Ethnobotany of einkorn and emmer in Romania and Slovakia: towards interpretation of archaeological evidence

Etnobotanika jednozrnky a dvouzrnky v Rumunsku a na Slovensku: příspěvek k interpretaci archeologických nálezů

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The study aims to stimulate discussions about farming in the past and archaeological interpretation of archaeobotanical data using recently acquired unique ethnographical evidence. The paper is divided into two parts.
The first part presents aspects of disappearing traditional agriculture in geographically similar sub-mountainous regions of Romania and central and northern Slovakia as observed during our ethnographic and ethnobotanic surveys. Farming practices and yields of mainly einkorn (Triticum monococcum), production of other cereal crops, some aspects of animal husbandry, as well as extension and division of agricultural land are described. In addition, productive attributes of land under different climatic and edaphic conditions managed by means of traditional farming practices were studied.
In the second part of the paper, results of our surveys are compared with some archaeological data on farming practices from prehistory to medieval period. Our results are confronted with current archaeological knowledge about a wide variety of aspects of prehistoric and early medieval farming in Central Europe.
einkorn, tillage, yields, traditional agriculture, prehistoric agriculture, Romania, Slovakia

V první části článek prezentuje některé prvky mizejícího tradičního zemědělství v geograficky příbuzných podhorských regionech rumunského Sedmihradska a středního a severního Slovenska, získané při etnografickém a etnobotanickém výzkumu. Patří sem zejména pěstování pšenice jednozrnky (Triticum monococcum), dvouzrnky a jiných obilnin, chov domácích zvířat, způsoby obdělávaní polí, rozloha a členění zemědělsky využívané krajiny a její produkční schopnosti při rozdílných klimatických a půdních podmínkách. Ukázalo se, že etnografická pozorování mají velký význam pro pochopení fungování zaniklých zemědělských forem. Proto jsou ve druhé části studie výsledky porovnány s dosavadními poznatky, týkajícími se diskutovaných aspektů pravěkého a středověkého zemědělství střední Evropy.
jednozrnka, obdělávání půdy, výnosy obilnin, tradiční zemědělství, pravěké zemědělství, Rumunsko, Slovensko

1. Introduction

For at least the last seven thousand years, people in Central Europe have depended upon the results of their farming activities. Prior to the industrial revolution, farming was the agent that transformed and shaped the landscape. Despite this, ancient farming has never been a main focus of study both in Czech and Slovak archaeological communities, with the exception of studies of *M. Beranová* (mostly *1980*; *2005a*; *2006*), *F. Kühn (1984*; *1990*; *1991)* and *E. Hajnalová* (*1989a*; *1999*; *1993*; *2001*).

Detailed investigations into farming, agriculture and herding practices have only received attention in the last few decades. Through the recent development and acceptance of environmental archaeology, the presence of archaeobotanists and archaeozoologists at archaeological excavations is becoming routine, and information on temporal and spatial differences in crop spectra and farming practices is starting to accumulate (*Dreslerová 2008*).

The most well-known discoveries are an assortment of cultivated crops and farming tools and implements mostly from late prehistoric, protohistoric and early medieval periods. Actualistic experiments with reconstructed farming equipment (*Beranová 1993*) and the cultivation of ancient cereals are very rare (*Beranová 1987*). In contrast to north-western Europe, remnants of prehistoric field systems are virtually non existent in the Czech Republic and Slovakia. Evidence of ploughing in the form of plough/ard marks and information on manuring or stabling of animals from phosphate analyses of floors of potentional stables and pens is absent, except for one example from a house floor at the oppidum of Závist (*Drda — Rybová 2008*, 69).

Due to the industrial development of agriculture ethnographic studies usable for archaeological modeling of prehistoric/early historic farming are very modest (cf. *Kunz 2004*; *Markuš 1975*; *Slavkovský 2002*). The majority of ethnographic studies used in archaeological modelling derive from the Mediterranean or the Middle East, e.g. from areas that are environmentally and culturally distant from the Central European perspective (cf. *Peña-Chocarro 1999*; *Palmer 1998*; *Jones 1987*; *Hillman 1984*).

In the first part this paper summarizes the results of ethnobotanic surveys and observations of surviving remnants of traditional farming communities in Romania and Slovakia undertaken between 2004 and 2008. It aims to show that, even in those (non-exotic) countries of Central and South-eastern Europe, remnants of traditional farming persists that are worth of documentation and have possible archaeological implications. In this study, the term "traditional" is used in the sense that the practices described, many of which are in the process of dissappearing, are those carried out by contemporary farmers who use a low level of mechanised farming equipment that includes hand-harvesting methods (cf. *Palmer 1998*, 129).[1]

In the second part of the study, possible archaeological implications of obtained information and results for reconstruction of prehistoric agriculture are drawn.

1.1. Why ethnobotany (in an archaeological periodical)?

Ethnographic and ethnobotanical observations, when cautiously selected, have been successfully applied to archaeology (e.g. *Hillman 1984*; *Jones 1987*; *Halstead 1995*). Archaeological reconstructions of past agricultural practices, cultivation regimes, and subsistence strategies rely heavily on the ecological characteristics of arable weeds.[2] As some plants have been observed to behave differently in different climates, it has long ago been advised to use local ecological studies (*Wasylikowa 1984*). Relevant ecological information on arable weeds in the Carpathian basin (a region on the fringes of continental, mediterranean and oceanic zones) is almost nonexistent.[3] Thus, the primary aim of our ethnobotanic fieldwork in Romania was to document responses of weeds to sowing times and weeding of einkorn (*Triticum monococcum*) cultivated under surviving traditional farming practices in the foothills of the Carpathians in Transylvania. Originating from climatically, culturally and environmentally similar regions those were seen as an excellent source of relevant floristic, ecological and ethnographic data for studying Central European archaeobotanical assemblages.[4] The results of this part of our fieldwork are touched on here, but are dealt with in more detail elsewhere (*Eliáš jun. — Hajnalová — Pažinová 2007*; *Hajnalová — Eliáš in prep.*). During later stages of the fieldwork we have collected a variety of other data highly useful for archaeological reasoning and modelling, and in this paper, we focus on presenting those results.

When preparing for the fieldwork in Slovakia, we collected extensive information on traditional cultivation practices and characteristics of emmer in several microregions of Western Carpathians. As its cultivation, still practiced in the early 1980's, is today abandoned in those areas, we decided to present here the bibliographical summary of Czech and Slovak authors, which might not be known to the international archaeobotanical community.

1.2. Why focus on einkorn and emmer

From a diverse package of cereals domesticated in or that spread through the Near East and that are also present in the Balkan Neolithic[5], farmers of the earliest Neolithic (early LBK) in Slovakia, Moravia and Bohemia cultivated almost exclusively einkorn and emmer. Free-threshing wheat and naked and hulled barley only appeared in the Middle Neolithic and Eneolithic respectively. According to the last archaeobotanical evaluations it seems that in Bohemia emmer had been the most important crop during the whole prehistory (*Hajnalová 2007*; *Kočár — Dreslerová 2010 this volume*).[6]

Einkorn, emmer, as well as spelt (*Triticum spelta*) are hulled (syn. glume) wheats where robust glumes surround the grain. To separate the grain from the glumes, additional steps in processing are necessary: parching by fire, pounding in mortars, repetitive winnowing and sieving. In contrast, ("modern") bread and macaroni wheats are free-threshing, which means that their grain falls out of glumes already at threshing. The advantage of hulled wheats is that robust glumes protect the grain more efficently against pests in the fields (birds and rodents), safeguard it against insects and fungal attacks during storage, thus making them more vigorous than free-threshing wheats (*Nesbitt — Samuel 1996*).[7]

Thanks to their vigorosity and adaptability to harsher climates glume wheats survived in cultivation in the sub- and mountainous areas of Europe, until the beginning of 20th century (cf. *Zohary — Hopf 2000*, 36, 44–45). A common feature of einkorn and emmer is that their cultivation was largely abandoned and is currently underutilized. However, they were able to survive for centuries in the subsistence farming systems of Europe and the Middle East and, as such, were never subject to modern plant breeding programmes (*Grausgruber et*

[1] Fieldworks in 2004, 2006, 2007 and 2008 were in frame of national VEGA grants and in 2006 and 2007 of ESF international EARTH programme.

[2] E.g. tolerance to light, soil moisture, soil reaction, nitrogen, tillage, and presence of other plants.

[3] The compact study of *A. Jurko* (*1990*) contains some, but not all necessary information.

[4] Especially for geographical regions and/or periods of prehistory, with a more continental climate.

[5] Comprising of einkorn (*Triticum monococcum*), emmer (*T. dicoccum*), spelt (*T. spelta*), free-threshing wheats (*T. aestivum* s.l., *T. durum*), naked and hulled barley (*Hordeum vulgare* s.l.), millet (*Panicum miliaceum*), rye (*Secale cereale*) and oat (*Avena* sp.).

[6] During later prehistory, emmer and spelt gradually become more important than einkorn. Free-threshing wheats *(T. aestivum* s.l.) appear to have altered cultivation in more favourable climatic regions of the eastern part of Central Europe since the Bronze Age, but predominanly since the La Tène period. Millet seems to have been established as a crop already in the Eneolithic, with increasing abundance in the Bronze Age. In the hilly regions of the Carpathians, free-threshing wheat does not play a significant role before the end of the Roman period or early Middle Ages, when it is accompanied by rye and oat.

[7] On the other hand, the disadvantage is that einkorn has only one grain per spiklet in comparison to emmer (two), spelt (two to three) and bread/macaroni wheat with two to five grains per spikelet.

al. 2004). Because of the absence of modifications from modern plant breeding, information on present einkorn cultivation in contemporary Central Europe is (and not only for archaeology) extremely valuable.

Today, **einkorn** production is only found in small isolated regions in France, India, Italy (Apulia region and mountainous areas of Daunian Apenine), Turkey and former Yugoslavia (*Troccolli — Codianni 2005*, 294). Our discovery of einkorn cultivation in Romania adds another point on the map for its current use.

