

Resilient Land Use in the Medieval and Early-modern Village

Crop and animal husbandry in Fjellie, southern Sweden, AD 1000-1800

Per Lagerås¹ and Ola Magnell²

¹ (Corresponding author) The Archaeologists, National Historical Museums, Odlarevägen 5, 226 60 Lund, Sweden (per.lageras@arkeologerna.com) ORCID 0000-0002-2804-8028.

² The Archaeologists, National Historical Museums, Odlarevägen 5, 226 60 Lund, Sweden (ola.magnell@arkeologerna.com) ORCID 0000-0002-4861-8067

ABSTRACT

Agrarian land-use in the village Fjellie, southern Sweden, AD 1000-1800, was studied through analysis of plant macrofossils, pollen, animal bones and strontium isotopes. Three different farmsteads in the village were studied and compared with other villages in the Öresund region. The composition of crop and animal husbandry was relatively constant through time, apart from a distinct increase in rye cultivation and a slight increase in cattle keeping. Similarities in crop composition between the farmsteads indicate that infield arable farming was practised in collaboration, since the 13th century probably in a three-course rotation system. Also, herding of livestock in grazing commons and fallow infields were collective efforts, whereas vegetable gardening, fishing, beer brewing and the species-composition of livestock showed differences between the individual farmsteads. The agricultural system of the village was characterised by diversity, which was reflected in several different spheres: crops and animals, biotopes, labour intensity and organisation. Further, fishing contributed to resilience by reducing dependency on agriculture. The high diversity within the framework of village agriculture probably contributed to sustainable management of the resources and to agricultural and social resilience.

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Introduction

For a long time, the agrarian village was the dominating settlement structure in much of southern Scandinavia. The dating of the earliest villages differs and depends on definition (Riddersporre 1999; Rindel 1999), but at least from the 11th century sedentary villages were common and widespread (Schmidt Sabo and Söderberg 2019). Typically, a village consisted of a village core with several farms situated together, surrounded by arable fields and meadows and with access to grazing commons. The village was not only a settlement structure, but also a social organisation with developed systems of collaboration between the farms (Myrdal 2011; Schmidt Sabo 2005).

In Sweden and Denmark the village organisation lasted until the land reforms of the 18th and 19th centuries, when the land belonging to individual farms were consolidated and farm buildings were moved from the village core out to individual blocks of land (Dombernowsky 1988; Gadd 2011, 152). These reforms were completed by the end of the 19th century and meant the end of an almost

one-thousand-year long tradition of village agriculture, social structure and collaboration.

In contrast to much of the earlier settlement in southern Scandinavia, which was characterised by a degree of mobility (Hedeager and Kristiansen 1988), the villages of the 2nd millennium AD represent a more permanent structure, regarding both the location of individual farm buildings and the spatial arrangement of fields and boundaries (Porsmose 1988). One would expect this long place-continuity to put high pressure on soils and other natural resources, but the longevity itself of the village organisation indicates that it was a resilient social-ecological system based on sustainable land use (Lennartsson et al. 1998). Furthermore, the system survived crises like the Black Death (Lagerås 2016a) and reoccurring wars and violent conflicts including the devastating Dano-Swedish wars of the 16th-17th centuries. It also survived climate change, most notably the transition from the Medieval Warm Period to the Little Ice Age (cf. Lamb 1995; Moberg et al. 2005).

Despite the obvious success of the village system, and the fact that it was heavily based on agri-



Figure 1. Map of western Scania and eastern Zealand with Fjellie and other sites discussed in the text. For references see Table 1.

culture, villages from the last millennium in southern Sweden have gained limited palaeoecological attention. Research on village agriculture is based mainly on written records (Myrdal 1985, 2012; Porsmose 1988), and for most villages records on agrarian production are from the 16th century or later. Most archaeobotanical analyses are published in grey literature and relatively little is known about the agrarian production of villages. Zooarchaeological studies of animal husbandry of rural sites in Scandinavia have mainly been published in site reports, but also in a few syntheses (Cardell 2005; Vretemark 1997). With a few exceptions (e.g. Bergman et al. 2017), archaeobotanical and zooarchaeological analyses have been presented separately, leading to separate interpretations of crop growing and animal husbandry with few discussions of the land-use system.

This study focuses on the village of Fjellie situated outside Lund in the province of Scania. Today, Scania is the southernmost province of Sweden, but it belonged to Denmark prior to 1658. We present analyses of archaeobotanical and faunal remains, strontium isotopes and pollen from the archaeological contexts of three abandoned farmsteads in the village core. The agrarian production over time and comparisons between the investigated farmsteads are presented and interpreted. The discussion focuses on the balance between individual (farm) and communal (village) production as well as between rigidity and flexibility. The results from Fjellie is set in a wider context by comparison

with archaeobotanical and zooarchaeological analysis of other villages from the Öresund region (Figure 1; Table 1). The aim is to better understand the resilient agricultural system of the village in southern Scandinavia.

Site description and archaeological contexts

Fjellie is situated in a gently undulating agricultural landscape, 4 km NW of Lund and 4.5 km E of the coast by the Öresund sound (Figure 1). Quaternary deposits are dominated by calcareous clay till (Ringberg 1987). Soils are fertile and today the area, like much of south-western Scania, is heavily cultivated with very little woodland.

According to an old map from 1769, the village at that time consisted of 22 farms, some cottages and a church (Figure 2). All farmsteads were situated close together on two sides along a village common and a brook. The farms were run by tenants and main landowners were the church and the nobility. Most of the farms were later moved from the village core in connection to land reforms. The Romanesque church, dated to the early 12th century, is the only visible reminder of its Medieval origin. The earliest mentioning of Fjellie in written documents is from 1269 (Skansjö 2019, 203).

In 2016 an area in the western part of the village core was subject to archaeological excavation

Site name	Archaeobotany	Zooarchaeology
Bunkeflo		Cardell 2009
Gårdstånga		Sten 1992
Häljarp		Cardell 1999a
Hjärup		Magnell 2016
Kyrkheddinge	Regnell 1998	Cardell 1998; Johansson 1998
Lockarp		Heimer et al. 2006
Önnerup		Ericson 1996; Gustavsson et al. 2001
Örja	Lagerås 2013	Cardell 2013
Östra Grevie		Lagerås & Magnell 2017
Östra Skrävlinge	Ingwald et al. 2009	
Övre Glumslöv		Cardell 1999c
Säby		Cardell 1999b
Södra Sallerup		Hårde et al. 1997
Tärnby	Robinson and Harild 2005	Enghoff 2005; Gotfredsen 2005
Vasatorp		Magnell 2015

Table 1. Site references

(Lindberg and Schmidt Sabo 2019). It covered three abandoned farmsteads, labelled 18, 19, and 22 on the 1769 map (Figure 2). By the time of the excavation the area was used as arable land, but the three farmsteads on the old map were readily distinguishable in archaeological structures beneath the plough layer (Figure 2). Traces of different generations of buildings could be followed back at

least to the 13th century. There were also remains of earlier settlement on the site, particularly a large Viking Age farm, which may have later developed into the village (Lindberg and Schmidt Sabo 2019, 235-238). It was situated at the plot of the later farm 18 but may not have been a direct predecessor of that farm. From ca. 1250 all three farmsteads were settled. Apart from temporary abandonment



Figure 2. Map of Fjelle village from 1769/1770 together with a plan of documented archaeological structures on farmsteads 18, 19 and 22.

of farm 22 in connection to the late-medieval crisis, all three farmsteads were settled until ca. 1800.

