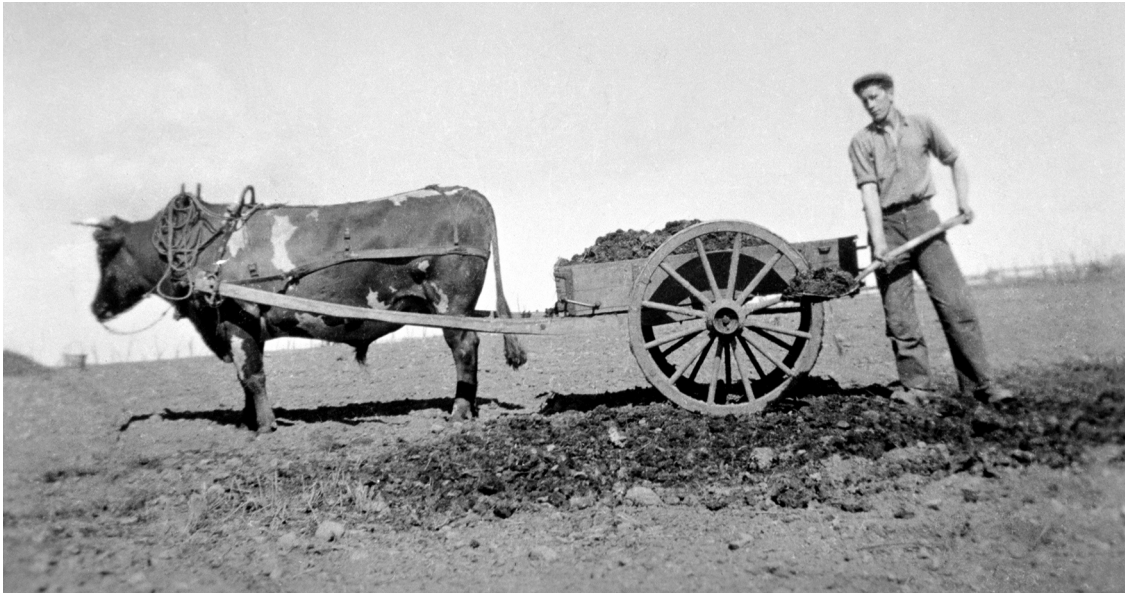


FIGURE 1. Manure is a key factor in the mixed farming system and, until the introduction of synthetic fertilizers and tractors, manual spread of waste from barns was a common sight across northern Europe.

Photo: manuring at Løten in inland Norway in 1937, taken by Even Narmo, CC PDM.

Myrdal argues that the introduction of mixed farming was also accompanied by significant technological changes, such as the introduction of iron implements. At this time byres and fences also became more common, making it possible to control the animals and their manure.⁸ The idea of the existence of uniform agricultural systems transformed by periods of upheaval can be criticized for oversimplifying a complex, diverse, and partially divergent source material, and at the same time inviting simplistic causal explanations.⁹ The transformation in agriculture can thus be seen as somewhat more nuanced, gradual and complex than the model of a limited number of major agricultural technology complexes suggests. Nevertheless, Myrdal's concept highlights crucial aspects of the major changes that appear as medium-term conjunctures in the history of agriculture. In this way, his perspectives form a framework that is well suited to a study of agriculture based on a large dataset of radiocarbon dates, where the aim is to capture the trends and breaks that led to the mixed farming economy.

⁸ Myrdal, 'Elisenhof'; see, e.g., Häggström, *Landskapsutnyttjande*, pp. 153–4, for a discussion of this argument.

⁹ For general arguments concerning simplistic causal explanations see, e.g., V. P. J. Arponen *et al.*, 'Environmental determinism and archaeology: Understanding and evaluating determinism in research design?', *Archaeological Dialogues* 26 (2019), pp. 1–9; for specific arguments concerning the introduction of mixed farming, see M. Widgren, *Fossila landskap: En forskningsöversikt över odlingslandskapets utveckling*

från yngre bronsålder till tidlig medeltid [Relic landscapes: A research history concerning agrarian landscape developments from Late Bronze Age to Middle Ages] (1997), p. 26; B. Myhre, 'Landbruk, landskap og samfunn 4000 f.kr.–800 e.Kr. [Agriculture, landscape and society 4000 BC–AD 800]', in B. Myhre and I. Øye (eds), *Norges landbrukshistorie* [The agrarian history of Norway, hereafter AHN], I (2002), pp. 99–101; Häggström, *Landskapsutnyttjande*, pp. 151–6.

II

The part of eastern Norway studied consists of 79,000 km² of land and encompasses a quarter of present-day Norway (Map 1). The topography is varied. The coastal strip has a temperate climate with deciduous forests. The lower part of the inland region is dominated by coniferous woodland (taiga), while there only birch and alpine vegetation is found at high altitudes. The mountainous landscape in the central part separates eastern Norway from the fjord landscape on the west coast, while there is no such clear landscape boundary to the neighbouring areas in Sweden.

Land upheaval combined with melting and moving glaciers has eroded the surface, rendering a varied landscape with till sediments, clay flats and river deposits.¹⁰ Most of the past and present cereal cultivation is located in the coastal zone, around the large lowland lakes, and in the low-altitude valleys, which are the areas with the best climatic and geological conditions for cultivation. Animal husbandry dominates agriculture in the higher and inner parts. At present 6.4 per cent of the area is used as farmland, while 55 per cent is forested.¹¹

The stone-rich areas with glacial till produced by the retreating ice sheet are only partly used as arable land today, whereas these areas played a key role during the Iron Age (see below). Parts of the former fields are therefore well preserved as areas with clearance cairns in the present forest landscape. The prehistoric farming land is more disturbed in areas that are used for cultivation today.

In the studied areas there are as many as 2,300 mapped sites with remains of farming from prehistory until the Middle Ages (before AD 1537), traces of former farming that represent multiple forms of agricultural practices since the Late Neolithic in the region. However, the presence of clearance cairns is an easily recognizable feature that appears at a significant number of the sites. This type of cairn is commonly linked to Iron Age farming in the region, while there have been multiple suggestions as to when this form of farming appeared in eastern Norway.

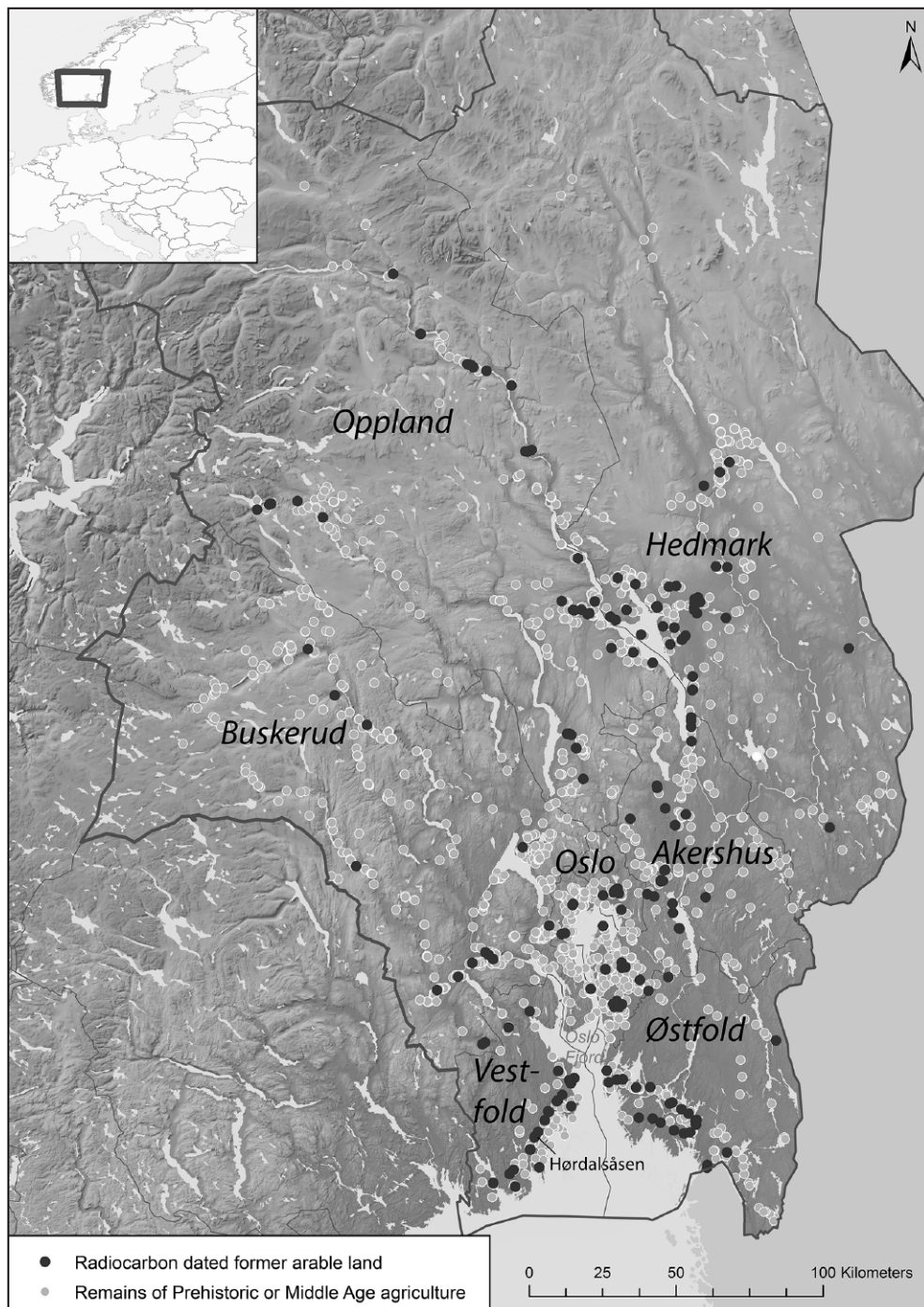
It has been argued that this practice of clearing stones to make arable land started in the Late Neolithic (c.2350 BC).¹² Other researchers have pinpointed 800 BC as the time of its introduction, based on radiocarbon ('C14') dates of single sites and references to more systematic Swedish research.¹³ By analysing a large number of radiocarbon-dated fields *with* and *without* clearance cairns it is possible to study the regions farming traditions through time. The comprehensive data can further be used as a basis for a discussion of the character of the Bronze Age and Iron Age farming and the transformation to a mixed farming economy in the region.