Historical sources document einkorn cultivation in Romania back to the 15th century (*Péntek — Szabó 1981*, 264). *M. Markuš* (*1975*, 37) finds einkorn cultivation in several areas in Romania as late as 1937–1946. The local name is "alac" or "alakor", a name whose origin is a topic of debate. Hungarian scientists suggest that the name comes from an unknown, now extinct European nation. Romanian scientists, on the other hand, believe that einkorn was brought by Roman legionary troops on their way from Spain to ancient Dacia. From the descendants of Dacia-Romanians this word was adopted in Hungarian and Germanic languages (*Markuš 1975*, 37).

In the study area of Transylvania, einkorn cultivation is closely related to a long-established, but rapidly diminishing, straw hat-making tradition (*Hajnalová — Eliáš jun. — Pažinová 2007*). It is likely that the einkorn variety cultivated today is an old local land-race; we have not found any evidence for an interruption in its cultivation, not even during the period of collectivization under communism. Locally cultivated einkorn has thin, up to 60–130(150) cm long straw of very pale colour, for which it is highly valued in hat-making (*Fig. 1*). Within living memory, einkorn grain was also used for making bread and valued for its specific taste. Einkorn is still prized as a good poultry feed and believed to be the cause of high quality eggs with delicious egg-yolks.

Despite the general assumption that **emmer** cultivation disappeared during the High Middle Ages it survived into modern times. The continuity of emmer cultivation since prehistory to modern times in the western Carpathians is assumed by *Z. Tempír* (*1976*, 31). He sees support for this in the exclusive presence of Turano-Balkan forms in all modern seed assemblages. Other support, according to Tempír, can be seen in the survival of relict ancient wheats on marginal agricultural areas or those difficult to access. A recent genetic study (*Švec et al. 2005*) of European emmer accessions are in support of his assumptions.[8]

In Slovakia, emmer was "hidden" under the colloquial names "tenkeľ or gengel" (*Tempír 1973*; *1976*)[9]. *M. Markuš* (*1975*) lists historical sources which claim the use of emmer for bread, but emmer has been reported also as very good fodder for livestock, pigs and poultry. Until recently (mid/late 20th century), it has been cultivated and used for special type of gruel (judaš) and for soups, but above all, dehusked emmer grain was the ingredient of a regional speciality – black pudding sausage. Emmer was considered to have the best qualities for producing this sausage and that perhaps was the reason for its survival in local cultivation (*Hammer et al. 1981*).

Fig. 1. *Romania, Dobó. Garden of Ida Tóth. Collection of floristic data. The average einkorn height at this small plot near the stream is 130 cm. Photo: Č. Čišecký. —* ***Obr. 1.*** *Rumunsko, Dobó. Zahrada paní I. Tóth. Sběr floristických dat. Průměrná výška jednozrnky na tomto malém poli u potoka je 130 cm. Foto: Č. Čišecký.*

2. Romania

2.1. Area under study

The area under study consists of two small rural micro-regions located in the foothills of the Harghita Mountains, a range in the Inner Carpathians submountainous zone in the Transylvanian part of Romania. The first micro-region contains the villages of Dobó (Dobeni) and Béta (Beta), close to the town of Székelyudvarhely (Odorheiu), and the second micro-region contains the villages of Bözöd (Bezid), Körispatak (Crişeni), Csöb (Cibu), and Ráva (Rava) situated around Lake Bözöd. The region is crossed by the border between the two counties of Harghita and Maros. The four larger towns of Segesvár (Sighisoara), Székelyudvarhely (Odorheiu), Szováta (Sovata) and Marosvásarhely (Targu - Mures) delimit the study area (*Fig. 2, 3*)[10]. The altitude of the villages and fields under study ranges from 363 to 609 m a.s.l. The highest point in the first micro-region is 725 m a.s.l. (Lés - Hegy) and 731 m a.s.l. in the second one (Magos - Tető). Meadows, pastures and

[8] "The analyses based on DNA polymorphism show that Slovak relic *dicoccon* wheats are related to Yugoslavian emmer and belong to the supracon variety *asiaticum*, convariety *serbicum*. All other European accessions, together with accessions from Morocco, India and Israel, were included in the second very clearly separated cluster of genotypes which can be classified in the supraconvariety *dicoccon*" (*Švec et al. 2005*, 205).

[9] In 1770 only in Zvolen district 272.8 tons of emmer was harvested (*Horváth 1962*, 37).

[10] The first names are Hungarian, with the names in brackets the Romanian equivalent. In this article, we use the Hungarian names as these villages are home to a Hungarian speaking minority and the population almost entirely ethnic Hungarians.

Fig. 2. *Romania. Area under study in Transylvania. —* ***Obr. 2.*** *Rumunsko, studovaná oblast v Transylvánii.*

forests are exploited up to 700 m a.s.l. Mean annual temperatures range between 6 and 8 °C and annual rainfall is 600–700 mm. According to local municipal officials in Mugeni and Etéd, the dominant soil types are cambisols, orthic luvisols and regosols. Enclaves of deciduous oak woodlands, mostly of *Quercus petraea*, are found in the lower altitudes in both micro-regions at 300–600 m; higher altitudes over 600 m and northern slopes at lower altitudes are covered by beech (*Fagus sylvatica*) woodland. In most cases there is a strong anthropogenic impact on these woodlands. The area around Bözöd has been settled since the Neolithic period (*RAN 2009*).[11] The second micro-region of Béta and Dobó has either not been studied archaeologically, because there is no published archaeological data on it, or it was unsettled prior to the 16th century AD. We think the latter is unlikely because the neighbouring cadastre of Mugeni has been settled since the Eneolithic period (*RAN 2009*)[12]. The whole study area, with its mostly Hungarian speaking minority, has been part of the Kingdom of Hungary (1003–1526), the Ottoman Empire (1566–1699) and, since 1867, part of the Austro-Hungarian Empire. In 1920, it was proclaimed part of Hungary but later, in 1947, it was ceded to Romania.

The study area has been a traditional agricultural landscape for centuries[13]. It consists of a balanced tapestry of fields, meadows, pastures and forests; however, today due to abandonement of traditional way of life, its character is rapidly changing. Fields are turned to fallow and species rich meadow and pasture communities deteriorate and vanish under the pressure of expansive (often invasive) plant taxa and, consequently, large areas of the landscape are becoming overgrown by forest.

2.2. Methods

Floristic and ecological data on the arable flora and information on arable practices was collected for 94 fields (148 relève). Out of those, 49 fields (98 relève) were of einkorn and the rest were of bread wheat, rye, barley, oat and *Triticale*. Sampling took place in three seasons (2005, 2006 and 2008)[14]. In five of the einkorn fields hand harvesting techniques (by sickle at four and by scythe at one) were photographed. During the last season, these data were supplemented by information on husbandry gained from interviewing 30 farmers who still grow einkorn. The questions concerned:

1. Cereal (mostly einkorn) crop cultivation – sowing times, sowing and harvest rates, soil preparation techniques, time and work force needed, weeding and soil improvement (organic manure, fallowing) strategies, processing techniques, gender related crop processing activities, use of processing products and by-products, and the production of textile and oil crops, such as flax and hemp and their traditional use.
2. The distribution of fields, meadows, and cattle and sheep pastures in space expressed in terms of the walking distance from home.
3. Animal husbandry – household stock size and composition, size of pasture areas, securing winter fodder supplies (hay production, chaff and straw feed, leafy-hay gathering), consumption and distribution of primary (meat) and secondary animal products (milk, milk products and wool); bread and beer production and consumption.
4. Household size and organization – number of people and the size of the land-holding, sources of income other than agriculture.

All farmers questioned are considered "poor or middle-class" within the studied village communities. Almost all of the respondents were over 60 years of age.[15]

2.3. Agricultural system

The relative isolation of the region in the mountainous terrain difficult to access enabled traditional agriculture to survive. After fall of the Iron Curtain, the land, but not agricultural machinery, was returned to private owners. Thus, today the surviving small-scale farmers use almost exclusively simple tools, such as scythes, sickles, spades and hoes, and animal traction or human labour.

A fixed system of crop rotation consisting of winter crop followed by a root crop and then a spring crop (alternatively fodder plants or vegetable) is used. Fallow, sometimes with forage crop (alfalfa), is also a part of the crop rotation. The length of the fallow today varies and can be anywhere from one to three to five years or more. It is applied mostly when the farmer does not have the capacity to till the land and/or has got sufficient of arable land under cultivation for his needs.

11 Eneolithic sites have been found in the cadastres of Körispatak and Ráva, sites from Bronze Age in Körispatak, Late Iron Age and Roman period in Bözöd and Körispatak, and Early Medieval Period (8th century AD) in Bözöd.

12 Archaeological finds in the Mugeni cadastre are from the Eneolithic, Bronze Age, Hallstatt, Roman and Migration period, as well as Middle Ages.

13 The development of estate economies and the ecology from pre World War II to the early 1970's for this region is well described in *S. G. Randall* (*1975*).