Preserved archaeological structures were dominated by floor and destruction layers, post holes and sills. There were also remains of ovens/fireplaces and other domestic features. Outside the buildings there were several wells and cultivation layers. The find material reflected everyday life and was mostly of local or regional origin. Some finds were connected to agriculture, like iron shod spades, sickles, a scythe and millstones (Lindberg and Schmidt Sabo 2019, 125). The archaeological finds and material culture with rather few prestigious objects and imports indicate that all farmsteads could be described as ordinary peasants and villagers, but differences in building techniques and number of houses may indicate some socio-economic differences between the farmsteads. During the 13th century, farmstead 18 consisted of only one house, while farm 19 and 22 consisted of two and four buildings, respectively (Lindberg and Schmidt Sabo 2019). The investigation had an interdisciplinary approach and samples for different types of analyses were taken throughout the excavation.

Based on the archaeological chronology of the site (Lindberg and Schmidt Sabo 2019, 237), the analytical results presented in this paper are grouped into four periods, dated to AD 1025-1225, 1225-1425, 1425-1600 and 1600-1800. These periods are based on a more detailed distinction of building phases of the individual farmsteads (Supplemental information; Lindberg and Schmidt Sabo 2019).

Material and methods

Pollen analysis

Samples from seven wells and two cultivation layers were analysed for pollen. Samples were prepared using standard methods (Berglund and Ralska-Jasiewiczowa 1986) and analysed using x400-1000 light microscopes. Pollen sums varied depending on pollen preservation and ranged 77-621 (mean value: 301). The pollen diagram was constructed using Tilia software. All pollen taxa except Asteraceae Liguliflorae (regarded as over-rep-

resented) were included in the pollen sum when calculating percentages.

Plant-macrofossil analysis

115 samples (144 litre) from different contexts (e.g. floor layers, pits, fireplaces, cultivation layers, wells) were analysed for plant macrofossils. Most samples only contained charred remains, but four samples (1.2 litres) from wells also contained uncharred plant remains. Samples were floated and sieved and all material >0.4 mm was analysed using a x6.3-63 stereo microscope.

Zooarchaeological analysis

90 kg of animal bones was collected from archaeological contexts belonging to the three farmsteads, of which 55 kg was selected for analysis. Quantification was based on the number of individual bone specimens (NISP). This type of quantification may be affected by different degrees of fragmentation between species, but it is the most used method and enables comparison of species composition between sites (Grayson 1984; Vretemark 1997, 32-35). To avoid bias due to concentrations of bone from complete or big parts of animals, such as carcasses, such concentrations were excluded from quantification.

The amount of age and sex diagnostic bone enabled tentative interpretations of the general kill-off pattern of cattle on village level but was too limited for comparison between farmsteads or periods. The age estimations were based on mandibular teeth (Grant 1982; Jones and Stadler 2010), whereas sexing was based on morphology of the pelvis and osteometric analysis of metapodials (Lemppenau 1964; Vretemark 1997, 43-48; Telledahl et al. 2012).

Strontium isotope analysis

To reveal possible mobility in livestock (cf. Evans et al. 2007; Gron et al. 2016; Gan et al. 2018), enamel of nine molariform teeth of cattle from Fjelie were analysed for strontium isotopes ($^{87}\text{Sr}/^{86}\text{Sr}$)

(Supplemental material; Evans 2019). The analysis was performed by the Isotope Geosciences Laboratory at the British Geological Survey (BGS). The results were compared with a local strontium-isotope baseline based on rodent teeth from Fjelle and other nearby sites (Lund, Uppåkra) (Arcini 2018).

Results

Pollen

Pollen assemblages were strongly dominated by herb-pollen taxa, whereas tree and shrub taxa were sparsely represented (Figure 3; Supplemental material). Even though there may have been some over-representation of open-land taxa due to activities close to the wells, the result strongly indicates a very open and almost treeless landscape. This open landscape, shaped by agricultural land use, was established already by the time when the earliest wells were in use (1225-1425).

Herb-pollen included cultivated taxa, particularly cereals, but also single pollen grains of hemp/hop (*Cannabis* type). *Sinapis* type reached unusually high values in one sample (PM28210; Figure 3) from a cultivation layer close to house remains. *Sinapis* type includes several different weed and ruderal taxa, but also the genus *Brassi-*

ca, which includes cultivated species like cabbage (*Brassica oleracea*), turnip (*B. rapa*) and black mustard (*B. nigra*). Probably, the high percentages of *Sinapis* type reflect the growing of one or several of these plants in vegetable gardening.

Macrofossils

More than ten thousand plant macrofossils were identified (Table 2; Supplemental material). They were dominated by cereal grain, followed by weeds and ruderals, plants of pastures and meadows and plants of lakes, fens and wet grassland. In smaller numbers there were also macrofossils representing cultivated vegetables, plants of sea, spices and medicinal plants and collected berries, nuts and fruits.

Cereals

Cereal grain was strongly dominated by barley, followed by rye, oats and bread wheat (Table 3). Of barley grain, 95 % was identified as hulled barley, 0 % as naked, and 5 % as unspecified. Therefore, it is likely that all barley was hulled. Of oats only five grains could be identified to species and they all belonged to the cultivated species *Avena sativa*. There were also eleven pedicels from the same species. No wild oats (*Avena fatua*) were identified,

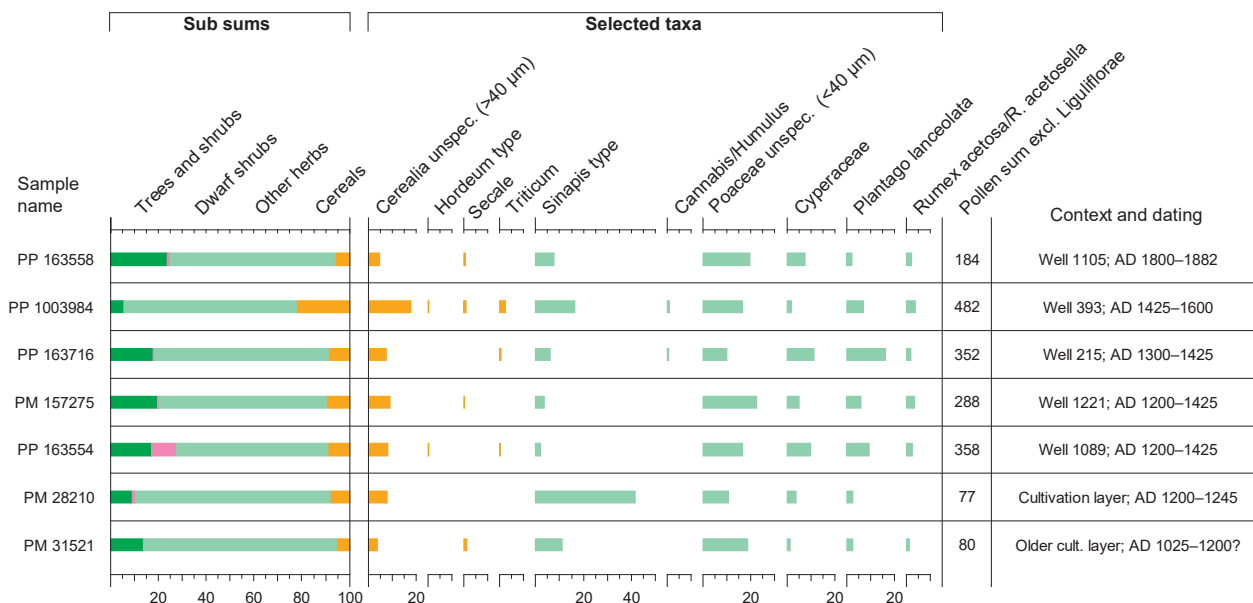


Figure 3. Simplified pollen diagram of samples from wells and cultivation layers in Fjelle showing sub sums and selected taxa. Bars show % of pollen sum excl. Asteraceae Liguliflorae. For raw pollen counts see Supplemental material.