¹⁰ O. Fredin *et al.*, 'Glacial landforms and Quaternary landscape development in Norway', in L. Olsen, O. Fredin, and O. Olesen (eds), *Quaternary geology of Norway* (2013), p. 6.

¹¹ Statistics Norway, 'Area of agricultural properties, by area classification', (www.ssb.no/en/statbank/table/10206, 2019).

¹² O. Rønne, 'Hus og gård i senneolitikum på Svinesund', *Primitive Tider* 7 (2004), pp. 61–9.

¹³ E.g. Myhre, 'Landbruk, landskap og samfunn', pp. 83–4; I. Holm, *Forvaltning av agrare kulturminner i utmark* [*Management of agrarian sites in forests*] (University of Bergen Archaeological Ser. 4, 2007), pp. 35–6.



MAP 1. In total, there are 2310 mapped sites with remains of former agriculture in the part of eastern Norway studied (Østfold, Akershus, Oslo, Vestfold, Buskerud, Oppland and Hedmark). In this article, 594 C14 dates from 203 of these sites are analysed (see supplemental material for details).

Map: Ingvild Tinglum Bøckman and Axel Mjærum, Museum of Cultural History.

III

In the last 30 years at least 203 sites have been C14-dated in the parts of eastern Norway that are included in this study. A total of 594 radiocarbon analyses are presently available from these sites. I will use the C14 data and the site contexts for a discussion of the transition in farming in the first millennium BC. Of the 594 radiocarbon dates, 577 are derived from wood charcoal.¹⁴ The rest of the analyses were of cereals (9), nutshells (4), cones (2), bones (1), and berries (1). Archaeologists have sampled the material from agricultural soils and in relation to clearance cairns during archaeological excavations and surveys over the last 40 years. Tests have been conducted to validate the results, a strategy that has been recommended by recent researchers to identify various sources of error.¹⁵

Connected to the material in question there are at least three source-critical aspects that affect the analyses and the outcome: the quality of the dated material, different standard deviations of the radiocarbon dates and the effects of sampling bias.

Remains of former arable land are often a result of long-term farming and multiple geological and biological processes. The dating of such prehistoric sites has largely relied on radiological analysis in Scandinavia, and in the literature, the relationship between the dated material and former farming has therefore been much discussed. Several researchers have stressed that it is often difficult to establish the beginning of farming in an area unless a charcoal horizon related to the first clearance by fire is identified.¹⁶ This conclusion has led to a practice of dating charcoal material found beneath clearance cairns, charred material which commonly originates from agricultural land clearance by fire (Figure 2).¹⁷ This dating strategy gives the earliest possible date (a *terminus post quem* date) of the farming, and thereby a focus on the clearance of new farmland. There is however a risk of dating fires or settlement activity that are in fact earlier than the first farmland clearance in the area by applying this approach.

In eastern Norway, the strategy of sampling charcoal underneath the cairns has been combined with more detailed studies of tilled layers in the last 15 years. The aim has been to establish a better understanding of the complex formation processes of the tillage and the dated material. By combining comprehensive excavations with multiple forms of archaeometrical data (e.g. micromorphological studies, pollen analysis, macrofossil sampling, and analyses of soil physics and chemistry) it has been possible to obtain more detailed information of the farming practices, including clearance, manuring and periods of leaving the land fallow (see Figure 3).¹⁸

¹⁴ See supplemental material: <https://perma.cc/X5P9-JKJZ>.

¹⁵ A. Bayliss, 'Quality in Bayesian chronological models in archaeology', *World Arch.* 47 (2015), pp. 677–700. B. Weninger *et al.*, 'Quantum theory of radiocarbon calibration', *World Arch.* 47 (2015), pp. 543–66.

¹⁶ E.g. L. Häggström, J. Baran, A. Ericsson, and A. Murray, 'The dating and interpretation of a field wall in Öggestorp', *Current Swedish Arch.* 22 (2004),

pp. 43–60; Holm, 'Management of agrarian sites'.

¹⁷ Lagerås, 'Agrara fluktuationer och befolkningsutveckling'.

¹⁸ E.g. K. Viklund, J. Linderholm, and R. I. Macphail, 'Integrated palaeoenvironmental study: Micro- and macrofossil analysis and geoarchaeology (soil chemistry, magnetic susceptibility and micromorphology)', in L. E. Gjerpe (ed.), *Oppsummering og arkeometriske analyser: E18-prosjektet Gulli-Langåker* [Results and

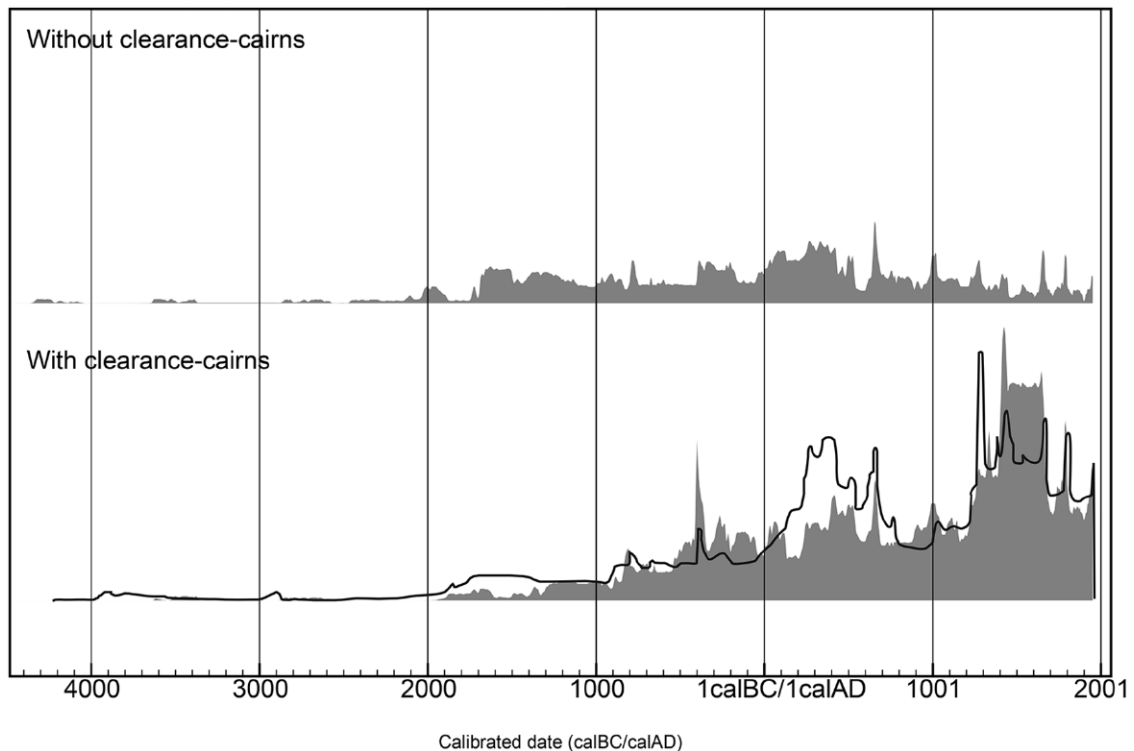


FIGURE 2. The plot at the top shows a significant increase in the number of sites without clearance-cairns (mainly agricultural layers, $n=171$) around 2000 BC and a further increase in the number of dates in the Roman Iron Age in eastern Norway. The second plot compares radiocarbon dates of clearance-cairn fields in central Sweden ($n=716$, black line) and eastern Norway ($n=407$, grey). The graphs prove that the stone clearance in the two areas must be regarded as one phenomenon during the Prehistory and the Middle Ages.

Illustration: author.

A focus on the tillage itself makes it possible to gain more reliable dates for the period the sites were used, and also in cases where clearance of stones was not practised as a part of farming. This strategy reduces the problems of getting *terminus post quem* dates from sites and makes the data from sites *with* and *without* clearance cairns comparable. This is of key importance when different farming systems in the region are discussed. Through such an approach, however, the focus is partly moved from the initial phase of farming to the time when the fields were in use, which can be a disadvantage when studying the timing of clearance of new farming land.