14 For used method of botanical sampling see *Eliáš jun. — Hajnalová — Pažinová 2007*.

15 The productive-age generation has either left the region or found an alternative employment.

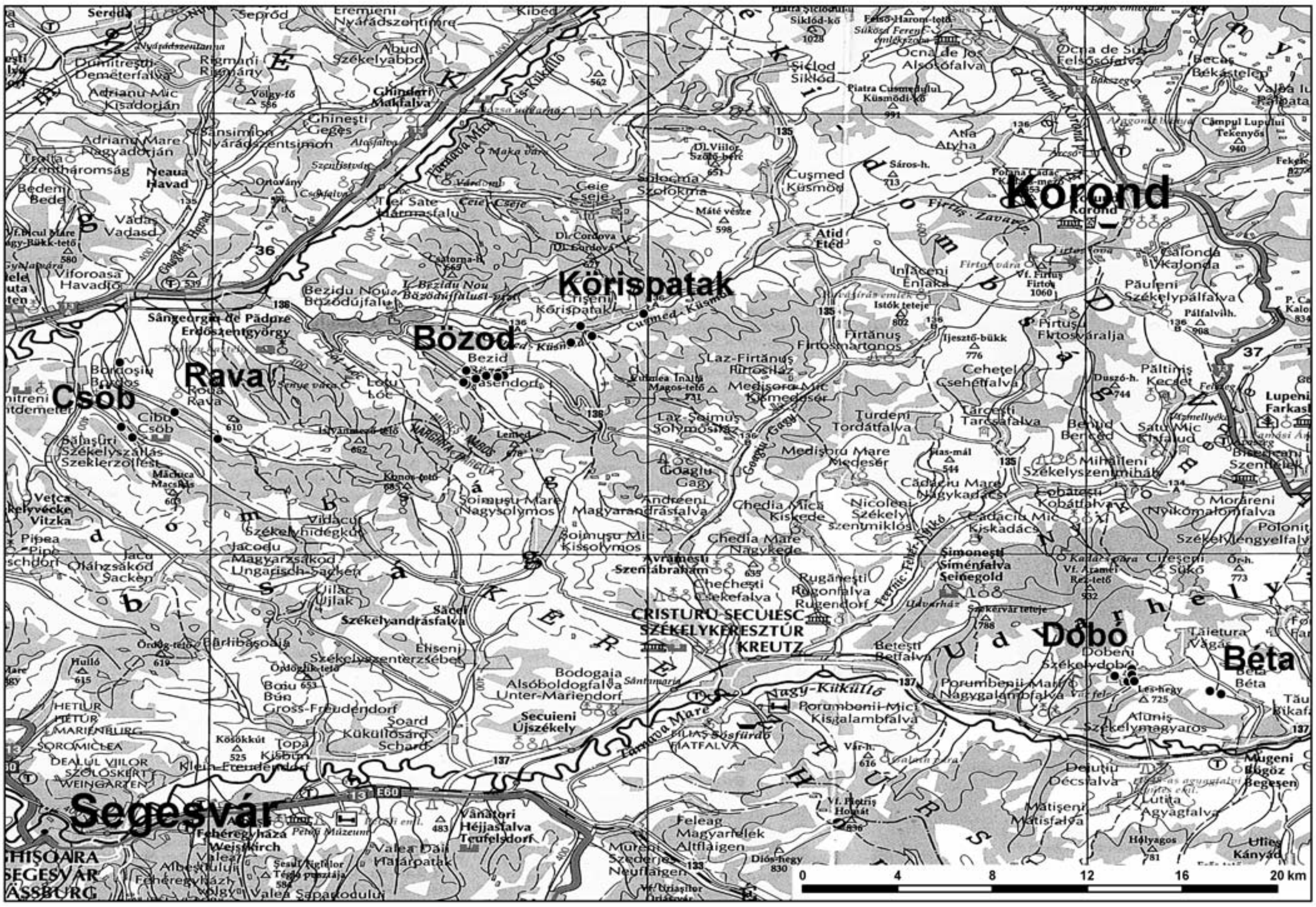

Fig. 3. Romania. Black dots represent einkorn fields studied in 2006. Map source: Tara Secuilor 1 : 250000. Kárpátia Téreképműhely Kft. Cartographia Kft. 1998. ISBN 963 03 6160. — Obr. 3. Rumunsko. Černé body označují místa jednozrnkových polí studovaných v roce 2006.

2.4. Fields

The fields are located as close to the villages (or a cluster of households) as possible. The vast majority of ploughed fields are within no more than half an hour walking distance (or by an animal drawn cart) from home. Fields are rarely located further away and this only generally occurs when a family member (bride or groom) comes from a nearby village and owns or inherits fields from there. Any distance greater than half an hour walking distance is considered uneconomic, with more distant plots exploited as meadows or pastures.

Fields are arranged in long narrow strips (*Fig. 4*). Sometimes, the whole strip is a single crop, in other cases it is divided to several smaller rectangle plots with different crops (*Fig. 5*). This arrangement of land is the result either of an open-field system tradition or/and the system of partible inheritance in which "children who reach adulthood and marry take with them equal portions of parental estate – reducing the total parcel of land remaining with the family of origin" (cf. *Randall 1975*, 278–279).

Field (plot) size varies from one to a maximum of twenty ares (a)[16]. The largest sampled field was of bread wheat and measured 15 ares. The difference in size of the sampled plots (not only einkorn) in the two microregions is shown in *Fig. 6*[17].

The average size of fields (200–400 m^2) is comparable with the average size of ancient fields (see below). It may reflect the workforce needed to complete the work cycle (soil tillage, planting, covering the seed) of a plot in a day.

There are no field boundaries, in the sense of stone walls, wooden fences, or hedges, between or around the fields. The only case of field protection, shown in *Fig. 7*, was to prevent trampling by cattle on their way to and from pasture. Interestingly and similar to other fields, this field was otherwise unprotected and thus easily accessible to wild animals. The abundance of deer, wild boar and brown bear in the region causes severe crop losses every year. Hunting is strictly regulated to very small numbers and is only the privilege of a few registered professional hunters; therefore, some farmers protect their fields by placing kennels and dogs at the field edges.

[16] *Are / ares* (*a*) is a traditional unit of area equal to 100 square meters. One are is approximately 1076.3910 square feet, 119.5990 square yards, or 0.02471 acre.

[17] The smaller size of the fields in Dobó than those found in Bözöd are probably due to the more variable terrain of the area.

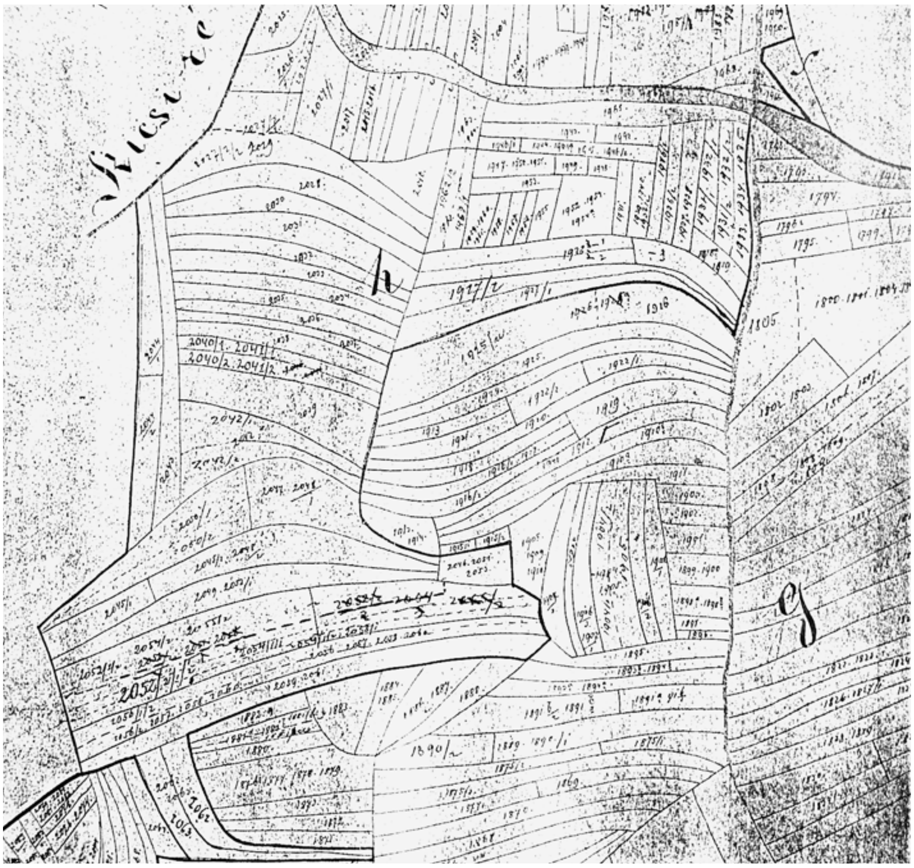

Fig. 4. Romania, Dobó. Present form of fields derives from traditional arrangement of long narrow strips. Part of the cadastral maps, probably 2nd part of the 19th century. Source: local municipality. — ***Obr. 4.*** Rumunsko, Dobó. Současný tvar polí vychází z tradičního uspořádání do dlouhých úzkých pásů. Výsek z katastrální mapy, pravděpodobně z 2. pol. 19. stol.

The delineation of fields by hedges or fences, as is well known in the Atlantic part of Europe, is neither known from prehistory, nor mentioned in historical sources in Romania, Slovakia or in the Czech Republic. Only minute remnants of modern hedges survive at Hriňová in Slovakia, and in the Česká Sibiř region near Vlašim in Bohemia.

2.5. Crop husbandry regime

We focused on recording cultivation practices involving einkorn. However, much of the following also applies to the cultivation of other cereals – two-row hulled barley, bread wheat, oat, rye, *Triticale* and broomcorn millet.