Group	No.	%
Cereals (grain)	5 300	52,3
Cereals (chaff)	223	2,2
Cultivated vegetables	182	1,8
Spices and medicinal plants	84	0,8
Collected berries, nuts, tubers, etc.	46	0,5
Weeds and ruderals	2 678	26,4
Plants of pastures and meadows	871	8,6
Plants of lakes, fens and wet grassland	659	6,5
Plants of sea and seashore	13	0,1
Other	74	0,7
Sum	10 130	100,0

Table 2. The number of plant macrofossils from Fjellie, AD 1025–1800, grouped according to ecology and possible use and cultivation. Taxa included in the different groups are presented in Supplemental material.

and therefore it is likely that all (or at least most) of the unspecified oats (*Avena sp.*) on the site represent cultivated oats.

Cereal composition changed through time, showing a gradual (or stepwise) increase in rye at the expense of barley (Table 3). The first increase in rye (1225–1425) coincided with the first appearance of corncockle and rye broom – two weeds that thrive among autumn sown crops (Supplemental material). When comparing phases from the same time at the different farmsteads, cereal composition was very similar.

Vegetable gardening

The plant macrofossils included several taxa that indicate vegetable gardening (Table 3). These include cultivated vegetables, like pea, faba bean and turnip, and spices and medicinal plants, like black mustard, motherwort, dill and caraway. They also include wild marjoram, chicory and henbane, although these species may also have been part of the weed flora. Flax and hemp probably also reflect garden cultivation, as do the single finds of hop and buckwheat.

Macrofossils indicative of vegetable gardening were most common from periods 1225–1425 and

1425–1600, and less common from before and after. However, this is probably due to preservation. The identification of many taxa indicative of vegetable gardening, particularly spices and medicinal plants, depends on the preservation of uncharred macrofossils (in this case from water-logged sediment from wells). Such conditions were limited to periods 1225–1425 and 1425–1600.

Beer brewing

Beer brewing was indicated by 18 sprouted grains of barely, 20 fruits of bog-myrtle and one fruit of hop. Sprouted barley indicates malting, whereas bog-myrtle and hop were common beer additives (Behre 1999; Heimdahl 2014). Chronologically, macrofossils indicating brewing were well distributed, from 1225–1425 to 1600–1800. Except for one single fruit of bog myrtle, all of them came from one of the three farmsteads, farm 19.

Seaweed and collected wild plants

One sample from an indoor fireplace contained numerous charred fragments of seaweed. Two species were identified, bladderwrack (*Fucus vesiculosus*) and sea oak (*Halidrys siliquosa*), which today grow in the Öresund sound, 5 km from Fjellie. The seaweed may have been used for different purposes, like fertiliser, fodder or fuel, to produce salt or in textile bleaching (Mooney 2018).

In addition to seaweed, also bog myrtle for beer brewing (see above) had to be collected far from the village or been purchased. Bog myrtle thrives in peatbogs or poor heathland, environments that could not be found in the vicinity of Fjellie. Berries of elder, dewberry and raspberry may have been collected in the village, whereas nuts of hazel and berries of juniper probably were collected in pasture commons.

Zooarchaeology

The analysis resulted in 2310 NISP of mammals, 199 NISP of birds and 2808 NISP of fish (Supplemental material). The faunal remains were well-preserved and included also fragile bones of new-born animals, amphibians, and small fish.

Period (years AD)	1025–1225	1225–1425	1425–1600	1600–1800
Cereal grain (%)				
Oats (<i>Avena sp.</i>)	11	5	10	12
Barley (<i>Hordeum vulgare/distichon</i>)	87	78	74	12
Rye (<i>Secale cereale</i>)	2	16	15	75
Bread wheat (<i>Triticum aestivum</i>)		1	1	1
Cultivated vegetables, etc.				
Pea (<i>Pisum sativum</i>)	*	*	*	*
Faba bean (<i>Vicia faba</i>)		*	*	
Flax (<i>Linum usitatissimum</i>)	*	*	*	*
Gold-of-pleasure (<i>Camelina sativa</i>)		*		*
Turnip (<i>Brassica rapa</i>)			*	*
Cabbage unspec. (<i>Brassica sp.</i>)		*	*	*
Hemp (<i>Cannabis sativa</i>)		*		
Hop (<i>Humulus lupulus</i>)			*	
Buckwheat (<i>Fagopyrum esculentum</i>)				*
Spices and medicinal plants				
Black mustard (<i>Brassica nigra</i>)		*	*	*
Motherwort (<i>Leonurus cardiaca</i>)			*	
Wild marjoram (<i>Origanum vulgare</i>)		*	*	
Chickory (<i>Cichorium intybus</i>)	*			
Dill (<i>Anethum graveolens</i>)		*	*	
Caraway (<i>Carum carvi</i>)			*	
Henbane (<i>Hyoscyamus niger</i>)		*	*	
Collected berries, nuts, etc.				
Elder (<i>Sambucus nigra</i>)		*	*	
Hazel (<i>Corylus avellana</i>)		*	*	
Juniper (<i>Juniperus communis</i>)			*	*
Bilberry, cowberry, etc. (<i>Vaccinium sp.</i>)		*		
Bog myrtle (<i>Myrica gale</i>)		*	*	*
Dewberry (<i>Rubus caesius</i>)			*	*
Raspberry (<i>Rubus idaeus</i>)		*		

Table 3. Chronological distribution of cultivated and other useful plants identified in plant macro-remains from Fjellie. For cereal grains, numbers show % of identified cereal grains. For other species, * indicates presence.

Livestock

Almost all identified mammalian bones from Fjellie were from livestock (Table 4), which is characteristic for rural sites in southern Scandinavia. Among the livestock bones, cattle and pig were the most common with rather equal abundance (39 % and 32 %, respectively), whereas sheep and goat made up 23 % and horse 6 %. Of sheep and goat, almost all bones came from sheep (93 %) and only few (7 %) from goat. The relatively equal proportions of cattle, pig and sheep seems to be typical for other sites in the Öresund region.

The composition of livestock in Fjellie was rather stable through time, but some minor chronological changes could be noticed. Cattle showed a slight increase from 31 % in 1225-1425 to 42 % in 1600-1800 (due to small sample size, the frequency of livestock from the period 1025-1225 is uncertain). The frequency of pig and sheep was rather constant through time. The frequency of horse bones was slightly higher 1025-1425 than during later periods.

There were some differences between farmsteads 18 and 19 (the material from farmstead 22

was too small for comparison). At farmstead 19 the frequency of cattle and horse was higher, whereas farmstead 18 showed higher frequency of small livestock, like pig and particularly sheep.

Only few bones could be identified to sex, but out of ten sex-diagnostic bones of cattle, eight were from cows, one from a bull and one from an ox. Age distribution of cattle for the period 1225-1425 showed a large proportion of calves (35 %) and subadult animals, aged 18-30 months (39 %), and low frequency of adults, older than 48 months (19 %). Age distribution for the period 1425-1600 was more even, with a lower proportion of calves (13 %) and a higher proportion of adults (40 %).

Pathological changes in bones from joints of cattle, such as eburnation in acetabulum of the hip joint and phalanges with exostosis and lipping, indicate that oxen were used as draught animals, most likely for ploughing the fields.

Poultry

Poultry was represented by bones of goose, duck, and chicken. All identified bones of goose and duck were from greylag goose/domestic goose and mallard/domestic duck, respectively. It was not possible to determine if these bones represented domestic or wild birds, but since no other wild species of goose or duck could be identified it was assumed that they originated from poultry.

Despite the fragility and smallness of bird bones, which probably make them underrepresented, 9 % of all bones from domestic animals were from poultry. In addition, eggshells from goose were recovered in a layer dating to the period 1225-1425.

The proportion of bones of goose and domestic chicken in relation to livestock increased from 12 % 1025-1225 to 55 % 1600-1800. Like livestock, poultry showed differences between the farmsteads, with higher proportion of goose at farm 19 and of chicken at farm 18. However, the sample sizes of poultry were rather small when separated on different farms.

Wild game and wild fowl

Evidence of hunting was two bones of roe deer. In addition, there were bones of small birds, doves and various taxa of passerines. They were interpreted

to represent birds caught for consumption since all came from kitchen refuse.