The effect of different sampling strategies can be studied on a small scale in Figure 4, and on a larger scale when the data sets from Sweden and Norway are compared (Figure 2). The general trend is that the periods of increase started a little bit earlier in Sweden than in eastern Norway, as is expected since the data collection in the Swedish study has been focused on the

Note 18 continued

archaeometric analysis from the E18 road project Gulli–Langåker] (2013), pp. 25–83; I. Holm and B. M. Sageidet, 'Origin of the sandy terraces at Grundset, Elverum, South-Eastern Norway: Evidence from archaeological soil micromorphology', *J. Nordic Archaeological Science* 18 (2013), pp. 67–83.

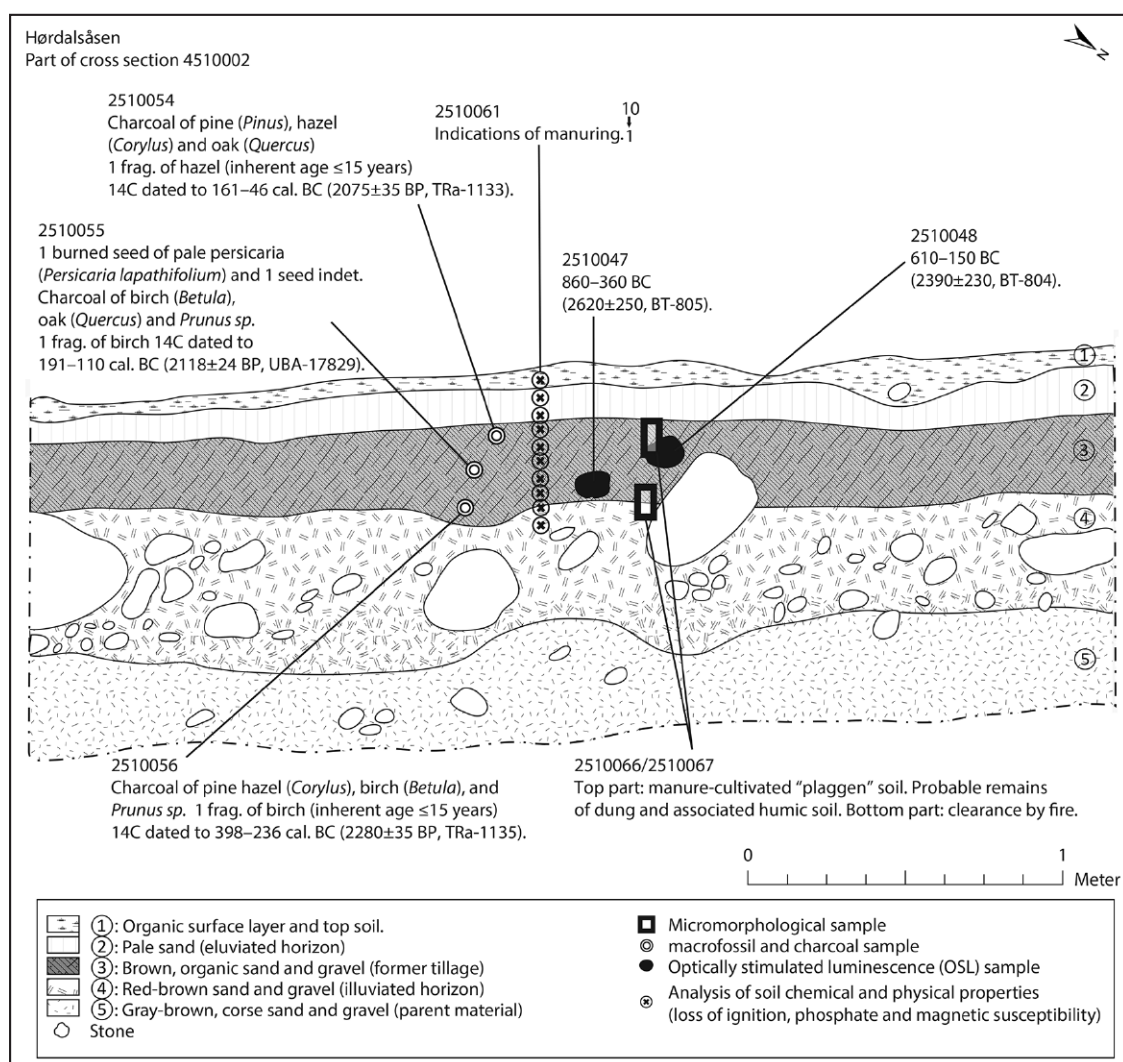


FIGURE 3. The tillage at Hørdalsåsen has been comprehensively analysed. Analyses from multiple cross-sections prove that farmers cleared the area c.400 BC and that the western part especially was intensively manured during the centuries that followed.

Illustration: Tone Wikstrøm and Axel Mjærø, Museum of Cultural History.

time of clearance, while parts of the Norwegian data represent the time when the fields were in use. The discrepancies between the graphs can thereby, at least partly, be a result of different sampling strategies, but cultural-historical differences are probably also of relevance. The graphs prove, however, that the clearance fields in the two regions must be treated as *one* phenomenon across the regions.

With few exceptions, botanists have studied the anatomy of the charred material used for the radiocarbon analyses in this study. Since oak and pine can potentially also reach a greater age than other common trees in the region, birch, spruce, hazel and other tree species are as

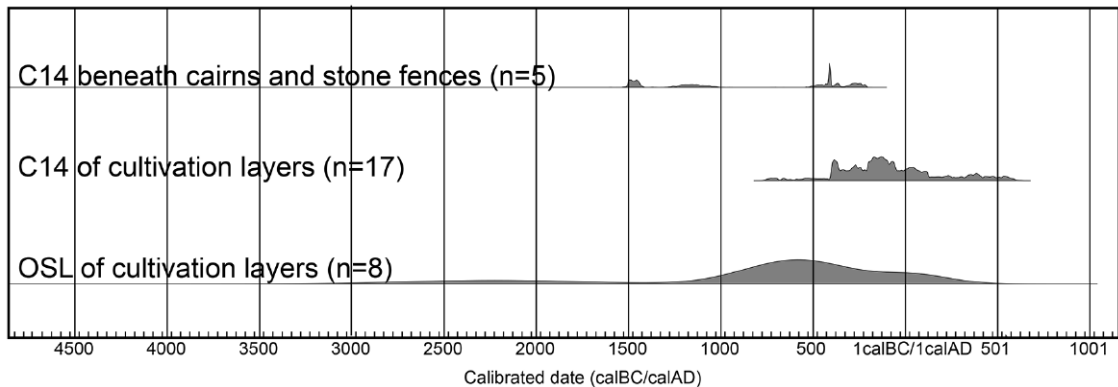


FIGURE 4. Charcoal found beneath clearance cairns gives an indication of when an area was cleared by fire, while dating of charcoal from the tillage itself represent the usage time of the fields. The differences can be seen clearly at Hørdalsåsen in eastern Norway.

Illustration: author.

a result preferred for datings. During the last decade, scientists have mainly selected younger branches and young trunks for C14 analysis in order to avoid using old wood.¹⁹ The effect of dating samples of old wood can be studied further by preparing sum diagrams in OxCal, where analyses conducted on wood that potentially attains a very high age (oak and pine) is compared to kinds of wood that rarely becomes grows to a great age.²⁰ The summaries show no clear differences between the two data sets before AD 1, the main period of concern in this article.

The large dataset also gives an independent opportunity to evaluate the effect that old wood has on the datings of former arable land. Only nine (1.5 per cent) of the 594 samples are dated to the Mesolithic (before 4000 BC/5200 uncal BP²¹), and six samples are dated to the Early and Middle Neolithic (c.4000 BC/5200 uncal BP–2350 BC/3850 uncal BP), periods when arable farming did not exist or was very limited (see section IV).²² This leads to the conclusion that the radiocarbon analysis dates farming at the site relatively accurately. Nevertheless, the results with a few outliers highlight that old wood can have implications for the dating and interpretation of single excavations.

Another possible source of error is the different standard deviations of the radiocarbon samples. Thirteen of them have a deviation of more than 100 years and 86 have a deviation of 50–99 years. For the rest the variance is stated to be 18–49 years. However, sum plots for

¹⁹ S. Bowman, *Radiocarbon dating: Interpreting the past* (1990).

²⁰ See supplemental material: <https://perma.cc/GTW9-WPKK>.

²¹ Radiocarbon measurements are commonly reported in terms of uncalibrated (uncal) years before present (BP). To be able to give the age in calendar years (BC/AD) the measured C14 years must be converted. This calibration process is needed because the proportion of atmospheric radiocarbon has varied over time and therefore dates must be adjusted according to

the present knowledge of the half-life of the radioactive C14 isotope. The calibration processes can be done in calibration programs such as OxCal (Bronk Ramsey, 'Bayesian analysis of radiocarbon dates'). Because of the calibration process, there is normally a discrepancy between the measured C14 years (uncal BP) and calendar years (BC/AD). For more information about radiocarbon calibration, see <https://c14.arch.ox.ac.uk/calibration.html>.