Fig. 5. *Romania, Dobó. Slopes of Les Hegy, south of village. Field strips with a single crop, or alternatively devided to several smaller rectangle plots of different crops. Photo: M. Hajnalová.* — ***Obr. 5.*** *Rumunsko, Dobó. Svahy Les Hegy, jižně od vsi. Dlouhé pásy polí jsou buď osety jednou plodinou nebo rozděleny do malých čtvercových políček s různými plodinami. Foto: M. Hajnalová.*

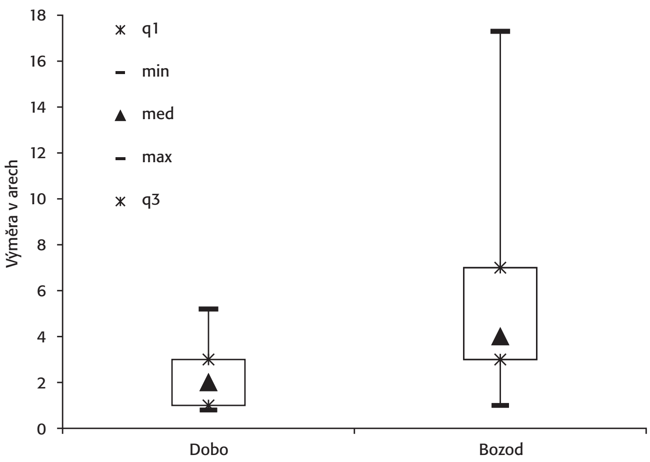

Fig. 6. *Romania. Sizes of floristically mapped fields in the two studied microregions. —* ***Obr. 6.*** *Rumunsko. Velikosti floristicky mapovaných polí ve dvou zkoumaných mikroregionech.*

2.5.1. Tillage/Ploughing

Soil for both winter and spring sown crops is ploughed after the harvest, between mid August and November. Autumn ploughing optimizes the stored water available for the spring crop. In cases where a farmer cannot plough a field in autumn, ploughing takes place in the spring, preferably immediately after the snows melt, but not later than the 24th of April. Spring ploughing is always done immediately before the sowing.[18] A pair of cows is most commonly used for tillage power, followed by the less frequent use of oxen and horses and, upon rare occasions, water buffalos (*Fig. 8*). While in the past, oxen were more commonly used, today keeping an ox is considered a luxury.

[18] Spring ploughing must be shallow; deep spring ploughing can negatively affect the yield (cf. *Čvančara 1962*, 151).

Fig. 7. *Romania, Csöb. A simple "prehistoric" fencing of a cereal field. Photo: M. Hajnalová. —* ***Obr. 7.*** *Rumunsko, Csöb. Jednoduché „pravěké" ohrazení obilného pole. Foto: M. Hajnalová.*

Fig. 8. *Romania, Körispatak. A pair of water buffalos pulling a wagon. Photo: Č. Čišecký. —* ***Obr. 8.*** *Rumunsko, Körispatak. Pár buvolic v zápřahu. Foto: Č. Čišecký.*

The farmers interviewed stated that 10 ares could be worked in a day by a pair of cows/oxen, or 2 (2.5) ares could be tilled by a pair of horses per hour. Similar numbers for tillage efficiency were recorded by *C. Palmer* (*1998,* 143) for the hilly area of northern Jordan.

Hand cultivation was recorded in two cases. In the first, a field of 2 ares worked by spade and rake. In the second, a smaller plot of 1 are was worked only by rake and hoe. This latter farmer first burned the plant cover (weeds and stubble), raked the burned surface, and then made furrows by hoe and covered the seed grain by raking. By such a practice a plot of 1 are could be worked (by a female elderly farmer) in one day. The interviewed farmers considered this practice "time consuming and laborious" but its results "very satisfactory".[19]

2.5.2. Manuring

In the crop rotation system, farmyard manure (FYM) is traditionally applied for the garden crop (sweet corn/potatoes) year, or for spring sown barley. FYM is transported to the fields and ploughed into the soil as close after the preceding harvest as possible. FYM is not applied to crops cultivated for straw as the stalks become "too long, weak and have tendency to lodge"[20], but this can vary.[21] In 2008, we recorded the application of manure for einkorn cultivated for straw in five out of the fourteen fields, three sown in autumn and two in the spring. Two respondents, who could not afford to keep livestock anymore, cultivated all crops without any manure.

In general, farmers claimed that one cow produced just enough manure for 1 ha of arable land (also the figure quoted by respondents in Slovakia and Bohemia).

2.5.3. Sowing

Sowing of einkorn is done by hand, either by broadcasting or planting in furrows. In the study area, farmers usually refer to sowing 1 véka per 7 ares (véka is the traditional local volume unit; 1 véka = 28.2 litre). The density of seed sown by broadcasting is normally "5 grains per cattle footprint". This corresponds to sowing of approximately 100–200 kg ha^{-1}.[22] The local einkorn land-race has a facultative growth habit (flowers and produces grain equally well when sown in autumn and in spring) thus the seed of the same stock can be sown both in autumn and spring. Moreover, farmers do not import seed from elsewhere and use their own seed from the previous year (or from two years ago) for sowing. Similarly, they only use local bread wheat or rye seed. The seed for sowing has always been selected from the best part of the harvest, from plots with the largest ears, and by separating the largest grains by hand sieving. Such practices help farmers retain a good seed stock.[23]

The majority of the farmers prefer to sow einkorn in the winter. They claim that this brings a better crop both in grain and straw. It is best when autumn sowing finishes before mid October. If the sowing can not be done by this time due to wet soils, early snow cover or lack of time, it is postponed until the spring. However, a few farmers believe that spring sown einkorn yields more stems and thus prefer spring sowing. In bad

Fig. 9. *Romania, Dobó. Weeding (pulling out) of thistles (Cirsium spp., Cardus spp.). Photo: M. Hajnalová. —* ***Obr. 9.*** *Rumunsko, Dobó. Pletí bodláků (Cirsium spp., Cardus spp.). Foto: M. Hajnalová.*

[19] A. Steensberg reached the same conclusion concerning the satisfactory results of hand cultivation, which in his study lead to a harvest at least three times as abundant as when a plough was used (*Steensberg 1986*, 110; from *Beranová 2006*, 16).

[20] In Jordan, farmers state the same thing, that manuring cereals cause abundant straw growth which can lead to lower yields. Manuring takes place during the fallow/year of vegetables/spring sown crops (*C. Palmer, pers. comm.*).

[21] According to *M. Markuš* (*1975*, 37), Romanian peasants living in mountainous areas traditionally sowed einkorn in unmanured forest soil, while Hungarian peasants in Hungarian villages of Transylvania sowed einkorn into manured soil.

[22] According to *J. L. Araus et al.* (*2003*, 684) written sources from the Middle East suggest that ancient cereal crops density might have been up to 0,08 t/ha^{-1} in the third millennium BP (Late Bronze and Iron Ages), after Jardé 1979, cited in *Araus et al. 2003.* Roman sources state that sowing densities for cereals ranged between 175 and 350 l/ha^{-1} – probably equivalent to at least ca. 0,08–0,18 t ha^{-1}.

[23] Modern agronomy rejects the use of seed grain from ones' own harvest as it is considered to lead to decreasing yield. It is advised at least to exchange the seed-stock among regions.

Fig. 10. *Romania, Béta. Toothed blade sickle which is traditionaly used for einkorn harvest. Photo: M. Hajnalová. —* ***Obr. 10.*** *Rumunsko, Béta. Zubatý srp tradičně používaný při sklizni jednozrnky. Foto: M. Hajnalová.*

Fig. 11. *Romania, Béta. Harvesting height of einkorn is low to the ground. Photo: M. Hajnalová. —* ***Obr. 11.*** *Rumunsko, Béta. Jednozrnka se sklízí blízko u země. Foto: M. Hajnalová.*

years, when autumn sowing fails, fields are grazed or are re-sown in spring with leftover stored grain.

When sowing in autumn, the soil is (deep) ploughed and the seed grain broadcast and then harrowed in. If the fields are ploughed in winter and subsequently sown in spring, prior to sowing the plots are only shallowly harrowed (see *above*); the seed grain is broadcast and covered with soil by a second harrowing.

2.5.4. Weeding

Despite the high weediness of the fields, with over 250 wild plant taxa, there is no general rule about when, how and how many times to weed. The only exception is pulling out thistles (*Cirsium* spp., *Cardus* spp.), which is usually done one to three times during spring (*Fig. 9*), but not before the crop reaches "ankle" height (ca. 20 cm). The remaining weeds are usually left in the fields as they are believed to keep the soil moist. In some cases, however, when there is time or the will, fields are weeded one to three times. In these cases, weeds are pulled out by hand; the hoe is almost never used.

2.5.5. Harvesting and post harvest processing

Harvesting is performed with sickles of two types, with a smooth or toothed blade (*Fig. 10*). The preference for either type differs from farmer to farmer, even within the same community.[24] The harvesting height is low to the ground (*Fig. 11*). As to the speed, an einkorn plot of one are can be harvested by sickle in half an hour.

An interesting additional procedure was recorded in the harvesting *chaîne opératoire*. After cutting a handful of stems, these are held just below the ears and the weeds "combed" away using the fingers of the other hand. The movement runs swiftly from the ear to the culm base, with the weeds just dropped on the spot and left in the field (*Fig. 12*). The result is that virtually weed-free cereal plants bound into tight sheaves are transported home. They are either left to dry or processed further right away. In sunny weather the sheaves (bundles) are dried in the yard (*Fig. 13a, 13b*), if it rains in the barn. This "de-weeding" technique was recorded for einkorn as well as rye and bread wheat, of which the whole or at least part of the straw harvest is destined for further uses, such as hat-making, bas-

[24] It has been observed that farmers in Bözöd, who normally use a toothed sickle for harvesting, have a tendency uproot cereals when using a sickle with a smooth blade. This was tested and showed on einkorn, bread wheat and rye (*Borzová — Pažinová in prep.*).

Fig. 12. *Romania, Béta. Bundle of stalks is weeded , by "combing" weeds away by fingers. Photo: M. Hajnalová. —* ***Obr. 12.*** *Rumunsko, Béta. Svazek obilných stébel je odplevelován vyčesáním plevelů prsty. Foto: M. Hajnalová.*

ketry, decorations and thatching. This is an important observation for archaeobotany (see *below*).[25]

If there is time pressure in the field due to inclement weather the sheaves are tied with weeds still mixed in them and transported home. "De-weeding" of the sheaves at home comprises of following steps: the cereal stalks are pulled out from the original sheaf one by one (*Fig. 14*) tied into new, smaller and weedless ones and left to dry.

Harvesting by scythe was documented in one case only (*Fig. 15*). This was in a very weedy field, where only a few sheaves of cereals were collected. The rest of the harvest was used as animal feed.