Fish

Fish bones were abundant in layers interpreted as kitchen refuse (Table 4), which indicates the importance of fish in the diet of the villagers in Fjellie. Marine fish, mainly herring and codfishes, dominated. On village level, herring was most abundant in the period 1225-1425, whereas the frequency of codfishes and flounder increased in 1425-1600. Similar trends have been noticed for other villages in the Öresund region (Cardell 2013, 198; Enghoff 2005, 472). A comparison between the farms seems to reveal different consumption patterns in 1225-1425. From this period, herring clearly dominated (68 %) the fish bones from farmstead 18, whereas fish bones from farmstead 19 were dominated by codfishes (62 %) together with an unusual high frequency of perch (24 %).

Strontium isotopes of cattle teeth

Strontium analysis ($^{87}\text{Sr}/^{86}\text{Sr}$) of nine cattle teeth showed that six of them had slightly higher strontium values than the local baseline and two had distinctly higher (Figure 4). The slightly higher values indicate that cattle were not raised only on the local Tertiary limestone, but also grazed in nearby areas with older sedimentary bedrock (Jurassic and Triassic shale) about 1 km east of the village. The two cattle with distinctly higher values seem to originate from areas with much older Fennoscandian bedrock, mainly granitoids and gneisses, found on the ridge of Linderödsåsen and in northern Scania, about 40-60 km from Fjellie (Bergström et al. 1988; Arcini 2018; Kjällquist & Price 2019, 191).

Discussion

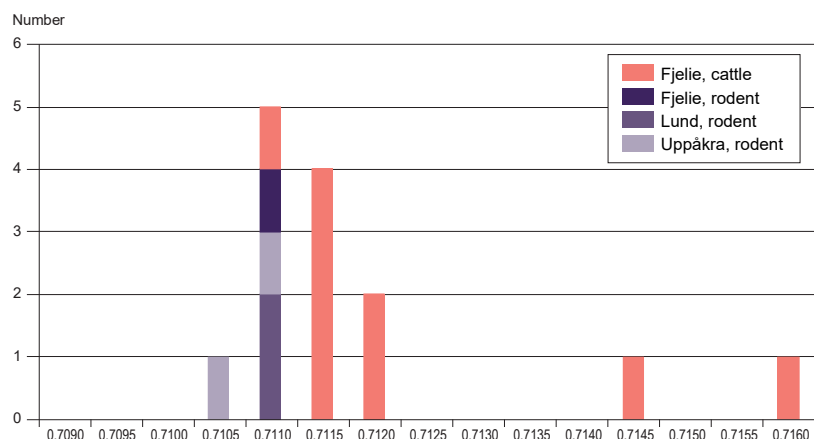
Crop and animal husbandry through time

Agriculture in the pre-industrial village of southern Scandinavia, like in most of Europe, was characterised by mixed farming, i.e. the combination of crop and livestock farming. Besides providing

Period (years AD)	1025– 1225	1225– 1425	1425– 1600	1600– 1800	total
Domesticated animals					
Cattle (<i>Bos taurus</i>)	22	497	247	166	957
Pig (<i>Sus domesticus</i>)	27	370	273	111	795
Sheep/goat (<i>Ovis/Capra</i>)	15	206	85	79	392
Sheep (<i>Ovis aries</i>)	2	17	7	14	45
Goat (<i>Capra hircus</i>)	6	1		2	3
Horse (<i>Equus caballus</i>)		98	37	20	174
Dog (<i>Canis familiaris</i>)		7	8	2	17
Cat (<i>Felis catus</i>)				5	2
Domestic/greylag goose (<i>Anser domesticus/anser</i>)	3	44	45	37	129
Domestic chicken (<i>Gallus domesticus</i>)		29	17	9	56
Domestic duck/mallard (<i>Anas domesticus/platyrhynchos</i>)	1	5		1	6
Wild animals					
Roe deer (<i>Capreolus capreolus</i>)		1		1	2
Common wood pidgeon (<i>Columba palumbus</i>)	1				1
Passerines (Passeriformes)		4	3		7
Fishes					
Herring (<i>Clupea harengus</i>)		1454	160	14	1628
Codfish (Gadidae)	2	722	210	9	943
Flounder (Pleuronectidae)	3	55	30	1	89
Perch (<i>Perca fluviatilis</i>)	1	94	3	1	99
Cyprinids (Cyprinidae)		14	8	4	26
Garfish (<i>Belone belone</i>)		1	1	1	3
Gurnard (Triglidae)			2		2
Sculpin (Cottidae)		1			1
Eel (<i>Anguilla anguilla</i>)		4	9		13
Whitefish (Coregonus)		1			1
Pike (<i>Esox lucius</i>)					3

Table 4. NISP of animal bones from Fjelle, AD 1025-1800, amphibians, rodents and insectivores excluded (see Supplemental material)

Figure 4. Strontium isotopes ($^{87}\text{Sr}/^{86}\text{Sr}$) of cattle teeth from Fjelle in relation to rodents from Fjelle and nearby Lund and Uppåkra (Arcini 2018), used as baseline for local values. See Supplementary Information.



a good mixture of nutrients, mixed farming was an efficient way of resource utilization. Waste from arable farming could be used for fodder, whereas animals were needed to pull ploughs and for transport and to provide manure for the arable fields. The system also created an energy flow from extensive outland pastures (via dung) to infield cultivation (Emanuelsson 1988; Frandsen 1988, 14). Within this basic system, there was room for local adaptation and development.

In Fjellie the most obvious development was in crop composition. Barley was the principle crop in the initial phase of the village. From around AD 1200 both barley and rye were cultivated, and after a further expansion 1600-1800 rye eventually replaced barley as the dominating crop (Figure 5). The onset of rye cultivation in Fjellie coincided with the first appearance of corncockle and rye broom, which indicates that rye already from the beginning was a winter crop (sown in the autumn).

According to written documents, Fjellie and most other villages in the region practised a three-course rotation system, at least from the 17th century onwards (Dahl 1942). In this system, the infields were divided into three parts, each part used for growing (summer) barley, (winter) rye and for fallow, in three-year's cycles (Dahl 1942, 111). In Fjellie written documents indicate that a three-course rotation system was practised during the 16th century (Skansjö 2019), but a plausible interpretation based on the above mentioned first significant appearance of macro-fossil rye and winter-crop weeds is that some kind of rotation system was practised already during the 13th century, at least on parts of the infields.

There may have been non-agrarian reasons for the introduction of rye, like the want for leavened bread (Franzén 2004, 152-158), but it is important to note that the change also laid the foundation for a more sustainable agriculture: rye had less need for manure than barley (Leino 2017, 36); the introduction of a winter crop moved some of the work with sowing and tilling to the autumn, reducing the work load in the busy springtime (Pedersen and Widgren 2011); and systematic fallow mitigated soil degradation and favoured grazing (Leino 2017). Furthermore, rye's modest environmental and climatic demands may have been an advantage. Rye is tolerant to both summer

drought and harsh winters. The latter is particularly true for winter rye (Cappers and Neef 2012; Leino 2017; Myrdal 2011). Therefore, rye may have been climatically favoured both during the Medieval Warm Period and during the Little Ice Age, but in different ways.

Parallel to the cultivation of barley and rye, also oats were grown. The relative amount of oats in the archaeobotanical record was small but rather constant and did not decrease when rye cultivation was introduced and further expanded. It indicates that oats were grown in separate fields from rye and barley. The interpretation is supported by a map of Fjellie from 1775. It shows that oat fields at least at that time were separate from the barley-and-rye fields and had a more peripheral position (Skansjö 2019), probably because of oats' less need for manure (Leino 2017).