²² See supplemental material: <https://perma.cc/X5P9-JKJZ>.

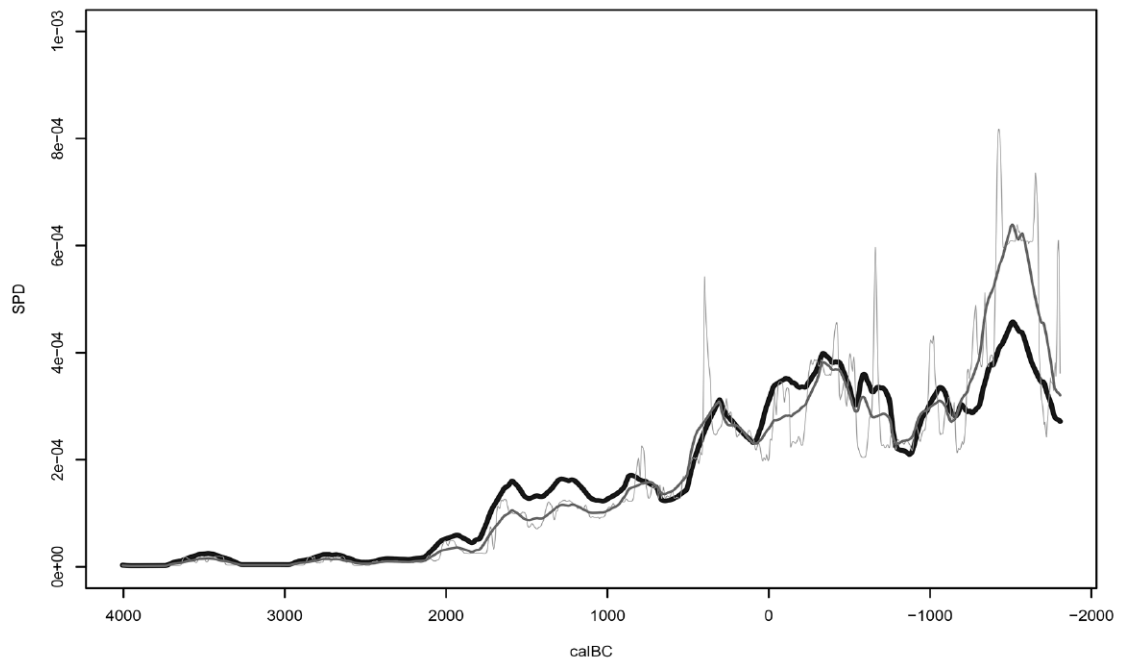


FIGURE 5. Radiocarbon dates of former cultivations in eastern Norway (n=594) displayed as an ordinary sum diagram (thin, grey line), as a moving average (thick, dark grey line) and with 200-year bindings (thick black line, n=358)

Illustration: Per Persson, edited by Axel Mjærum.

groups with a standard deviation above and below 50 years show no significant differences in the dating results.²³

The analyses are partly presented in ordinary sum plots created in OxCal (see Figures 2 and 4).²⁴ However, there are between 1 and 63 radiocarbon dates from each site included in the study, which potentially can cause sampling bias. In order to correct for this effect, I have grouped the data in 200-year long site phases in the simulations (Figure 5). Several overlapping dates from one site were then counted as one, if they represent a site phase of less than 200 years. This binding process was done automatically in the software R using the Bchron package.²⁵

In order to produce models of summed dates which could be compared with a simulated model (number of simulations=1000), the Monte Carlo test was used. This enables the production of datasets, which are statistically comparable (see Figure 7).²⁶

²³ See supplemental material: <https://perma.cc/GTW9-WPKK>.

²⁴ OxCal. v4.3.2 and IntCal13 atmospheric curve. C. Bronk Ramsey, 'Bayesian analysis of radiocarbon dates', *Radiocarbon* 51 (2009), pp. 337–60. C. Bronk Ramsey, 'Methods for Summarizing Radiocarbon Datasets', *Radiocarbon* 59 (2017), pp. 1809–33; P. J. Reimer *et al.*, 'IntCal13 and Marine13 Radiocarbon Age Calibration

Curves 0–50,000 Years cal BP', *Radiocarbon* 55 (2013), pp. 1869–87..

²⁵ A. Parnell, 'Bchron: Radiocarbon dating, age-depth modelling, relative sea level rate estimation, and non-parametric phase modelling' (<https://CRAN.R-project.org/package=Bchron>, 2016).

²⁶ Simulations of this type can be found in S. Shennan, 'Demographic continuities and discontinuities in

IV

The oldest dates from agricultural horizons are spread relatively evenly (before 2350 BC/7600–3850 uncal BP, $n=15$, see Figures 2 and 5). There are thus no significant differences between the Mesolithic and Neolithic before c.2350 BC and only a slight increase in dates between 2350 and 2000 BC. I therefore argue that most of the dates from fields before approximately 2000 BC are outliers not related to early farming in eastern Norway. The lack of identified cultivated soils and clearance cairn fields dated before c.2000 BC may at first sight look like a paradox, since changes in settlement patterns, material culture, finds of cereals, and pollen analyses point towards animal husbandry and also farming in many parts of eastern Norway since c.2350 BC, and even smaller-scale cultivation from the Early Neolithic.²⁷ This lack of identified cultivated soils in the main part of the Neolithic, however, makes a clear and interesting contrast to the results of studies from the Bronze Age and the Iron Age. This supports the widespread idea that the earliest farming in Scandinavia in general was based on a slash-and-burn process and had an extensive, peripatetic character.²⁸ By moving the fields after a few years, it was possible to overcome the problem of soil exhaustion without systematically manuring the fields, which generally is needed in the acidic Scandinavian soil.²⁹ It can be concluded that fully integrated mixed farming was not practised in this initial stage, even though both livestock and arable farming were parts of the economy.

V

A relatively large number of dates fall into the period c.2000–1000 BC (3500–2850 uncal BP, $n=43$) in eastern Norway (Figures 2 and 5). In this period, the sites *without* clearance cairns are significantly overrepresented (Figure 7), which shows much more clearly than in earlier studies that stone-free, sandy ground was preferred as cultivated cropland. Out of the 25 sites *without* clearance cairns dated before 1000 BC, 19 are in the counties around the Oslo Fjord (Østfold,

Note 26 *continued*

Neolithic Europe: Evidence, methods and implications', *J. Archaeological Method and Theory* 20 (2013), pp. 300–11; A. Timpson *et al.*, 'Reconstructing regional population fluctuations in the European Neolithic using radiocarbon dates: A new case-study using an improved method', *J. Archaeological Science* 52 (2014), pp. 549–57.

²⁷ C. Prescott, 'Third millennium transformation in Norway. Modeling an interpredictive platform', in C. Prescott and H. Glørstad (eds), *Becoming European: the transformation of third millennium Northern and Western Europe* (2018), pp. 115–27; L. Sørensen, L. and S. Karg, 'The expansion of agrarian societies towards the north – new evidence for agriculture during the Mesolithic/Neolithic transition in Southern Scandinavia', *J. Archaeological Science* 51 (2013) pp. 98–114; G. Reitan, L. Sundström, and J.-S. F. Stokke, 'Grains of truth: Traces of early farming in Neolithic southeast

Norway', in G. Reitan and L. Sundström (eds), *The Stone Age coastal settlement in Aust-Agder, southeast Norway* (2018), pp. 547–65.

²⁸ E.g. L. Sørensen, *From hunter to farmer in Northern Europe: Migration and adaptation during the Neolithic and Bronze Age* (Acta archaeologica, 85:1, 2014). J. Simonsen, *Daily life at the turn of the Neolithic: A comparative study of longhouses with sunken floors at Resengaard and nine other settlements in the Limfjord region, South Scandinavia* (2017), pp. 379–85; L. S. Halvorsen and K. L. Hjelle, 'Prehistoric agriculture in western Norway – Evidence for shifting and permanent cultivation based on botanical investigations from archaeological sites', *J. Archaeological Science: Reports* 13 (2017), pp. 682–96.

²⁹ See R. Jones, 'Science and practice: The ecology of manure in historical retrospect', in Jones (ed.), *Manure matters*, p. 14.



FIGURE 6.

Left: Ard marks are well known in eastern Norway, both from the Early Bronze Age and from later periods. They are most commonly found under later burial mounds, as here from Østfold, Norway, or preserved underneath present-day ploughzone layers.

Photo: Kristin Orvik, Museum of Cultural History.

Right: Clearance cairns are one of the most common types of cultural heritage in eastern Norway. The cairns are often 3 to 9 m in diameter and consist of stones that measure 0.1 to 0.5 m.

Photo: author.