When the grain is dry, two methods are used to separate grain from straw. In the first method, the unthreshed ears are cut away either with a knife one plant at a time or by using a special device for a bunch of plants (*Fig. 16*). The cut ears are left to wither for a few days, and then threshed with a wooden chopping board/paddle (*Fig. 17*) on the house porch. In the second method, the ears are threshed while still attached to the straw. The remaining basal ears (for einkorn) or rachis internodes (for free-threshing cereals) are cut away and fed to poultry. The separated stems are tied to bundles and stored in a dry place (under the roof or in the barn). The first method is more often used for einkorn (a glume wheat) or when the threshing is done on a small-scale by a person who is less fit. The second method is more often used for free-threshing cereals (bread wheat and rye).

2.5.6. Yields

While obtaining information on sowing rates is relatively easy, to collect precise data on yields/productivity in standard measurements is almost impossible. The harvest is normally only considered as good, sufficient or insufficient.[26]

[25] We counted the number of einkorn plants in three sheaves made by different farmers in the field, two without and one with weeds in it, and found that bundles were made of ca. 1000 stems in total.

[26] "Yield is the product of the number of grains per unit land area and the average grain weight. Most of the evidence indicates that there is no relationship between cereal yields and the average size of individual grains... It has been generally found that the yield of cereals is far more closely related to the number of grains per unit land area than to individual grain weight" (*Araus et al. 2003*, 684).

		Traditional **Béta**	Traditional **Kőrispatak**	Modern **Rava**	'Modernized' **Bözöd**
Sowing	time	autumn	April (2/3)*	March (3/3)	September
	by broadcasting	yes	yes	yes	yes
	spikelets / field size	15 l / 4 ar	20 l / 10 ar	28 l / 13 ar	80 l / 5 ar
Manuring	farm yard manure	yes	yes	mineral	yes
	when	1 year before sowing	1 year before sowing	–	2 weeks before sowing
	under/with crop	einkorn	Zea	einkorn	einkorn
	how much	–	–	–	1 cartload
Ploughing	by	horse	horse	tractor	horse
	time	late summer	late summer	last summer	August
Harrowing by horse	after sowing	–	–	yes	yes
	before sowing	–	–	yes	–
Weeding	method	hand (Cirsium)	hand (Cirsium)	herbicides	herbicides
	time	2x spring	1x May/June	June	May
rotation		?-Einkorn-Einkorn	?-Zea-Einkorn	?-Zea-Einkorn	Zea-Sorghum-Einkorn
No. of weed taxa		25	37	25	20

Tab. 1. *Agricultural practices applied at four einkorn fields with 1 m² trial plots. *Such a late sowing time was due to a very long winter and very wet spring of 2006. —* ***Tab. 1.*** *Způsoby obdělávání použité na čtyřech jednozrnkových polích s pokusnými čtverci (1 m²) * Pozdní datum setby bylo způsobeno dlouhou zimou a vlhkým jarem 2006.*

Fig. 13. *Romania, Béta. Harvested cereals are tight to bundles of ca. 1000 stems. The bundles are transported home, where they are left to dry. Photo: Č. Čišecký and D. Dreslerová.* — ***Obr. 13.*** *Rumunsko, Béta. Pokosené obilí je svázáno do svazku (snopu) o přibl. 1000 stéblech. Snopy jsou transportovány domů a tam sušeny. Foto: Č. Čišecký and D. Dreslerová.*

The einkorn yield is usually expressed in the number of sheaves or in multiples (fold) relative to the sown seed. Most often it is estimated to be six- to tenfold. In a good year, or from a manually tilled plot, 20 sheaves of einkorn can be harvested from 1 are, in "normal" years 10 sheaves.

Due to receiving very different and rather unclear answers concerning the yields, during 2006 we made our own estimation of the real einkorn yields based on direct field observations. To calculate real cereal yields four 1 m^2 trial plots at four fields were selected. The fields were farmed using variable practices. As shown in *Tab. 1*, the fields in Béta and Kőrispatak were farmed traditionally, without mechanization, mineral fertilizers or artificial weedkillers. Similarly, in Bözöd no mechanization and farm yard manure was used, but herbicides were applied. Ráva is the only einkorn field in the region where, in 2006, modern practices (tractor ploughing, fertilization by mineral fertilizer and herbicide treatment) were applied.

Fig. 14. *Romania, Bözöd. The cereal plants are pulled out from the original bundle and tight into new, weedless ones. Photo: M. Borza. —* ***Obr. 14.*** *Rumunsko, Bözöd. Obilná stébla jsou vybírána ze svazku a svázána do nového, zbaveného plevelů. Foto: M. Borza.*

Fig. 15. *Romania, Körispatak. Harvesting of einkorn by scythe (documented in one case only). Photo: M. Hajnalová. —* ***Obr. 15.*** *Rumunsko, Körispatak. Sklizeň jednozrnky kosou (zachyceno pouze v jediném případě). Foto: M. Hajnalová.*

Fig. 16. *Romania, Béta. Separation of grain from straw by special device for a bunch of plants. Photo: M. Hajnalová. —* ***Obr. 16.*** *Rumunsko, Béta. Odřezávání klasů od slámy pomocí speciálního zařízení. Foto: M. Hajnalová.*

At each plot, the number of plants, number of stems per plant (tillers), number of ears per plant, and number of spikelets per ear were counted (*Tab. 2*).[27]

Back in the laboratory, the weight and the volume of 1000 randomly selected spikelets and 1000 kernels

[27] While at the experimental plots the average number of tillers per plant is three, Mrs. Tóth had, in a small garden plot with well watered and good soil, plants with 10–12 tillers each with ears of 28–30 spikelets. According to her claims, which are in contradiction to general belief, the spring sown einkorn produces more tillers than the autumn-sown one (only 7–8 tillers).

Fig. 17. *Romania, Körispatak. Wooden chopping board/paddle used for threshing. Photo: Č. Čišecký. —* ***Obr. 17.*** *Rumunsko, Körispatak. Dřevěné prkénko používané k mlácení obilí. Foto: Č. Čišecký.*

were measured and the kernel fraction calculated (*Tab. 3*). To obtain a real number for the sowing rate (usually given by farmers in volume units) the volume of one kilogram of einkorn spikelets was assessed. It was calculated that there are 14100 einkorn spikelets weighing 380 g in one litre; thus, one kilogram of einkorn spikelets equals 2.65 litres. Using this number, the maximum einkorn sowing rate of 0.153 t ha^{-1} (ca 570 spikelets/grains per 1 m^2) was calculated, which is based on farmers' reports of sowing 1 véka (28.2 liters) of spikelets/grain per 7 ares. A minimum sowing rate of 0.135 t ha^{-1} was calculated from the farmers'estimate of "5 spikelets/grains per cattle footprint", which is ca 500 spikelets/grains per 1 m^2.

The gross yield of einkorn (spikelets) fluctuates between 1.13 t ha^{-1} and 3.72 t ha^{-1} (*Tab. 4*). The lower yield is probably the result of a very bad year (farmers pers. comm.), the higher yield is probably the result of very dense sowing and application of herbicides; therefore, the mean einkorn yield was estimated to ca 2.10 t ha^{-1}. Our results fit well with other published data (*Tab. 5*). Please note that, the seed to sown ratio (fold) is usually

1 m^2	Béta	Kőrispatak	Rava	Bözöd
Plants	46 (?)	109	276	433
Stems	292	593	581	1738
Ears fertile	249	331	304	893
Ears sterile		22	65	57
Spikelets fertile	6883	6997	4187	13783
Spikelets sterile		354	455	855
Average fertile spikelets per ear	28	21	14	15
% of fertile spikelets		95,2	90,2	94,2
Seed / Sown ratio	69	64	15	32
Estimated spikelet yield (kg) / ha	1377	1399	837	2757

Tab. 2. *Data collected from einkorn 1 m^2 trial plots. For calculations of spikelet yield, an average spikelet weight of 27 g per 1000 spikelets was used (Tab. 3). —* ***Tab. 2.*** *Data získaná z pokusných jednozrnkových ploch. K výpočtu úrody klásků byla použita průměrná váha 27 g/1000 klásků (viz Tab. 3).*

	1000-kernels	1000-spikelets
Weight (g)	20	27
Volume (ml)	55	70
Weight fraction %	74	26
Volume fraction %	71	29

Tab. 3. *Average weight and volume of 1000 einkorn kernels and 1000 einkorn spikelets based on samples from the trial plots. —* ***Tab. 3.*** *Průměrná váha a objem 1000 jednozrnkových zrn a 1000 jednozrnkových klásků na základě vzorků z pokusných čtverců.*

claimed to be between six- to tenfold, but at the trial plots it was between four-and-a-half- and eighteenfold (*Tab. 4*).

2.5.7. Losses in yields

The final amount of grain, left after processing and ready for storage, corresponds only to a part of the theoretical harvest extrapolated from numbers of seed sown, or the plants and ears counted at the cultivated plots.[28] Firstly, not all planted grains germinate; however, this can be compensated for by the remaining plants producing more tillers if not densely planted.

Other cereal crop losses are brought about by rodents, deer or wild boar. Einkorn with its hard glumes is not favoured by deer or boar, but is susceptible to damage by birds. Hand harvesting minimises grain losses, but some losses do occur during the transportation of sheaves home and especially during further drying outside, when again the grain is susceptible to birds. In both cases, losses can be reduced by guarding the harvest or fields, a task which can be done by children. This practice, though, has not been recorded in our study area.

If the hypothetical harvest of a field is 2 t ha^{-1} and farmers claim to harvest (and store) between 1.2 t ha^{-1} and 2 t ha^{-1} (six- to tenfold), estimated losses are between 0 to 40 %. *E. Rozsypalová* (*2000*, 69–70) assesses the losses during harvest, transport and processing to be 17–20 %, which appears realistic.

[28] In one recorded case, bread wheat replicated at a ratio of 1 : 276 (J. Hajnal pers. comm.).