A comparison with other villages in south-western Scania and eastern Denmark reveals some common features (Figure 5): (1) barley was the major crop at least until 1600, (2) rye increased (generally after 1200) at the expense of barley, (3) oats show low and relatively constant values, and (3) bread wheat was generally rare. Kyrkheddinge is an exception, being the only village in the comparison with strong evidence of bread wheat cultivation. The similarities indicate that the major traits in Fjellie – with an introduction of a rotation system with rye and barley, and with oats grown in separate fields – may be valid for other villages as well. It should be noted that rye was introduced on some sites in southern Scandinavia already during the Late Iron Age, approximately from the 6th century onwards, and the weed flora indicates that it was grown as a winter crop from the 9th century onwards (Henriksen 2003; Grabowski 2011). However, this study shows that several villages started rye cultivation considerably later.

When it comes to livestock, Fjellie and other villages in the region showed only minor changes through time, which indicates a rather stable system of animal practice (Figure 6). In Fjellie a slight and steady increase of cattle was noticed from the 11th to the 17th century, whereas the general trend in the region was stable values during the 11-16th centuries (median 30 %), followed by an increase in the 17th-18th centuries (median 40 %) (Figure 6). For other parts of Sweden an increase

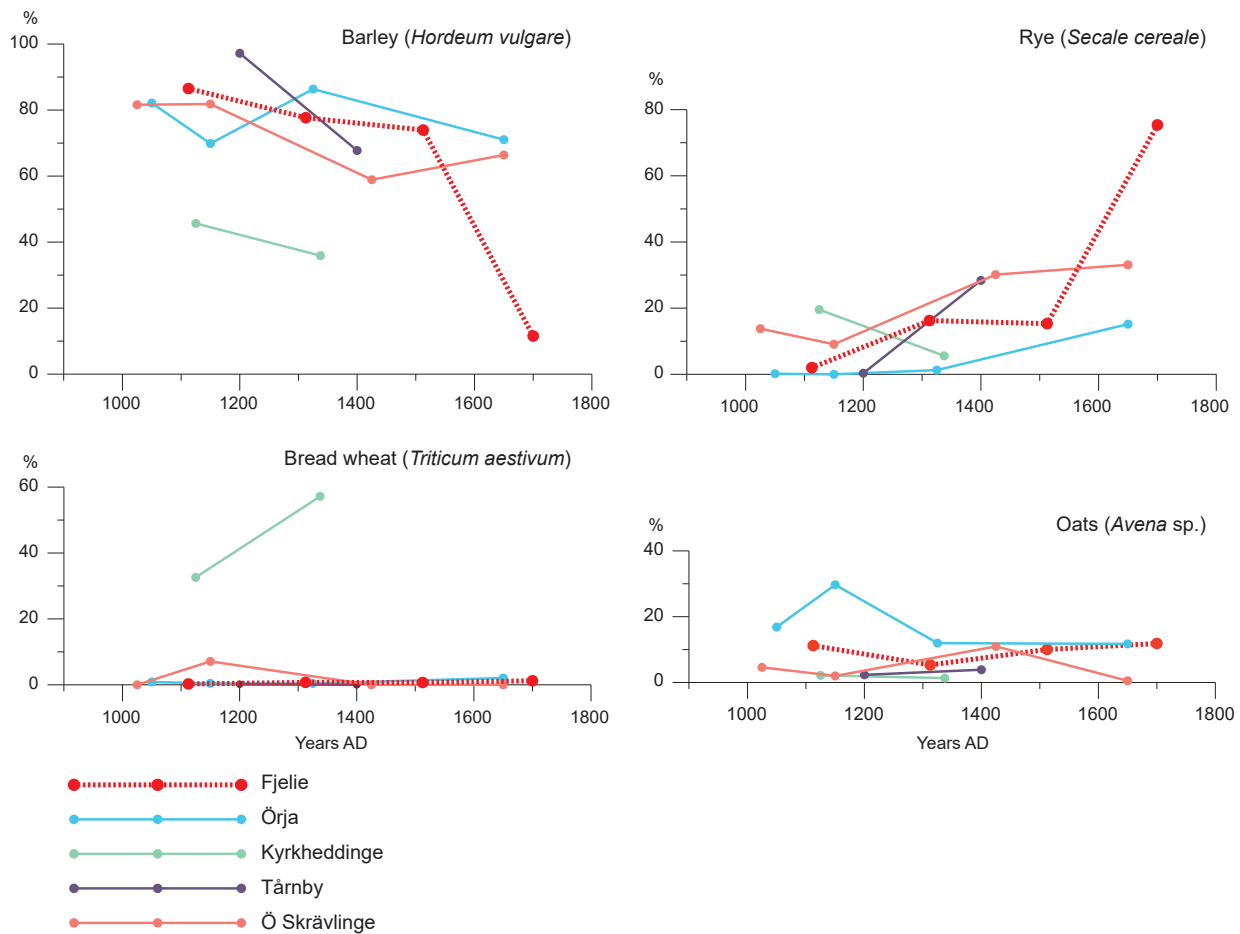


Figure 5. Frequency of main crops/cereals from Fjelie and four other villages in the Öresund region in relation to chronology. Mid-points of periods were used for the plot.

in cattle during the 17-18th centuries are also evident from historical sources (Dahlström 2006, 116-123). Since cattle produce more manure than other livestock (Börling et al. 2017, 18-19), the relative increase of cattle may reflect an increased focus on crop farming, which led to increased need for draught animals and manure.

Sex and age distribution of cattle in Fjelie showed a large proportion of cows and calves during the 13th-14th centuries. A similar distribution is found in other Medieval faunal assemblages in southern Scandinavia and indicates that cattle keeping was focused on dairy production (Vretemark 1997, 82-84, 175). The low frequency of adult animals may also indicate a surplus production of meat, where older, less productive cows were sent to Lund for slaughter. A more even age distribution during the 15th-16th centuries indicates a changed focus, now with kill-off aiming primarily to support local domestic consumption of meat within the village.

The frequency of pig and sheep in Fjelie and other villages in the region was rather constant through time, except for some minor fluctuations (Figure 6). The relatively great importance of pig breeding (pork production) in the region probably reflects a strong emphasis on crop farming, which produced waste usable to feed pigs. The steady occurrence of sheep may reflect a constant need for wool for clothing, besides providing milk and meat.

Horse showed rather stable and similar frequencies of 5-10 % in most villages, but with a slight decrease in the 16-18th centuries (Figure 6). Horse was used for transport and as draught animal in agriculture. Scania was known for its extensive horse breeding and in the 18th century one fifth of all horse in Sweden originated from this region (Bohman 2010, 38).

Since domestic fowl and goose could be raised on cereal and household waste and on small plots of grassland, the relative increase of poultry in

relation to livestock from the 11-12th to the 16-18th centuries could possibly reflect a decrease of available pastures for sheep and cattle. Written records from the 18-19th century show that goose keeping was common and widespread in Scania at that time (Bohman 2010, 40-41). In Fjellie and other villages, the zooarchaeological record shows higher frequency of goose in relation to domestic chicken during the 15th-18th centuries (median 80 %) than during earlier periods (median 42 %), which indicates that the major expansion of goose keeping started not until the Early-modern period, possibly driven by new culinary preferences.

Finds of eggshells of goose from the 13-14th centuries in Fjellie indicate that egg production was an important reason for keeping poultry. Eggshells are generally rare in the archaeological record due to their fragility and liability to dissolution in the soil (Serjeantson 2009, 169-170). The finds from Fjellie probably reflect good preservation conditions rather than unusually high consumption of

eggs. Besides meat and egg, geese also provided feather down and pens (Serjeantson 2009, 184).

In addition to the above-mentioned trends and changes in crops and animals, there was one period in Fjellie when animal husbandry may have gained in importance in relation to crop farming. The archaeological documentation revealed that one of the farmsteads (22) was uninhabited ca. 1400-1600, which indicates temporary abandonment of this farm in the wake of the Black Death and throughout the Late-medieval crisis. There are no archaeobotanical or zooarchaeological data from the abandoned farm, but on the other two farms (18 and 19), which both survived the crisis, archaeobotanical samples showed an unusually high proportion of grassland species during the same period. It may reflect increased handling of hay, and, hypothetically, that the abandoned farmstead was used for pasture or as hay meadow by neighbouring farms. Such a use of abandoned farms during the Late-medieval crisis are known from other parts of present-day Sweden (Lagerås 2016b).