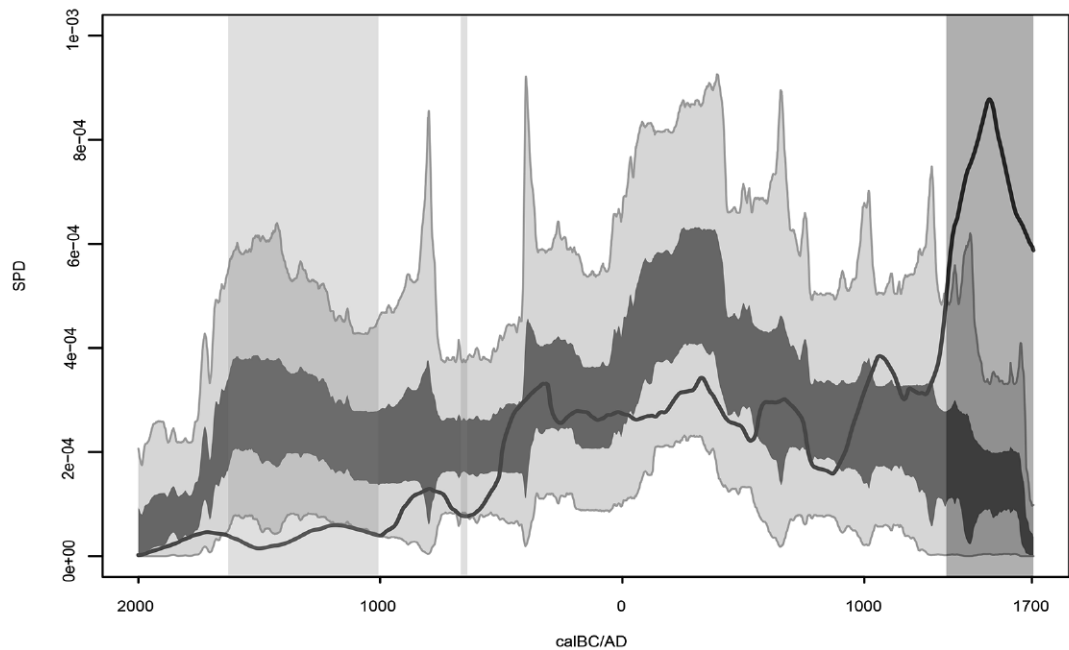


FIGURE 7. Results from 407 summed radiocarbon dates (SPD) from 109 sites with clearance cairns (marked with a black line) fitted with a model of expected distribution based on 167 C14 dates from 89 sites without clearance cairns. The dark grey area marks the expected distribution of dates from clearance cairn fields with 68.3 per cent probability, while the light grey area marks the same distribution with a 95.5 per cent probability. The model is based on 1000 simulations. The significant positive deviation is marked with a dark grey vertical column and negative deviations with light grey, vertical columns.

Illustration: Per Persson, edited by Axel Mjærum.

Vestfold and Akershus), but there are also such sites in the valleys inland.³⁰ The excavations provide little information about the size of the fields. However, at five sites from the period, marks of cross-arding have been identified, all of them along the Skagerak coast.³¹

By applying different archaeo-metrical methods the question of manuring has been addressed. There are indications of clearance by fire and trampling by cattle. In clear contrast to later periods, however, conclusive evidence for deliberate addition of organic matter to improve the soil in the early Bronze Age is so far lacking. Archaeologists have commonly found fragments of cereals and flint sickles at these sites. Spelt wheat (*Triticum spelta*), emmer wheat (*Triticum dicoccum*) and naked barley (*Hordeum vulgare* var. *nudum*) are among the most common grains from Late Neolithic and Early Bronze Age contexts in Norway, as in other parts of Scandinavia.³²

It has recently been argued that there was large-scale congruent land use management in the coastal areas in north-western Atlantic Europe in the Bronze Age, from southern England to Belgium, the Netherlands and western part of Denmark.³³ The low-lying sandy and silty, stone-free areas which appear in this region were preferred as farmland. Here extensive clearance of stones was not needed and ards could easily be used.³⁴ At Bjerre in Jutland, Denmark, remains of such farming have been studied in detail. Semi-oval fields have been identified, as well as traces of extensive livestock farming. The evidence for manuring is not conclusive, however, but there is a trend towards a more permanent cultivation system during the course of the Bronze Age.

The Bronze Age crop cultivation in Scandinavia and along the North Sea was also in general combined with livestock farming, and it is likely that livestock in some areas were moved seasonally from the coast to pastures inland.³⁵ Based on sources such as pollen analysis, the location of the sites and the distribution of artefacts in the landscape, several researchers have

³⁰ E.g. I. M. Gundersen, *Gård og utmark i Gudbrandsdalen* [Farms and outfields in the Gudbrandsdalen valley] (2016).

³¹ L. E. Gjerpe (ed.), *Hus, boplass- og dyrkningsspor* [Houses, settlements, and arable land]: *E18-prosjekte, Vestfold*, III, *Varia* 73 (2008) pp. 212–3; G. A. Bårdseth, 'Kva dyrka Vodurid, brødherren? Jordbruk og næringsgrunnlag i Tune i førhistorisk tid [What did Vodurid cultivate? Agriculture and economy in Tune in past times]', *Viking* (2009), pp. 123–36.

³² Indications of clearance by fire, trampling by cattle and analysis of macrofossils from eastern Norway are presented in Viklund *et al.*, 'Integrated palaeoenvironmental study'. Reviews of macrofossils from the Iron Age in other parts of Scandinavia can be found in R. Grabowski, 'Changes in cereal cultivation during the Iron Age in southern Sweden: A compilation and interpretation of the archaeobotanical material', *Vegetation Hist. and Archaeobotany* 20, no. 5 (2011), pp. 479–94; id. 'Cereal cultivation in east-central Jutland during the Iron Age, 500 BC–AD 1100', *Danish J. Arch.* 2 (2013), pp. 164–96.

³³ J.-H. Bech, M. Rasmussen, J. Olsen, and M. Kastrup, 'Thy and the outside world in the Bronze Age', in: J.-H. Bech, B.V. Eriksen, and K. Kristiansen (eds), *Bronze Age settlement and land-use in Thy, Northwest Denmark* (2018), pp. 56–62, 86–7.

³⁴ W. H. Zimmermann, 'Ackerbau in ur- und frühgeschichtlicher Zeit auf der Geest und in der Marsch', in H.-E. Dannenberg and H.-J. Schulze (eds), *Geschichte des Landes zwischen Elbe und Weser, I, Vor- und Frühgeschichte* (1995), pp. 289–315.

³⁵ On transhumance see C. Prescott, *From Stone Age to Iron Age: A study from Sogn, western Norway* (1995). Multiple authors have emphasized the importance of animal husbandry in the Scandinavian Bronze Age, e.g. K. Kristiansen, *Europe before history* (1998), pp. 306–7; S. Welinder, 'Early farming households 3900–800 BC', in Myrdal and Morell (eds), *AHS*, pp. 18–45; J. Jensen, *The prehistory of Denmark: From the Stone Age to the Vikings* (2013), pp. 147–9. K. A. Oma, *The Sheep People: The ontology of making lives, building homes and forging herds in Early Bronze Age Norway* (2018).

also argued for an extensive breeding of livestock in the eastern Norwegian Bronze Age.³⁶ Seasonal movement of animals could very well have been a part of the region's farming systems in the Early Bronze Age, as multiple forms of transhumance have been practised in eastern Norway in recent times.³⁷

In general terms, the archaeological record in eastern Norway points towards a farming practice that fits well into the farming system practised along other parts of the North Sea littoral. Permanent fields were established in stone-free areas, and animal husbandry played a key role in the society. However, the evidence of a systematic integration between animal husbandry and crop cultivation is not as conclusive as in later periods.

VI

In the forests of eastern Norway and central Sweden thousands of fields with clearance cairns are preserved. Many of these areas are linked to early Iron Age farming, and it has been argued that each farm had 10,000–30,000 m² of arable land.³⁸ Compilations of radiocarbon analyses from clearance cairn fields in eastern Norway and central Sweden prove a near total lack of radiocarbon dates from clearance cairn fields before 1800 BC. There is a small increase in the number of cairn fields dated from 1800 and 800 BC, especially in Sweden (Figure 2). Some of these early dates are however related to the inherent age of the charcoal and the fact that some of the dates must be regarded as *terminus post quem* dates of the clearance fields (see section III for a discussion of this source-critical problem). In the sum plots for both central Sweden and eastern Norway there is an increase of dates from c.800 BC, and a further increase in eastern Norway from c.500 BC. From then on, the number of dates stays at a high level until recent times. A further processing of the data (Figure 7) also proves that removing the stones from the fields was not a significant part of farming practice until after c.1000 BC. A more precise time for the introduction of this form of agriculture is difficult to set due to the inherent age of some of the charcoal and the major plateau in the calibration curve between approximately 800–400 BC, problems that may be solved by more detailed studies of the chronologies of sites in the future.³⁹

³⁶ E. Mikkelsen, *Fra jeger til bonde: Utviklingen av jordbrukssamfunn i Telemark i steinalder og bronsealder* [From hunter to farmer: The development of rural communities in Telemark during the Stone Age and Bronze Age], Universitetets Oldsaksamlings skrifter, Ny rekke 11 (1989), pp. 312–22; E. Østmo, 'Hellerbosetning i østnorsk yngre steinalder: Utgravingen av Sandtrahelleren i Tjølling, Larvik, Vestfold [The use of rock shelters during the East Norwegian Neolithic: The excavation of the Sandtrahelleren rock shelter in Tjølling, Larvik, Østfold]', *Universitetets Oldsaksamling Årbok* (1991–92), pp. 87–102; D. Vogt, *Rock carvings in Østfold and Bohuslän, South Scandinavia: An interpretation of political and economic landscapes* (2011).