	Béta (min)	Kőrispatak (max)	Rava (min)	Bözöd (max)
Corn seed sown (kg ha^{-1})	1240	760	836	6080
Spikelets sown per 1 m^2	462	284	313	228
Yield (kg) spikelets from 1 ha	1858,41	1889,19	1130,49	3721,41
Yield (kg) kernels from 1 ha	1376,6	1399,4	837,4	2756,6
Seed : Yield ratio	1:11	1:18	1:10	1:4.5

Tab. 4. *Calculations of einkorn yields and seeding and harvesting rates at the trial plots. —* ***Tab. 4.*** *Výpočet výnosu jednozrnky a poměr výsev – sklizeň v pokusných čtvercích.*

Source	Crop		Yield (g/m^2)	1000-kernel weight (g)	1000-spikelet weight (g)	Kernel fraction (%)	Plant height (cm)	Spikelets per ear	Ears per m^2	Seeding rate per m^2
Romania 2006 and 2008 ethnobotany	Einkorn	min	113	20	27	69	60	1	249	
		max	372	20	28,8	74	160	36	893	
		mean	210	20	27,9	71,5	100–140	16–26	444	1000–500
Grausgruber et al. 2004 experimental data (modern) eastern Austria	Winter Einkorn *	min	42,2	12,7	–	59,3	–	–	–	–
		max	430,6	28	–	78,2	–	–	–	–
		mean	**300,3**	**21,3**	–	**72,6**	–	–	–	
	Winter Emmer *	min	149,7	25	–	62	–	–	–	
		max	653	57,6	–	81	–	–	–	–
		mean	**383,2**	**37,7**	–	**70,8**	–	–	–	–
	Spring Emmer *	min	119,4	19,6	–	66	–	–	–	–
		max	485,2	51,8	–	81	–	–	–	–
		mean	**273,1**	**28,8**	–	**75,2**	–	–	–	–
Castagna et al. 1995 experimental data (modern) Italy (various locations)	Einkorn **	min	84	16	–	68	–	26	288	–
		max	457	28	–	90	–	32	436	–
		mean	**204–283**	**23**	–	**76,9**	101–126	**29,1**	**342,9**	**300**
Troccoli – Codianni 2005 experimental data (modern) southern Italy	Winter Einkorn**	min	137	20,4	–	–	–	–	–	–
		max	147	24,6	–	–	–	–	–	–
		mean	**142**	**22,5**	–	–	116	–	419	100, 150, 200
	Winter Emmer **	min	341	35,9	–	–	–	–	–	–
		max	367	39	–	–	–	–	–	–
		mean	**354**	**39**	–	–	127	–	442	–
	Winter Spelt**	min	274	34,3	–	–	–	–	–	–
		max	286	34,4	–	–	–	–	–	–
		mean	**280**	**32,3**	–	–	112	–	354	–
Ünal 2009 Turkey ethnobotany (?)	Einkorn	min	–	29,1	35,8	–	–	–	–	–
		max	–	32,4	40,7	–	–	–	–	–
		mean	–	**30,8**	**37,3**	–	–	–	–	–
	Emmer	min	–	35,1	73,3	–	–	–	–	–
		max	–	39,8	81,8	–	–	–	–	–
		mean	–	**37,1**	**78,2**	–	–	–	–	–

Tab. 5. *Experimental and ethnobotanical data on glume wheat characteristics and yields. Note: * spikelet (gross) weight, ** kernel (net) weight. —* ***Tab. 5.*** *Experimentální a etnobotanická data vztahující se k výnosu a charakteristikám pluchatých pšenic. Pozn.: * váha klásku (brutto), ** váha zrna (netto).*

2.5.8. Other crops

The main contemporary cultivated crops of the region are bread wheat, barley, rye, oat, potatoes and sweet-corn. The yields for bread wheat are stated to be ca 2 t ha^{-1}, what is same value given by small-subsistence farmers in Slovakia and in Southern Bohemia (*Dreslerová — Venclová 2007*). Apart of these staple field crops, there are 17 other crops (including in gardens). These are pea, bean, Celtic bean, flax, hemp, poppy, beat, alfalfa, birdsfoot trefoil (*Lotus corniculatus*), cabbage, carrot, parsley, cucumber, pumpkin, celery, onion, garlic and dill.

2.6. Other parts of the agricultural landscape, meadows and pastures

Fields and meadows are in close vicinity to the village (*Fig. 18*). Arable fields are preferably the closest, but steeper slopes or difficult to access areas are covered with meadows. Grassy stands within gardens and meadows close to the village are mown three-times a year. More distant parcels twice a year and those over half an hour walking distance away only once a year. If possible and when is abundance of FYM, meadows are also manured. The productive capacity of Carpathian meadows is on average 5 t ha^{-1} of hay.[29] Meadows are enclosed by pastures and fringed by forest (*Fig. 19*). Pasture areas include solitary trees and look like savannas (*Fig. 20*; cf. *Rackham 1998*). Some of the summer pastures (either for sheep or heifer) are situated further away, and often form spacious openings in the forest. According to the inter-

[29] In the Czech Republic the annual dry mass production (DMP) of grasslands varies between 0.5 and 15 t ha^{-1}. The DMP of the unmanured pastures is between 2 and 4 t ha^{-1} (*Pavlů — Gaisler — Hejcman 2006*).

__Fig. 18.__ Romania, Dobó. Disappearing tapestry of fields and meadows in the close vicinity of the village. Photo: M. Hajnalová. — __Obr. 18.__ Rumunsko, Dobó. Mizející mozaika polí a luk v blízkém okolí vesnice. Foto: M. Hajnalová.

__Fig. 19.__ Romania, Dobó. Traditional agricultural division of the landscape. Field-meadow area is enclosed by pastures and fringed by forest. Photo: M. Hajnalová. — __Obr. 19.__ Rumunsko, Dobó. Tradiční zemědělské rozdělení krajiny. Pole a louky jsou lemovány pastvinami a lesem. Foto: M. Hajnalová.

viewed farmers, leafy fodder was collected and used as fodder only once in living memory; in 1946, which was an extremely dry year.

Deforested land is divided to arable land, meadows and pastures approximately in the ratio of 2 : 1 : 0.8 (*Fig. 21*). Although this contemporary model cannot be directly transferred to prehistory, a similar division of land has been proposed in some prehistoric land use models, which also assume that fallow fields were used as pastures (*Dreslerová 1995*).

Fig. 20. *Romania, Székelyderzs. Pasture areas include solitaire trees and look like savannas (cf. Rackham 1998). Photo: M. Hajnalová. —* ***Obr. 20.*** *Rumunsko, Székelyderzs. Na pastvinách, které připomínají savany jsou ponechány solitérní stromy (srov. Rackham 1998). Foto: M. Hajnalová.*

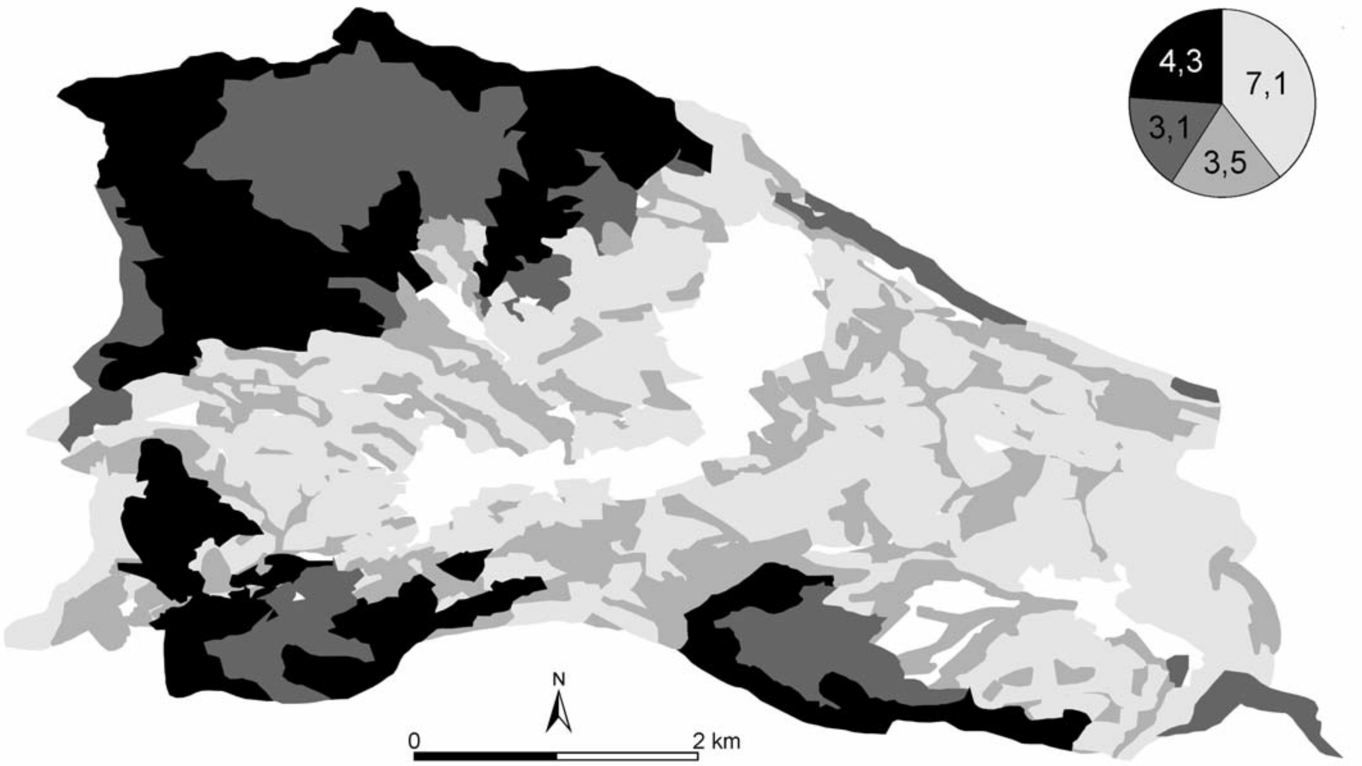

Fig. 21. *Romania, Dobó, Béta, Vagas. Agricultural use of the cadastres – deforested land is divided to arable land, meadows and pastures approximately in the ratio of 2 : 1 : 0.8 (light grey – fields, mid grey – meadows, dark grey – pastures, black – forest, white – intravillan). Image by Č. Čišecký. —* ***Obr. 21.*** *Rumunsko, Dobó, Béta, Vagas. Hospodářské využití katastrů. Odlesněná půda je rozdělena mezi pole, louky a pastviny zhruba v poměru 2 : 1 : 0,8 (světle šedá – pole, středně šedá – louky, tmavě šedá – pastviny, černá – les, bílá – intravilán). Zpracoval: Č. Čišecký.*

2.7. Storage of crop, hay and straw

The amount of grain stored for sowing is, if conditions allow, twice what is needed for one year. This is to ensure that a sufficient amount is left over for the next year in case of crop failure. Most commonly, grain is stored in variously sized solid wooden chests (Hungarian "*láda*") placed in the attic of the house. Exceptionally, and usually only for a short periods of time, grain can be stored in textile bags. In the past, storage chests were also made of wicker plastered with daub to prevent rodent attack, or were made of hollow out tree trunks.