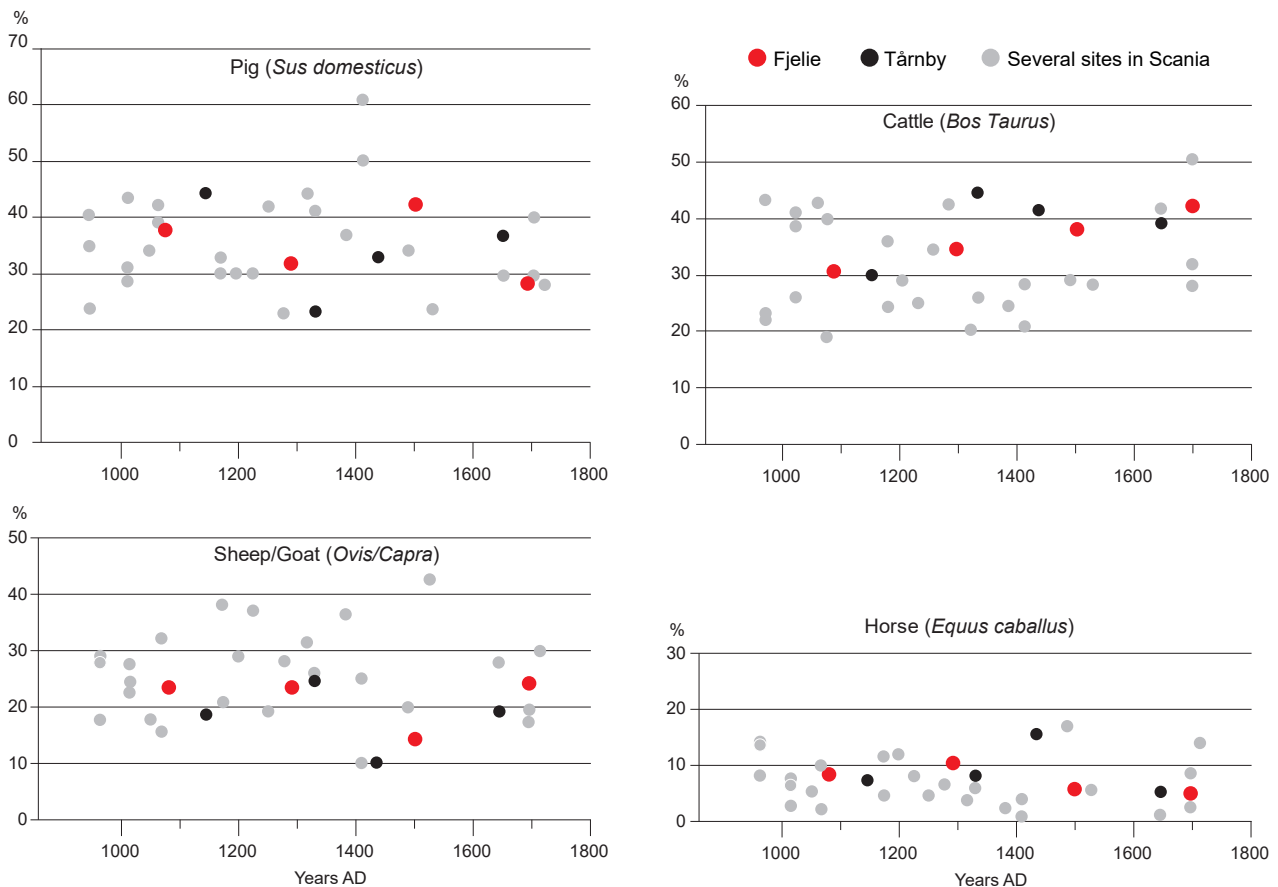


Figure 6. Frequency of animal bones (NISP) of livestock from Fjellie and 14 other villages in the Öresund region in relation to chronology.

Collaboration in the infields

By comparing archaeobotanical results from the different farmsteads in Fjellie, we can reveal similarities and differences within the village (Figure 7). For cereal grain, the material allows for comparison between farms 18 and 19 for the periods 1225-1425 and 1425-1600, and between farms 19 and 22 for 1600-1800. A striking result from this comparison is that the cereal grain composition from any period is similar between the farms. It indicates that the different farms within the village grew crops in the same proportions. When rye was introduced around 1200 it was introduced on more than one farm, and when it further increased around 1600 it did so on more than one farm. The two changes in crop composition obviously affected several farms – and hypothetically most farms – in the village.

According to numerous written records from Scania from the 17th century onwards the three-course rotation system was coordinated on village level (Dahl 1942). Even though each of the three fields were divided into numerous individually owned strips of land, all strips within one field were grown with the same crop (or went fallow) during any particular year. This coordinated open-field system saved the farmers from laborious fencing (no fences were needed within the fields) and also facilitated the organisation of post-harvest grazing in the fields (Gadd 2005, 64). It depended on collective decisions by the villagers, not only on cropping system, but also on the timing of sowing and harvest. In Fjellie and many other villages in densely settled areas, the three-course rotation was coordinated not only within the village, but also with neighbouring villages to reduce the need for fencing even further (Dahl 1968).

The coordinated arable farming in the infields was at the heart of the village system and in a way defined the pre-modern village. The archaeobotanical results from Fjellie indicate coordinated arable farming at least from around 1200, probably in a three-course rotation system that included rye and barley.

Arable land use and collaboration in the infields may also be interpreted from Medieval laws, in this case the Scanian Law. The earliest preserved copies of this law were written down around AD 1300,

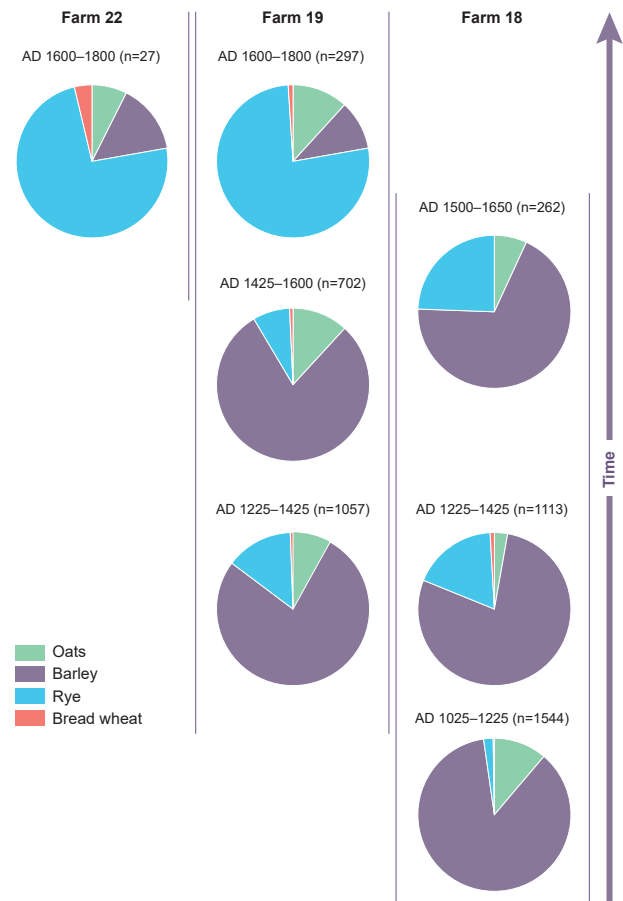


Figure 7. Frequency of main crops (cereals) at different farmsteads in Fjellie in relation to chronology.

but include passages that reflect older conditions, probably from the early 13th century (Hoff 1997, 19; Holmbäck and Wessén 1979). According to the law, rye and barley were the most important crops and they were cultivated after each other in the same fields, usually interpreted as a three-course rotation system (Holmbäck and Wessén 1979, 118). The law mentions the villager's obligations to contribute to common fencing, but also regulations on individually fenced strips of arable land (Hoff 1997, 188). It seems to reflect a transition period from individually fenced strips (but with coordinated crops and post-harvest grazing) to a fully developed open field system with no fences within the fields.