³⁷ K. Daugstad, M. F. Mier, and L. Peña-Chocarro, 'Landscapes of transhumance in Norway and Spain: Farmers' practices, perceptions, and value orientations',

Norwegian J. Geog. 68 (2014), pp. 248–58.

³⁸ P. Connelid, C. Mascher, J. Regnell, and E. Weiler, 'Röstorp – tvärvetenskapliga studier av ett röjningsröseområde i södra Västergötland [Röstorp – interdisciplinary studies of a clearance cairn field in southern Västergötland]', in M. Widgren (ed.) *Röjningsröseområden på sydsvenska höglandet [Clearance cairn fields in the southern Swedish highlands]* (2003), pp. 169–205; A. Mjærum, 'Jordbruk i grenseland [Farming at the edge]', in C. L. Rødsrud and A. Mjærum (eds) *Ingen vei utenom: Arkeologiske undersøkelser i forbindelse med etablering av ny rv. 3/25 i Løten og Elverum kommuner, Innlandet [No other way: Excavations related to the rv. 3/25 road project, Innlandet county, Norway]* (2020).

³⁹ See W. D. Hamilton, C. Haselgrove and C. Gosden, 'The impact of Bayesian chronologies on the British Iron Age', *World Archaeol.* 47 (2015), pp. 642–60.

This conclusion indicates a significant change in the farming technology in the last part of the Bronze Age. Radiocarbon dates from Sweden also suggest a period of farming expansion at the beginning of the first century AD.⁴⁰ Such an expansion is however not as evident in the record from eastern Norway (Figure 2).

Which form of agriculture these cairn fields actually represent has been a key question, and researchers have especially discussed whether this farmland was fertilized.⁴¹ Recent years' large-scale excavations, with incorporation of micro-morphology and other archaeo-metric data, clearly indicate a variance in the use of these fields, but some of them were heavily manured.⁴² The farmers' large investment in clearing stones measuring some 10–50 cm in diameter at the sites was also of major importance, since this large effort made tilling possible. The flexible ard, which lacked a mouldboard, could then move smaller stones and manoeuvre around larger stones and cairns.⁴³

The use of manuring in crop cultivation is known from the well-preserved field system at Hørdalsåsen in Vestfold, a hill that today is located in forest terrain. A large part of this approximately 44,000 m² hillock was transformed to arable land c.400 BC, resulting in more than 100 clearance cairns and construction of stone walls (Figure 8).⁴⁴ Excavated evidence and archaeometrical analysis point towards varied use of the area as farmland until c. AD 400. The western part was cleared almost free of stones with a diameter of 0.1–0.5 m and the layer of plaggan-like cultivation soil was up to 0.4 m thick (see Figures 3 and 6). The eastern part was defined by lynchets, stone alignments and cultivation layers that formed a complex system of irregular plots (250–400 m²). The farmers likely practised a multi-course rotation in this eastern area, with periods of crop cultivation, fallow and grazing. A cattle track with dung-rich deposits that led from the settlement area formed a key element during the whole period of use.⁴⁵ The vicinity of Hørdalsåsen consisted of a varied landscape of forested, hilly terrain and less well-drained and stone-free ground. Excavations indicate that parts of the surrounding area were managed by fire, partly cleared free of stones and that also more or less stone-free areas were used for crop farming. The Iron Age farmers also used these areas to obtain sufficient grass, hay and leaf-fodder for the animals as winter fodder, a necessity when animals were kept indoors or in pens part of the year.⁴⁶ Parts of similar systems of farming

⁴⁰ Häggström, *Landskapsutnyttjande*, pp. 153–4; Pedersen and Widgren, 'Agriculture in Sweden', pp. 52–3; Lagerås, 'Agrara fluktuationer och befolkningsutveckling'.

⁴¹ L. Gren, 'Det småländska högländets röjningsröseområden [The clearance cairn fields of the highlands of Småland]'. *Arkeologi i Sverige* 2, pp. 77–96; Widgren, *Relic landscapes*, pp. 31–3; P. Lagerås 'Järnålderns odlingssystem och landskapets långsiktiga förändring [Iron Age cultivation systems and long-term change of the landscape]', in P. Lagerås (ed.), *Arkeologi och paleoekologi i sydvästra Småland [Archaeology and paleoecology in southwestern Småland]* (Rikssantikvarieämbetet, Arkeologiska undersökningar, 2000), pp. 167–229; Holm, 'Forvaltning av agrare kulturer', pp. 34–7.

⁴² Häggström, *Landskapsutnyttjande*, p. 158.

⁴³ M. Widgren, 'Reading the prehistoric landscape', *Ymer* 130 (2010), pp. 75–6.

⁴⁴ E. A. Pedersen, 'Transformations to sedentary farming in eastern Norway: AD 100 or 1000 BC', in C. Fabeck and J. Ringtvedt (eds), *Settlement and landscape* (Jutland Archaeological Soc., 1999), pp. 45–52; R. J. S. Cannell, 'The application of multi-elemental analysis at Hørdalen (site 51): An evaluation of methods and results', in L. E. Gjerpe (ed.), *Results and archaeometric analysis* (2013), pp. 111–124; Viklund *et al.*, 'Integrated palaeoenvironmental study', pp. 25–83.

⁴⁵ Viklund *et al.*, 'Integrated palaeoenvironmental study', p. 58.

⁴⁶ A. Mjærum, 'Åkre og beitemarker i Fevang-grenda', Häggström, *Landskapsutnyttjande*, see also

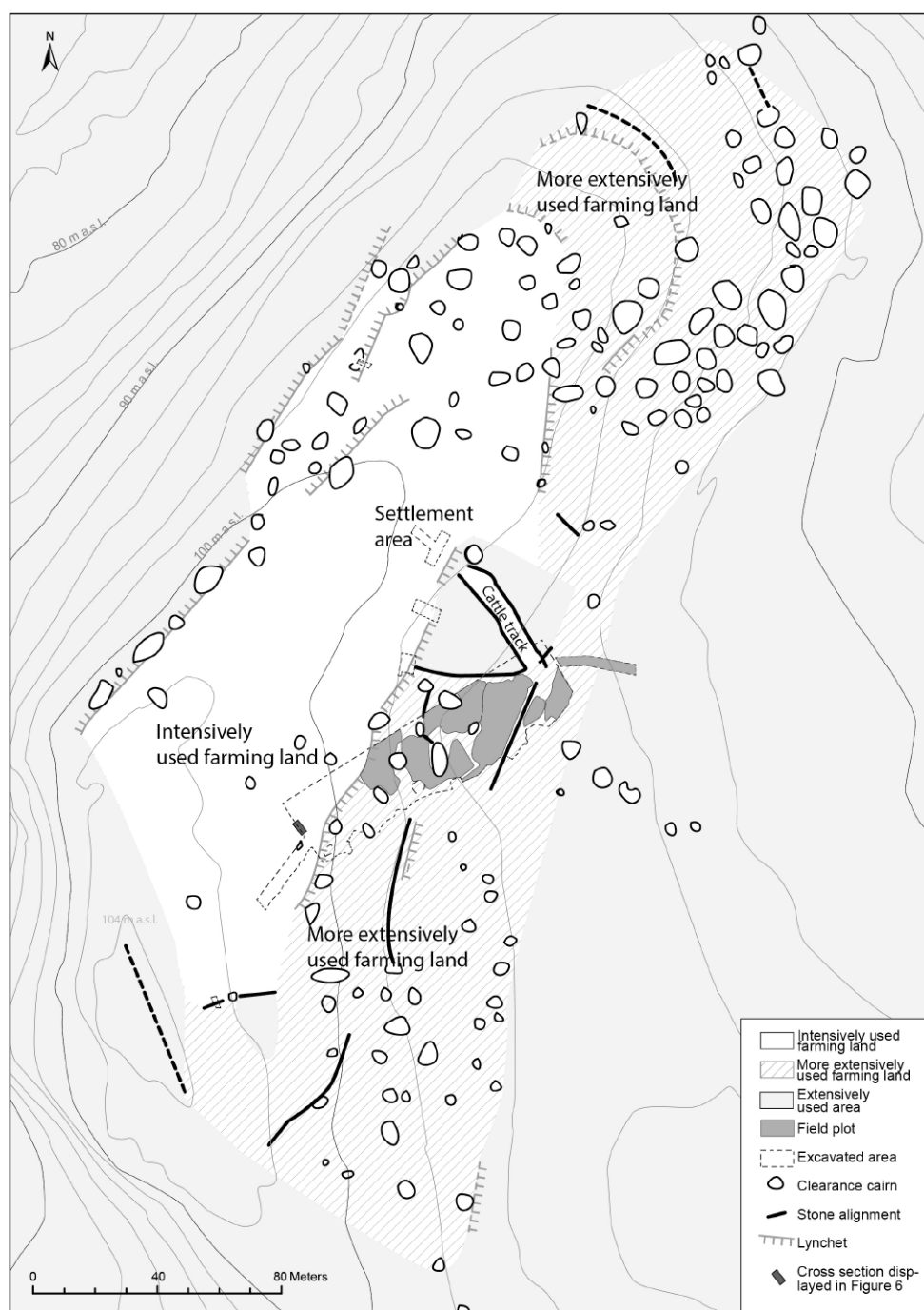


FIGURE 8. An area of 44,000 m² was cleared for cultivation c.400 BC at Hørdalsåsen in eastern Norway. The farming land consisted of a large, heavily manured field in the west and smaller, more extensively used field plots (250–400 m²) in the east.