Fig. 22. *Romania, Ráva. Hay and straw are stored in the rectangular straw-stacks or oblong haystacks. Photo: M. Hajnalová.* — ***Obr. 22.*** *Rumunsko, Ráva. Venkovní skladování sena a slámy v oblých homolích. Foto: M. Hajnalová.*

Grain stored in this way remains capable of germination for a minimum of 2–3 years.[30]

Hay and straw are stored in barns and/or outside on rectangular straw-stacks or oblong haystacks (*Fig. 22*). In this way, it survives without damage for more than a year. The volume of stored hay depends on numbers of animals kept and it is difficult to estimate quantitatively. According to local farmers there simply "has to be enough hay".

Butser Farm experiment, harvest data 1986, einkorn					
Field no.	Sowing	Manuring	Cropping	t ha^{-1}	Ratio
III.	spring	not	continuous	1,23	1:19
IV.	spring	not	rotation	1,44	1:23
IV.	spring	yes	rotation	1,82	1:29
VI.	spring	bienially	continuous	1,09	1:17
Sowing:	0, 063 t ha^{-1}		Ø	**1,4**	**1:22**

Tab. 6. *Butser Farm experiment, harvest data 1986 on einkorn (after Reynolds 1986).* — ***Tab. 6.*** *Butser Farm experiment, výnosy jednozrnky v roce 1986 (podle Reynolds 1986).*

2.8. Animals

The number of grazed animals is proportional to the size of land owned. Recalculated as "large cattle units (VDJ)"[31], each farmer keeps numbers of cattle/horses/buffaloes/sheep in proportion to the area from which he/she can harvest the hay (*Tab. 6*).

From late spring to early autumn livestock graze on communal pastures. Cattle, heifers and sheep graze separately on different parts of the pastures. Some village communities keep heifers out of the village on remote pastures, often at higher altitudes. For almost all respondents, keeping a goat is a symbol of poverty and therefore only the poorest people keep one or two.

Sheep (sometimes also goats) are kept on the "*esztena*" (in Slovak "*salaš*", summer farm, sheeling). A sheep kept at the summer farm bring 7 kg of sweet semi-hard cheese and 1 kg of soft "*brânză*" cheese per sheep per year.[32] Milk and cheese produced over this agreed volume is left to the shepherd as additional income.

Summer farm starts on St. George's Day (24th April) and lasts until St. Michael's Day (29th September). In a good year, sheep do not return to the village before the 1st of December. Herders stay up at summer farm throughout the season. Returning to the village to get food supplies and bring back cheese is usually done once a week or "when needed", and depends on orders.

Cows, oxen, female water buffalos, and horses are used as traction and plough animals individually or in pairs. The use of horses for ploughing is only economical when the arable land extends over 10 ha (according to respondents in Bohemia) or in hilly or mountainous terrain where ploughing with cows would be too slow. Small farmers can not afford to keep "more expensive" plough animals (oxen, horses) and plough with cows. If cows are used for traction then there is a loss in milk production but this can be minimalised by substituting a portion of fodder by grain. In comparison to milk cows, cows used also for traction produce half to two thirds of the average quantity (4–8 l) of milk per day.

[30] A unique tradition of storing cereals and meat (bacon/salted lard and ham) in the fortified church has survived in Sekelyderzs (Harghita district). Here for generations families have been storing grain in wooden chests protected under the roofed fortification wall. For meat, each family owns a hook in well aired rooms in higher stories of two fortification towers. Access to the grain is daily, between 7 and 7.30 in the morning, but for the meat only once a week and this time is announced by the church bell.

[31] VDJ = 500 kg of life weight.

[32] Almost identical amounts of milk and cheese are produced at summer farms in the Slovak Carpathians and in the Bohemian Beskydy mts. (*Chalupecký — Harabin 2004*; *Kunz 2005*).

Every village has one "communal" bull. Information about keeping a single bull for hundred milk cows, is rather high, and pays for the gradual implementation of modern artificial insemination. *F. Kraupner* (in *1871*) writes: "Not to wear away, a good bull should not fecundate more than 50 to 60 cows a year". In the past in Romania the bulls were kept only by the wealthiest families in the village. Being able to keep a bull was also a demonstration of high social status.

2.9. Farm size

The sizes of land-holding unit (fields, meadows and pastures) per household vary between 1 and 16 ha, with the average farm size 4.7 ha (*Tab. 7*).[33] The number of family members ranges from 3 to 8 with an average of 5 (parents, grandparents and children). Farmers who own less than 1 ha per family member gain extra income through specialized craft work (e.g. blacksmith, wheelwright etc.) or through wage labour. This finding is in agreement with *E. Rozsypalová* (*2000*, 70) who argues that to provide sustenance for one person it is necessary to farm approximately 1 ha of soil (or, according to us, exploit it by any agricultural means).[34] Farmers, except the poorest ones who were only able to sell their labour, used to exchange part of their produce at the market in the past as well. Among the most common commodities were eggs, poultry, milk, cheese, or animals. Selling the grain is never mentioned; it was not the main market commodity.

Fig. 23. *Romania, Körispatak. Bread oven in the yard. Photo: M. Hajnalová. —* ***Obr. 23.*** *Rumunsko, Körispatak. Chlebová pec na dvoře. Foto: M. Hajnalová.*

[33] According to *S. G. Randall* (*1975*, 283) the upland Carpathian estate of a family relying most heavily upon traditional agriculture is 4 to 5 hectares.

[34] Calculations of the dietary requirements of the Neolithic farmers in the Netherlands led to figures of 0.6–2.3 ha of cultivated land per household of 6 persons (*Bakels — Zeiler 2005*, 314). A. Bogaard even states 1 ha of arable land as sufficient for a Neolithic household of 5 people (*Bogaard 2004*, 159).

Source	Location	Century	Crop	Yield t ha^{-1}	Seed-yield	Reference	Note
experiment	Butser farm, s. England		einkorn	1.4	1:22	*Reynolds 1986*	manured and non-manured
experiment	Foggia, southern Italy		einkorn	0,84		*Castagna et al. 1995*	rotation, seeding 300 kernels per m^2
experiment	Milano, Italy		einkorn	2,85		*Castagna et al. 1995*	rotation, seeding 300 kernels per m^2
experiment	Cologne, Germany		einkorn	4,57		*Castagna et al. 1995*	rotation, seeding 300 kernels per m^2
experiment	Catalonia, Spain		emmer	0.11–3.58	1:1.5–1:51	*Cubero i Corpas et al. 2008*	rotation with beans and fallow
experiment	Bohemia, Czech Republic		emmer	av. 1.7	av. 1:30	*Beranová 1987*	
ethnography	Slovakia, Carpathian Mount.		emmer	2.5–2.8		*Tempír 1976*	area about Senica
ethnography	Slovakia, Carpathian Mount.		emmer	0.73–1.09		*Tempír 1976*	area about Krupina
ethnography	Northern Jordan		durum wheat	0.6–1.1		*Palmer 1998*	traditional farming
historical data	Artois, northern France	14th	wheat		1:9–1:13	*Comet 1997*	
historical data	around Lille, northern France	13th	wheat?		1:10–1:12	*Comet 1997*	
historical data	near Brussels, Belgium	15th	wheat?		1:14	*Comet 1997*	50 years in a row
historical data	Winchester, England	13th			1:4	*Comet 1997*	
historical data	Lower Austria	18th	bread wheat		1:10	*Kunz 2004*	
historical data	Moravia, Czech Republic	18th	bread wheat		1:15–1:20	*Kunz 2004*	fertile areas
historical data	Netherlands	16th	wheat		1:10	*Petráň — Petráňová 2000*	beginning of rotation with beet
historical data	Bohemia, Czech Republic	medieval	wheat		1:3–1:4	*Beranová 1980*; *Klápště 2005*	three field systém
historical data	Bohemia, Czech Republic	16th	wheat		1:6–1:9	Jiřina 1958 *after Rozsypalová 2000*	
historical data	northern Slovakia	16–18th	cereals		1:2–1:3	*Horváth 1962*	average for all cereals
historical data	south and east Slovakia	16–18th	cereals		1:4–1:5	*Horváth 1962*	average for all cereals

Tab. 7. *Some historical, experimental and ethnographic data on cereal yields. —* ***Tab. 7.*** *Výběr historických, experimentálních a etnografických dat vztahujících se k výnosům obilí.*

2.10. Bread

Related to cereal yields, and because we think that information can be transposed to prehistory and Early Middle Ages, we would like to include some observations about bread and bread-making.[35] Home-made bread is still highly valued. It used to be baked regularly on a weekly basis, but this tradition survives only with a few farmers. Mostly, today it is only made on special occasions like Easter, Christmas and other social or family festivities.