Pastures – a Common Pool Resource

Except for the rich occurrence of bones, animal husbandry is rather invisible in the archaeologi-

cal material. Evidence of byres is rare and usually ambiguous on Swedish investigation sites and very few tools are connected to animal husbandry. Still, Medieval laws and other written records show that animal husbandry was an important and integrated part of the village system. These sources also offer insights into how it was managed and organized.

In Scania livestock was kept outside during most of the year and indoors during the coldest parts of winter (Bohman 2010, 38-40). Outland pastures and infield fallow were grazed throughout the grazing season, and, in addition, mowed meadows and harvested fields were grazed in the autumn. Outland pastures were grazed by cattle, sheep, goats and horses, and the same animals also grazed fallow infields, together with smaller animals like geese and pigs. Pigs were probably kept close to the settlement and fed on household waste (including waste from threshing, malting, etc.), except during mast years, when pigs may have been brought to woodlands to feed on acorns (in Scania particularly from beech) (Bohman 2010, 40; Ericsson 2014, 239-241).

At Fjellie cattle were the most important animals closely followed by pig and then by sheep. A similar distribution between the species was common also in most other villages in the region, indicating a broad livestock base rather than specialization. The diversity of livestock on each farm guaranteed an efficient use of fodder and grazing resources.

In contrast to winter stalling, when animals were kept and cared for on the individual farmsteads, grazing during most parts of the year was a collective effort. Livestock grazed together in mixed herds on common pastures and fallow infields. The animals were individually owned and marked for identification (Hoff 1997, 215), but watched over by a common herder. In southern Scandinavia the herder was usually a professional herdsman hired by all the villagers together (Hoff 1997, 220; Myrdal 2011, 87).

Grazing commons in the pre-modern village may be defined as a Common Pool Resource (CPR) (Ostrom 1990). As such, it was characterised by collective-choice arrangements and the possibility for all appropriators (the villagers) to participate in the decision-making process. The system was labour saving, particularly by reducing the need for

fencing. But like in all CPRs, strict regulations, for instance on the number of animals (Hoff 1997, 213), were necessary to prevent over grazing and to guarantee a sustainable management. Indeed, the scarcity of pastures in the heavily cultivated regions of southern Scandinavia, put high demands on an effective system of regulations, monitoring and sanctions (Ostrom 1990, 90). A map from AD 1775, shows that the common pastures of Fjellie bordered those of seven neighbouring villages, with no fences in-between (Dahl 1968). It means that regulations were necessary, not only within the village but also between the villages, to guarantee a sustainable management of the grazing resources.

The grazing commons in Fjellie were situated approx. 1 km east of the village core, on older bedrock than both the infields and the village core. The slightly increased strontium values in several cattle teeth in comparison to local rodents reflects the use of these grazing commons for cattle grazing, as expected. However, two cattle teeth (dated to 1425-1600 and 1600-1750, respectively) showed distinctly higher strontium values, indicating an origin in more remote areas with much older bedrock. Such bedrock is found in the uplands of central and northern Scania and further north. Possibly, Fjellie was engaged in a system of transhumance or long-distance herding. An alternative interpretation may be that the high strontium values represent livestock trading and animals bought at livestock markets to avoid inbreeding and to improve the local cattle stock.

Farm-specific production and consumption

In addition to collective and coordinated practices, like infield cultivation, livestock herding and fencing, there seem to have been certain spheres of the village economy that allowed for diversity and specialization by the individual farms. One of these spheres was vegetable gardening and similar small-scale cultivation. Studies of old maps from southern Sweden have shown that vegetable gardening was widespread in the countryside at least from the 18th century onwards, and usually practised on small plots close to the individual farmsteads (Hallgren 2016). For older periods the picture is

less clear, but archaeobotanical records from Fjellie and some other villages prove vegetable gardening already during the Middle Ages (cf. Lagerås 2013). In Fjellie the identification of legumes and root crops, like pea, faba bean and turnip, and spices and medicinal plants, like black mustard, motherwort, dill, caraway, etc., reflects garden cultivation, at least from the 13th century onwards (Table 3). In addition, there were cultivation layers close to the house remains that were interpreted as plots for vegetable gardening. This small-scale cultivation may have been an important complement to cereal cropping, and since it was individually managed by the different farmsteads, it was more flexible and enabled diversity and variation according to different preferences, taste and needs. Also, gathering of berries and nuts and catching of small birds were probably carried out by the individual farmsteads.

Fishing by the villagers may have been a collective effort, but there are reasons to assume that it was rather organized on farm level. Fisherman as a profession is not known from Medieval laws in Scandinavia and the fishing in Öresund was during the Middle Ages pursued by farmers and townsmen (Cardell 2005, 291; Eriksson 1980, 26). The fish-bone species composition at two farms in Fjellie indicated different consumption patterns – one farm (18) showed a high proportion of herring whereas the other (19) had more cod and perch (Figure 8). Since there was an established large-scale market for salted herring in southern Scandinavia during the Middle Ages (Cardell 2005, 290-291; Ersgård 1988), most of the herring consumed on farm 18 may have been bought, for instance in nearby Lund or at the fish-market in Skanör-Falsterbo, whereas the cod and perch on farm 19 possibly reflect household fishing. Similarly, in village Örja, the fish-bone material indicated farm-specific specialization (Cardell 2013, 199-200).

When it comes to animal husbandry, herding was centralized and the number of animals that grazed the common pastures was regulated. Still, between-farm variation in the faunal remains from Fjellie indicated that there may have been room for differences in what type of animals each farm focused on. One farm (19) showed a relatively high frequency of cattle, horse, and goose, whereas another (18) seemed to have depended more on sheep, pig, and chicken (Figure 9). It may re-

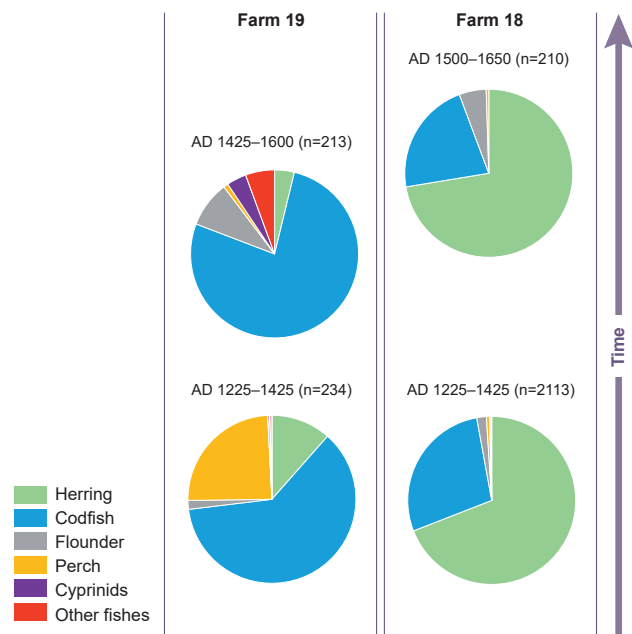


Figure 8. Frequency of different taxa of fish based on NISP at two farmsteads in Fjellie in relation to chronology.

fect socio-economic differences, varying facilities for winter stalling or different demands. During 1225-1425, farmstead 18 consisted of only one building, whereas farmstead 19 consisted of at least two buildings – a dwelling house and probably a separate stable for horse and cattle. In later periods farmstead 19 consisted of more buildings than farmstead 18. Between-farm variation in the proportion of livestock has been noted before in villages where several contemporary farms have been excavated, such as Örja and Bunkeflo (Cardell 2009, 551; 2013, 196).