Map: based on A. Mjærum, 'Åkre og beitemarker i Fevanggrenda – nytt om jernalderlandbruket i Vestfold [Fields and meadows at Fevang: The agricultural landscape of Early Iron Age Vestfold]', *Viking* (2012), Figure 2.

have been found in recent years at multiple sites in Norway and Sweden.⁴⁷ The results link the clearance fields to a dynamic system of intensively used, well-manured land, combined with more extensive landscape utilization.

Hulled barley (*Hordeum vulgare* var. *vulgare*) becomes significantly more common in the material from eastern Norway in the Early Iron Age, and it is likely that this cereal was grown together with wheat (*Triticum*) at Hørdalsåsen.⁴⁸ Hulled barley responds well to fertilizing, and it has been argued that the increased importance of this species was linked to more extensive manuring.⁴⁹ This argument has partly been confirmed by isotope analyses which suggests a more intensive and systematic manuring practice in Scandinavia.⁵⁰ A wide range of grains and weeds are known, however, which indicates that loamy as well as sandy soils were cultivated, a practice that probably required an intensified use of manure.⁵¹

The increased number of dated sites *without* clearance cairns, some of them with traces of cross-arding, support this interpretation of the cultivation of different types of soils (Figures 2 and 7). The local and regional expansion into new areas of arable land was thus not a replacement, but a supplement to the land that was already in use for cultivation. This was a system that could easily be adapted to new landscapes in the region. The result was a large variation of systems where livestock breeding and arable cultivation were integrated in the Early Iron Age, as has been the case until recently.⁵²

VII

In the Early Bronze Age, crop cultivation primarily took place on stone-free, sandy and silty ground in eastern Norway. Arable farming was combined with animal husbandry, and both stray finds and pollen data suggest that many areas of the eastern Norwegian landscape were used as pastures as well as for more extensive forms of cultivation.⁵³ Most likely, some of the fields in the region were intentionally manured, but the use of fertilizers is not as comprehensive as in later periods.

The Early Iron Age was a period of expansion of farming land into stone-rich moraines with sandy ground in eastern Norway. These clearance fields were only one component of the farming systems, as large parts of the varied eastern Norwegian landscapes were exploited in a fully integrated, more intensive mixed farming economy. Based on the analyses of the radiocarbon data, this transformation happened during the last part of the Bronze

Note 46 *continued*

H. Zimmermann, 'Why was cattle-stalling introduced in prehistory? The significance of byre and stable and of outwintering', in Fabech and Ringvedt (eds), *Settlement and landscape*, pp. 301–18.

⁴⁷ Häggström, *Landskapsutnyttjande*, p. 101; Pedersen and Widgren, 'Agriculture in Sweden', pp. 50–1; Mjærum, 'Jordbruk i grenseland'.

⁴⁸ Mjærum, 'Åkre og beitemarker i Fevanggrenda'.

⁴⁹ K. Viklund, *Cereals, weeds and crop processing in Iron Age Sweden: Methodological and interpretive*

aspects of archaeobotanical evidence (1998).

⁵⁰ M. Kanstrup and others, 'Searching for long-term trends in prehistoric manuring practice: $\delta^{15}\text{N}$ analyses of charred cereal grains from the 4th to the 1st millennium BC', *J. Archaeological Science* 51 (2014), pp. 115–25.

⁵¹ Viklund *et al.*, 'Integrated palaeoenvironmental study', p. 73.

⁵² Bårdseth, 'Kva dyrka Vodurid, brøðherren?'; Mjærum, 'Jordbruk i grenseland'.

⁵³ E.g., Mjærum, 'Jordbruk i grenseland'.

Age (1000–500 BC, Figure 7). Taking into consideration that the datasets in Sweden and Norway partly are based on *terminus post quem* dates, and then the problems of calibrating radiocarbon dates in the last part of the Bronze Age (see section III), there is, however, a lack of unambiguous dates that support a full-scale introduction as early as 1000 BC. The dates presented in Figure 7 can therefore be understood as the result of a somewhat slower transformation process until the clearance fields consisted of a significant and stable part of the farming systems from c.500 BC (see Figure 7).

The farming economy in the Early Bronze Age and the Early Iron Age must then be considered as two clearly different agricultural systems, where the fields were manured more systematically and on a large scale in the latter of these two periods. This points forward to the historically known farming traditions in northern Europe, and I argue that the Early Iron Age economy should be regarded as a precursor to a historically known mixed farming economy.

When Myrdal originally formulated his idea of the emergence of a new agricultural complex in the first millennium BC, he linked this change to some major technological developments that he thought were crucial in a full-scale mixed farming economy. He argued especially for the importance of indoor stalling of animals to gain control of their manure.⁵⁴ In later publications, others have discussed and nuanced Myrdal's arguments.⁵⁵ Animal waste can be collected without indoor stalling, such as by using pens or by keeping animals in the fields for parts of the year. House-byres may also have been introduced for multiple other reasons. For instance, indoor stalling can make it easier to look after the animals and to milk them, and it protects the livestock from theft and predators. Animals exposed to cold weather also need more food to keep themselves warm. Fodder could thereby be saved by keeping animals indoors in the coldest part of the year. The ideological and social reasons for stalling animals should also be emphasized, since stalling is an effective way to display one's wealth in the form of livestock. It has consequently been argued that the introduction of indoor stalling marks a shift from a collective to an individually focused ownership, in the same way as ploughing and manuring were investments that strengthened the bond between the farmer and his land.⁵⁶ This moving of animals indoors for part of the year thereby had multiple implications beside the getting better control of the animal manure.

It is clear that longhouses with integrated barns were introduced at different times across northern Europe during the Bronze Age (c.1700–500 BC). The spread of this technology is complex and has been difficult to follow in detail.⁵⁷ An alternative approach is therefore

⁵⁴ Myrdal, 'Elisenhof'.

⁵⁵ E.g. Pedersen and Widgren, 'Agriculture in Sweden', pp. 49–53; Myrdal, 'Swedish agrarian history', pp. 260–1.

⁵⁶ For the concept of 'landesque capital', see N. T. Håkansson, M. Widgren (eds), *Landesque capital: The historical ecology of enduring landscape modifications* (2014). See also H. Fokkens, 'Cattle and martiality: Changing relations between man and landscape in the Late Neolithic and the Bronze Age', in Fabeck and Ringtvedt (eds), *Settlement and landscape*, see especially p. 38; M. Pedersen, 'Livestock without bones: The long-house

as contributor to the interpretation of livestock management in the Southern Scandinavian Early Bronze Age', in Fabeck and Ringtvedt (eds), *Settlement and landscape*, pp. 281–91. See also M. Olausson, "'Säg mig hur många djur du har ...': Om arkeologi och stallning ['Tell me how many animals you own ...': About archeology and stables]", in K. Viklund, R. Engelmärk, and J. Linderholm (eds), *Fåhus från bronsålder till i dag [Stables from the Bronze Age to the present]* (1998), pp. 28–58.

⁵⁷ Olausson, "'Säg mig hur många djur du har ...'", p. 30; Bech *et al.*, 'Thy and the outside world', pp. 28–54.