We may also expect specialisation in the processing of food products. In village Örja, one of the documented farms had specialised in fish processing, probably smoking (Schmidt Sabo 2013, 118-122), while in Fjellie, finds of sprouted barley grain, bog-myrtle and hop indicated that one of the farms (19) specialised in beer brewing. This farm also had oven structures that tentatively may have been connected to the malting process. Even though all households in the village probably consumed beer, brewing may have been confined to specific farms. Most studies on beer brewing in Scandinavia are from towns, and very little is known about brewing in rural households (Heimdahl 2014).

Production and specialisation at individual farms may also have been influenced by demands

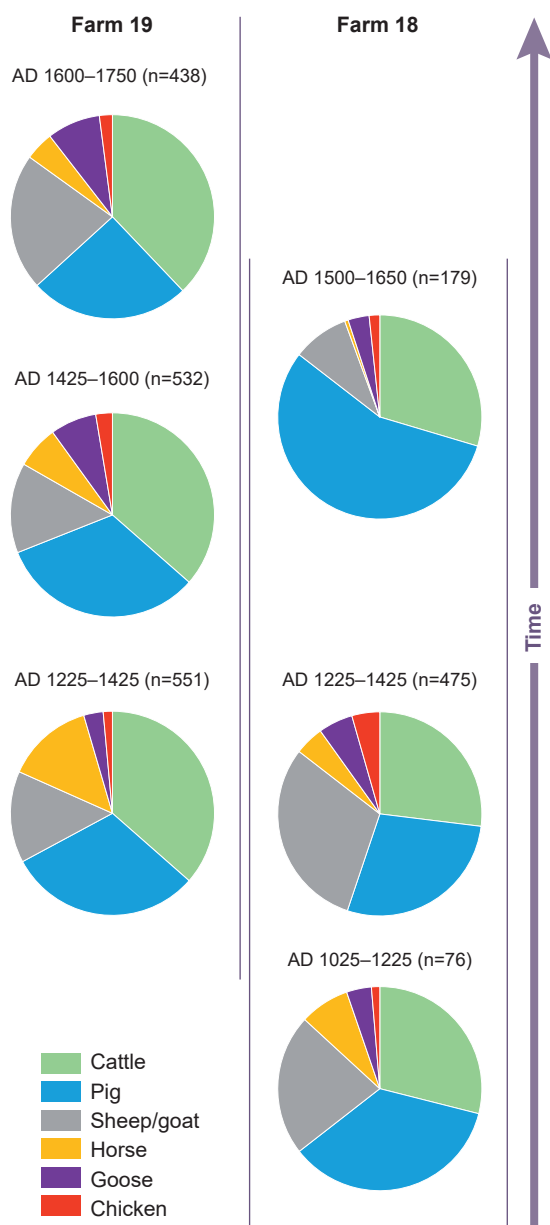


Figure 9. Frequency of livestock and poultry based on NISP at two farmsteads in Fjelle in relation to chronology.

by the landowners. In Fjelle the landowners during the Middle Ages were the nobility and the church, but the ownership of separate farms is unknown. According to written sources, farms that belonged to the cathedral chapter of Lund had to pay a yearly tax called *teja*, specified to include barley, lamb, chicken, and goose (Skansjö 2019, 211). Although not possible to prove at present, such demands by landowners may have influenced the farm-specific production.

Agrarian resilience

In the study of Fjelle we have identified several different types of diversity that characterised land-use and organisation and which may have contributed to agrarian resilience. Fjelle was in many respects a typical village for the fertile plains of southern Scandinavia and the conclusions below may be valid to villages in general in this region, even though details may differ.

Firstly, agriculture was based on a combination of many different species of cultivated plants and animals. Among plants, the most important ones were barley and rye, followed by oats. Because of its small climatic demands the latter was an important emergency crop when other cereals failed and as fodder for animals (Bakels 2012; Bohman 2010, 37–38). In addition, several non-cereal plants were grown, like legumes and root crops, spices and medicinal plants. Among livestock, most important were cattle, closely followed by pig and a slightly lower occurrence of sheep, as well as horse and poultry, particularly goose and chicken. The combination of different plants and animals, with different demands for soil, climate and fodder, meant an efficient way of utilising the resources. The diversity was also a way to reduce vulnerability to bad weather and to mitigate the effects of crop blights and infectious diseases among plants and animals. The combination of summer crops (barley and oats) and winter crops (rye) also fits well with such a risk minimising strategy. In addition, non-agricultural activities, particularly fishing, reduced vulnerability and weather dependency even further.

Secondly, agriculture was based on (and shaped) a diversity of environments and biotopes, which together may be referred to as the village's ecosystem territory (Lennartsson et al. 1998). Even though the entire landscape was affected by land use, i.e. a domesticated landscape (Eriksson et al. 2018), it typically ranged from intensively managed land close by the settlement to more extensively managed land in the periphery. In Fjelle, from centre to periphery, there was a range from garden cultivation, manured barley and rye fields, via oat fields (probably less manured due to their peripheral setting) and mowed meadows, to outland grazing commons. If also fishing by the coast (5 km away)

and long-distance grazing in remote uplands or cattle trading (as indicated by strontium analysis of cattle) are considered, the ecosystem territory of the village extended far beyond the village borders. From an ecological point of view, it was a range from completely manmade biotopes with cultivated introduced plants on manured, weeded and tilled soils, via semi-natural grasslands to natural fishing grounds. The semi-natural grasslands were shaped by grazing but still dominated by native plant species and natural soils. Hence, there was a gradient from much to less human impact on the environment from centre to periphery.

In terms of production, this range also represents a scale from the highly productive (in terms of production per acre) and labour-intensive land use of gardens and arable fields to the less productive and less labour demanding herding of livestock and land use of grazing commons. This broad spectrum of labour intensity offered flexibility, which may have been particularly valuable in periods of population fluctuation or just local changes in household size. Other studies have shown that the importance of animal husbandry in relation to crop farming increased in the wake of the Black Death of the 14th century, probably due to shortage of labour (Lagerås 2016b; Myrdal 2006). Similarly, the balance between crop farming and animal husbandry within village agriculture may have shifted due to war, plague outbreaks and other crises. In Fjellie, one farm (22) was abandoned c. 1400-1600, and from this period grassland species were common in the archaeobotanical record of the surviving farms (18 and 19), indicating increased importance of animal husbandry during the Late-medieval crisis.

Village agriculture showed diversity also when it came to the social organisation of land use, characterised by a range from collective (organised on village level) to individual (organised on farm level). Collective land use may be exemplified by the utilisation of grazing commons and the grazing on infield fallow. Arable farming was by large a collective effort, since choice of crops and time for sowing and harvest had to be coordinated on village level, even though strips of land were individually owned and managed. The same is true for infield meadows. Also fencing was probably organised on village level. Spheres for individual

decisions on farm level were garden cultivation, processing (like beer brewing) and non-agrarian contributions to the economy, particularly fishing. Differences in animal husbandry noticed between farms probably reflect variations in availability of stables and fodder for animals during winter, depending on different socio-economic conditions and sizes of the households. Like the range from labour-intensive to extensive land use, the range from collective to individual probably created flexibility in times of fluctuating population and household sizes.

To sum up, even though the long-lived settlement structure of the Medieval and Early-modern village seems to indicate rigidity, the study of Fjellie showed that village agriculture was characterised by diversity in several different ways. We identified diversity in crops and animals, biotopes, labour intensity and social organisation. The combination of different crops and animals and the dependency on several different biotopes reduced vulnerability to bad weather, crop blights and animal diseases, and the range from highly productive and labour-intensive land use to extensive land use, and probably also the combination of individual and collective, made the system resilient to fluctuations in population. This multiple diversity within the agricultural system (and complemented by fishing) seems to have been a strategy to minimize risks, both from low-order crises like temporary harvest failures and from major crises like the Black Death and war. Diversity, therefore, may have been a key factor behind the resilience of the Medieval and Early-modern village, both as an agricultural system and as a social organisation.

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Supplemental material

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