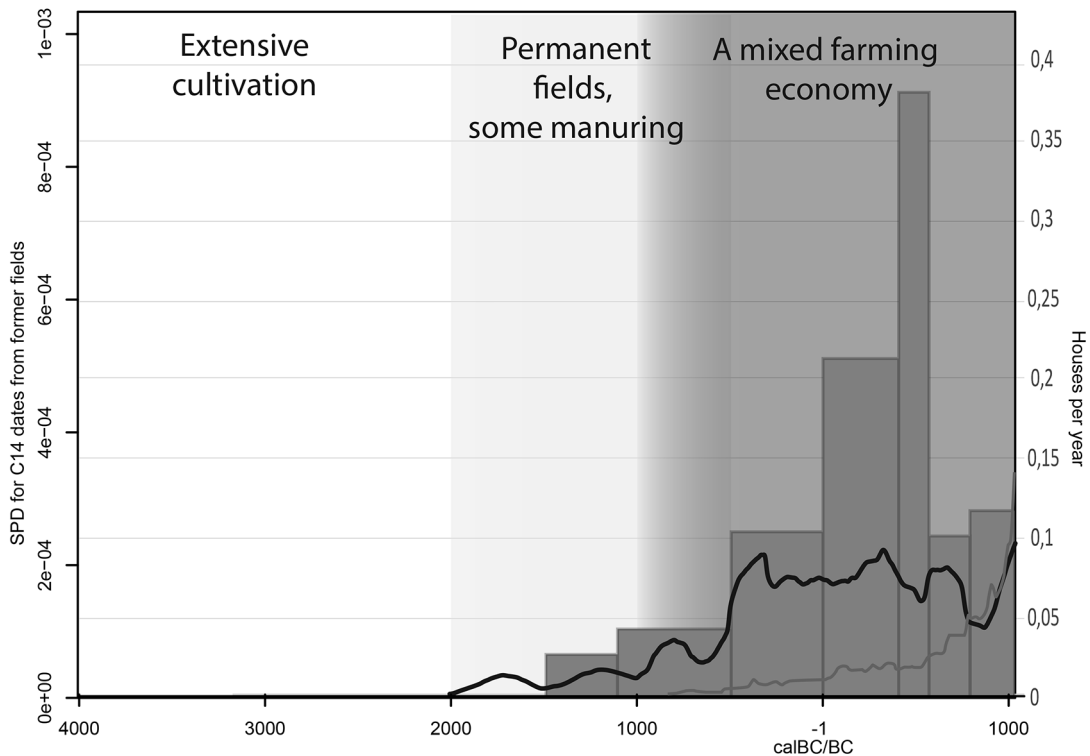


FIGURE 9. The developments in cultivation, longhouses and iron production. Dated clearance cairn field in eastern Norway (409 C14 dates, black line). The columns mark the number of houses per year from excavated sites in eastern Norway. The dataset include mainly sites with three-aisled longhouses ($n=328$, the two-aisled longhouses from the Late Neolithic and Early Bronze Age ($n=6$ sites) are excluded from the dataset). The black line is a part of a graph representing 1902 C14 dates from pre-industrial iron production sites in southern Norway (including eastern and western Norway). (Kjetil Loftsgarden has produced the graph concerning iron, using the summed probability distributions function in Rcarbon.)

Illustration: author.

to look at the number of three-aisled longhouses in the region, a house type that appeared c.1300 BC in eastern Norway and which commonly had an integrated part for the animals.⁵⁸ There is a significant increase in the number of excavated remains of longhouses during the last part of the Bronze Age in eastern Norway, and a further growth in the Pre-Roman Iron Age (500–1 BC, Figure 9). This fluctuation is covariant with the expansion of arable land and the mixed farming economy.

Another part of Myrdal's original argument is that the emergence of mixed farming was closely linked to the introduction of iron technology. Iron made it possible to produce long-edged, sharp blades for sickles and scythes that could be used to secure hay and foliage for the winter. In an attempt to date the introduction of iron farming implements in Sweden

⁵⁸ L. E. Gjerpe, 'Effektive hus. Bosetning, jord og rettigheter på Østlandet i jernalder [Efficient houses. Settlements, land and property rights]' (Unpubl. PhD thesis, University of Oslo, 2017).

and Norway, researchers have been faced with a problem because relatively few artefacts are preserved from the first millennium BC in the region in general, combined with shortcomings in radiocarbon techniques (see section VI). It has also been stressed that a large proportion of early iron tools, as well as most bronze sickles, never ended up in the earth, because the valuable metal would have been recycled.⁵⁹ Agricultural implements appear nevertheless in the archaeological record from approximately 200 BC.⁶⁰

The numerous iron production sites in the region offer an opportunity to approach this question from another angle (Figure 9). Dates from these sites indicate that iron was processed in relatively large quantities from c.500 BC, which also made it possible to make iron tools for agricultural use. The dates from the iron production sites show that agricultural iron implements therefore cannot have been directly linked to the initial phase of the transformation of the farming economy. The importance of iron for intensive farming should not be exaggerated, however.⁶¹ Farmers had already been using wooden ards for approximately 1000 years in the region (see section IV) and other tools made of wood, bone, stone and bronze were available. Nevertheless, the new system certainly created a need for long-edged implements. The co-variance between the number of iron production sites and the agricultural expansion from c.500 BC during the Iron Age therefore supports the idea that a further spread of a mixed farming economy was made possible in part by technological developments.⁶² It is consequently difficult to find a direct link between a mixed farming economy and the introduction of iron, as Myrdal originally claimed.

VIII

Instead of attempting to link the introduction of mixed farming to a specific technological innovation, I find it fruitful to emphasize another part of Myrdal's original argument. He argues that those large-scale transformations in farming technology commonly relate intimately to other social or structural changes.⁶³ In the course of the seventh century BC, the contact networks in Europe were shifting and the exchange system of bronze was starting to collapse. Multiple social, cultural and economic changes in the Scandinavian societies followed. The transformation is commonly seen as the period when the chieftain societies of the Bronze Age with long-distance contacts were replaced by the family-based farming societies of Early Iron Age Scandinavia.⁶⁴

⁵⁹ Jensen, *Prehistory of Denmark*, p. 577.

⁶⁰ B. Solberg, *Jernalderen i Norge. Ca. 500 f.Kr.–1030 e.Kr.* [*The Iron Age of Norway. c.500 BC–AD 1030*] (2000), pp. 45–6; Myhre, 'Agriculture, landscape and society', p. 108; Pedersen and Widgren, 'Agriculture in Sweden', p. 52.

⁶¹ Häggström, *Landskapsutnyttjande*, p. 14.

⁶² See Figures 5 and 9. See also Myrdal, 'Elisenhof'; Häggström, *Landskapsutnyttjande*, pp. 153–4; Pedersen and Widgren, 'Agriculture in Sweden', pp. 52–3.

⁶³ Myrdal, 'Elisenhof'; and see A. Bogaard, *Neolithic farming in central Europe: An archaeobotanical study of*

crop husbandry practices (2004).

⁶⁴ Solberg, *Jernalderen i Norge*, pp. 64–5, and Myhre, 'Landbruk, landskap og samfunn', pp. 114–6, discuss the general changes in Norway, even though neither of them emphasizes the transformation of farming as a prominent part of this transition, see also Jensen, *Prehistory of Denmark*, pp. 537–55, for a discussion of the developments in Denmark. Kristiansen, *Europe before history*, has a discussion of the transformations in the Late Bronze Age in a European context, e.g., see pp. 207–9, 410–1.

In this new system, the longhouses with integrated barns became the focal point of the farmstead, where each farm had a defined area of land at its disposal.⁶⁵ In the emerging system of family-based production, it was expedient for individual farmers to make larger investments in the cropland and thereby introduce the new way of farming.⁶⁶ The Bronze Age was also a period with a large growth in population in eastern Norway, which probably resulted in a shortage of land and soil degradation.⁶⁷ The moraines in eastern Norway were, however, well suited for crop farming, as long as sufficient resources were invested in clearance and fertilization. Social and cultural factors made it possible to introduce technology that was already partly known in the North Sea area, such as farming on systematically manured field plots, and indoor stalling of livestock (see sections V and VII).⁶⁸ The outcome of these processes was that a closer integration between the single household, livestock breeding, and cultivation of arable land was adapted to the environment of eastern Norway. Simultaneous processes took place in neighbouring regions, and consequently different types of extensively and more intensively used permanent field systems became widespread across northwest Europe in the lattermost part of the Bronze Age.⁶⁹

Based on analyses and interpretations of C14 data from eastern Norway, I therefore conclude that the introduction of a mixed farming economy was a process that started c.1000 BC and ended in a final breakthrough c.500 BC. The start of the practice of using stone-rich moraine as arable land is the most visible trace of this new way of farming. This agronomic system was however only a part of a dynamic farming system where much of the varied landscape was utilized as pastures and to obtain grass, and leaf fodder for the animals.

The shift to a closer integration between livestock breeding and cultivation was also a part of the emergence of the Iron Age farming societies. The growth in farming coincided with an increase in the number of settlements and a larger production of iron (see Figure 9). During the latter part of the Bronze Age, we thus see the breakthrough of a way of farming that has dominated eastern Norway and other parts of northern Europe until recently.⁷⁰

⁶⁵ F. Herschend, *The early Iron Age in south Scandinavia: Social order in settlement and landscape* (Societas Archaeologica Upsaliensis, 2009); Gjerpe, 'Effektive hus'.

⁶⁶ See section I; and see Anderson *et al.*, 'The dimension of tools'.

⁶⁷ On demography in eastern Norway, see, e.g., S. Solheim and Per Persson 'Early and mid-Holocene coastal settlement and demography in southeastern Norway', *J. Archaeological Science: Reports* 19 (2018), Fig. 3. See Kristiansen, *Europe before history*, pp. 306–7 for more about soil degradation in the Late Bronze Age.

⁶⁸ See also e.g. S. Arnoldussen, 'The fields that outlived the Celts: The use-histories of Later Prehistoric field systems (Celtic fields or *raatakkers*) in the Netherlands',

Proc. Prehistoric Soc., 84 (2018), pp. 303–27.

⁶⁹ Pedersen and Widgren, 'Agriculture in Sweden', pp. 50–1, convincingly argue that square or rectangular, embanked 'Celtic fields' and clearance cairn fields in essence are the same farming tradition, but adopted to different landscapes in the first millennium BC; N. H. Nielsen *et al.*, 'Low and variable: Manuring intensity in Danish Celtic fields', *J. Archaeological Science: Reports* 27 (2019), discuss manuring of Celtic fields. See, e.g., Arnoldussen, 'The fields that outlived the Celts' for dating of Celtic fields in northern Europe.

⁷⁰ E.g., Grigg, *Agricultural systems*; K. Lunden, *AHN*, II, 1350–1814 (2002); B. Gjerdåker, *AHN*, III, 1814–1920 (2002).