Home-made bread is now either wheat or half wheat (rye or wheat) and half potatoes, but until recently it was also made from einkorn. Hungarians in Transylvania, in contrast to Romanians, used to add a portion of rye flour to einkorn (*Markuš 1975*, 37). The specific slightly sour taste (reportedly remindful of childhood) of einkorn bread is one of the reasons for the survival of einkorn cultivation in some parts of Turkey (F. Ertüğ pers. comm.).

There are also very small variations in recipes for bread – in proportions of flour and potatoes, when to kneed, how long it is left to rise, whether a cabbage leaf or cloth is used as to line the rising basin or how much wood for fuel is needed (most often, one armful of beech wood is enough for baking a weekly batch). Traditionally, the average household used to consume six 2 kg loaves per week (10 kg of bread flour, 1–2 kg of potatoes).[36] Today, bread ovens are isolated structures situated outside in the yard (*Fig. 23*).

3. Slovakia

3.1. Traditional farming of emmer: an annotated bibliography

Traditional farming survived in the sub-mountainous regions of Slovakia on the modern borders with Moravia and south-eastern Poland until the last third of the twentieth century. It was the subject of fieldwork for many ethnographers, as well as ethnobotanists, who mapped diminishing land-races of cereals threatened by intensification and industrialisation of agriculture (*Hammer et al. 1981*, from local scholars namely *Tempír 1963*; *1976*; *Markuš 1975* and *Kühn — Hammer — Hanelt 1976*; *1980*). At that time, though as marginal crops only, old land races of *Triticum aestivum* and *Triticum dicoccum* were still cultivated in the north of Eastern Slovakia and near Krupina in Central Slovakia[37]. In the following we briefly summarise their findings on emmer, the crop virtually unknown today, which had been for millennia a staple cereal in Slovakia (see *above*) and leading crop throughout prehistory of Bohemia (*Dreslerová — Kočár in prep.*).

In the western Carpathians emmer was planted/sown as a spring crop on rocky and sandy soils on slopes, most often in unmanured plots, where other crops gave very low yields.[38] It was also planted on freshly deforested plots worked only by hoe not by plough. According to some farmers, it exhausted soil, thus after emmer it was necessary to manure the plot or leave it fallow. Emmer was planted on shallowly prepared soil quite sparsely as it produces many tillers. It was resistant to pathogens and did not lodge.

Whole spikelets (usually with 2 grains) were planted as dehusking the grain would cause damage and lower yields. The soil was harrowed after sowing.[39] Tooth-bladed sickles were used for harvesting. Due to the semi-brittle nature of emmer ears and the easy shedding of spikelets, dew was essential for "holding" ears together, so the harvest was done either very early in the morning or during the night. Threshing was done by fists, flails and trampling horses. The straw was tough and sharp and was not suitable for fodder. Thus, in winter, baskets and hats were made out of it. Threshed spikelets were stored in textile bags or in wooden chests. Grain for consumption was dried in ovens to prevent infestation by insects (*Markuš 1975*; *Tempír 1976*).

3.2. Traditional farming today

At the beginning of twenty-first century, remnants of traditional agriculture are almost non-existent in Slovakia. Hoping to find farming similar to that which we observed in Transylvania, we travelled the regions of North-Eastern and Central Slovakia (*Fig. 24*), but with poor results. Elements of traditional farming survive in sub-mountainous regions with a few families, but they have other primary means of supporting their household economy.

We surveyed in detail the regions of Krupina in Central Slovakia, where emmer cultivation was known still in 1990, Hriňová in Central Slovakia, and Pieniny in the north, where recent botanical surveys have reported the

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[35] The first evidence of baking of rised bread is known from pre-dynastic Egypt from period of 3500–3400 BC. Loaves were 13–23 cm high, 18–25 cm in diameter, weighted 3.3–6.5 kg and were baked from emmer (*Curtis 2001*). The earliest find of probably rised bread in Europe comes from Twann – a site of Cortaillod culture in Switzerland and dates to mid fourth millennium BC (*Währen 1984*). Since the Bronze Age, fragments of fermented dough were probably dried and stored and rised bread was made from flour of different cereals and with of other various ingredients. Bread also was probably common in La Tène period (*Beranová 2005b*, 41–43). Ancient rised bread loaves were mostly round in shape but smaller than modern ones. The Slovak find of earliest rised bread preserved by charring comes from Bratislava - Devín and dates to the 5th century AD (*Hajnalová 1989b*). Loaf of 23 cm in diameter and 4–5 cm in height is similar to smaller modern specimens.

[36] If 520 kg of bread flour is used annually and given ratio is 100 kg of grain = 74 kg of flour, one household consumes 700 kg of grain (140–175 kg per person). With yields of 2 t ha^{-1} this means at least 30 ares for bread cereal. In Hungary the 1800 estimates for consumption of "bread grain" are higher: 366.5 kg per adult and 185.5 kg per child (Schartner 1809 according to *Kunz 2004*, 123).

[37] Emmer was still cultivated in the early nineties of the last century by a few bio-farmers in the hills near Zvolen and Krupina (*Hajnalová 1999*, 32).

[38] *A. Troccoli — P. Codianni* (*2005*) show, that hulled wheats (emmer in particular) are more suitable for cultivation in marginal areas where economically profitable crops are precluded by water deficiency and poor soils.

[39] In the village of Dolné Strháre, harrows were made entirely from wood and were still in use in 1970.

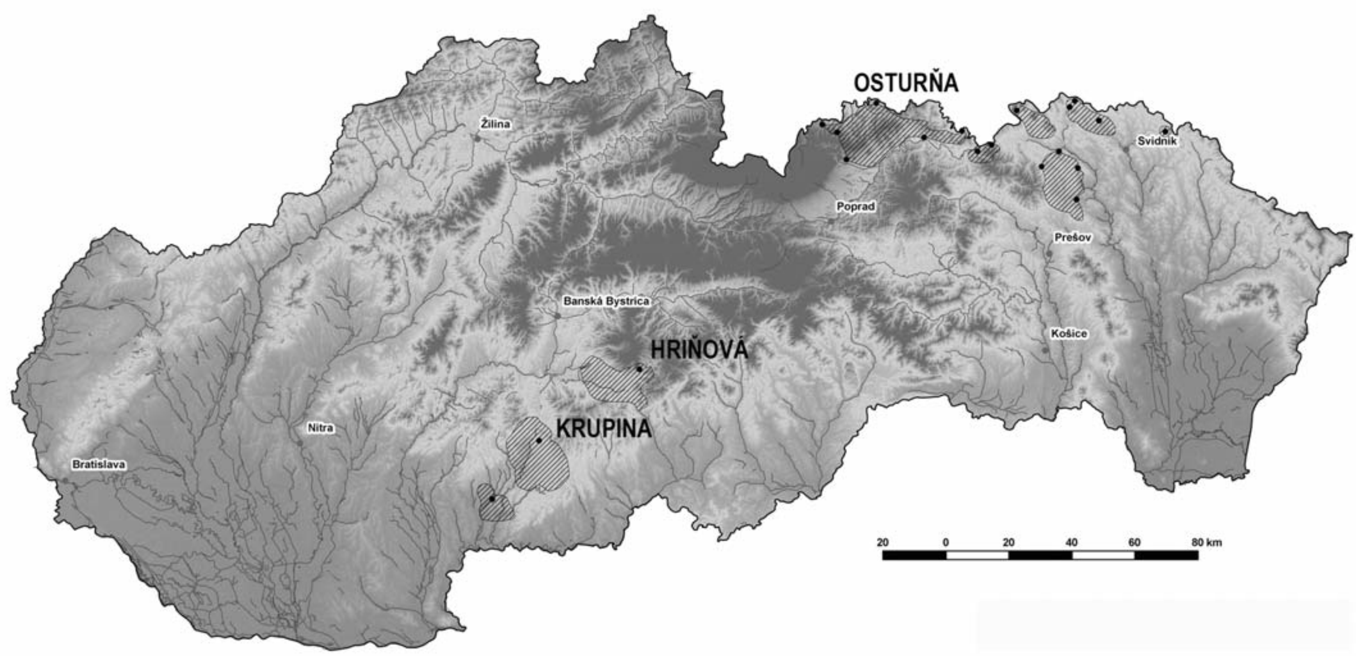

Fig. 24. Slovakia. Regions with remnants of traditional farming (hatched zones). Map by Č. Čišecký and studio AGAMA. — ***Obr. 24.*** *Slovensko. Oblasti s rezidui tradičního zemědělství (šrafovaně). Zpracoval: Č. Čišecký a studio AGAMA.*

existence of rare arable weeds connected with traditional farming practices (cf. *Eliáš jun. 2006*; *Eliáš jun. — Eliáš sen. — Baranec 2007*). Despite the mentioned problems, we did collect some interesting information that is important for understanding farming variability and its adaptations in otherwise unsuitable natural settings.

3.2.1. North of Eastern Slovakia

Osturňa

No doubt, Osturňa is the most interesting village in Pieniny, a sub-mountainous and extremely poor farming area. It spreads along a long and narrow valley at an altitude of 800 m a.s.l. (*Fig. 25*).

Thanks to Mr. Harabin, local chronicler, this village has its own written history (*Chalupecký — Harabin 2004*). Osturňa, one of the poorest villages in Slovakia, was established during the mid 16th century AD. The first settlers were herders. Agricultural land was cleared from the forest, with each plot taking 4 (!) years to deforest. In the first year, part of the forest was cut down, with wood for construction removed and the remaining wood left to dry. In the second year, a new plot of land was cleared of trees and the previous year's plot still left to dry. In the third year, another plot was cut, wood on

Fig. 25. *North Slovakia, Osturňa. Disappearing agricultural terraces in the vicinity of the village. Photo: D. Dreslerová.* — ***Obr. 25.*** *Severní Slovensko, Osturňa. Zanikající zemědělské terasy v okolí vesnice. Foto: D. Dreslerová.*

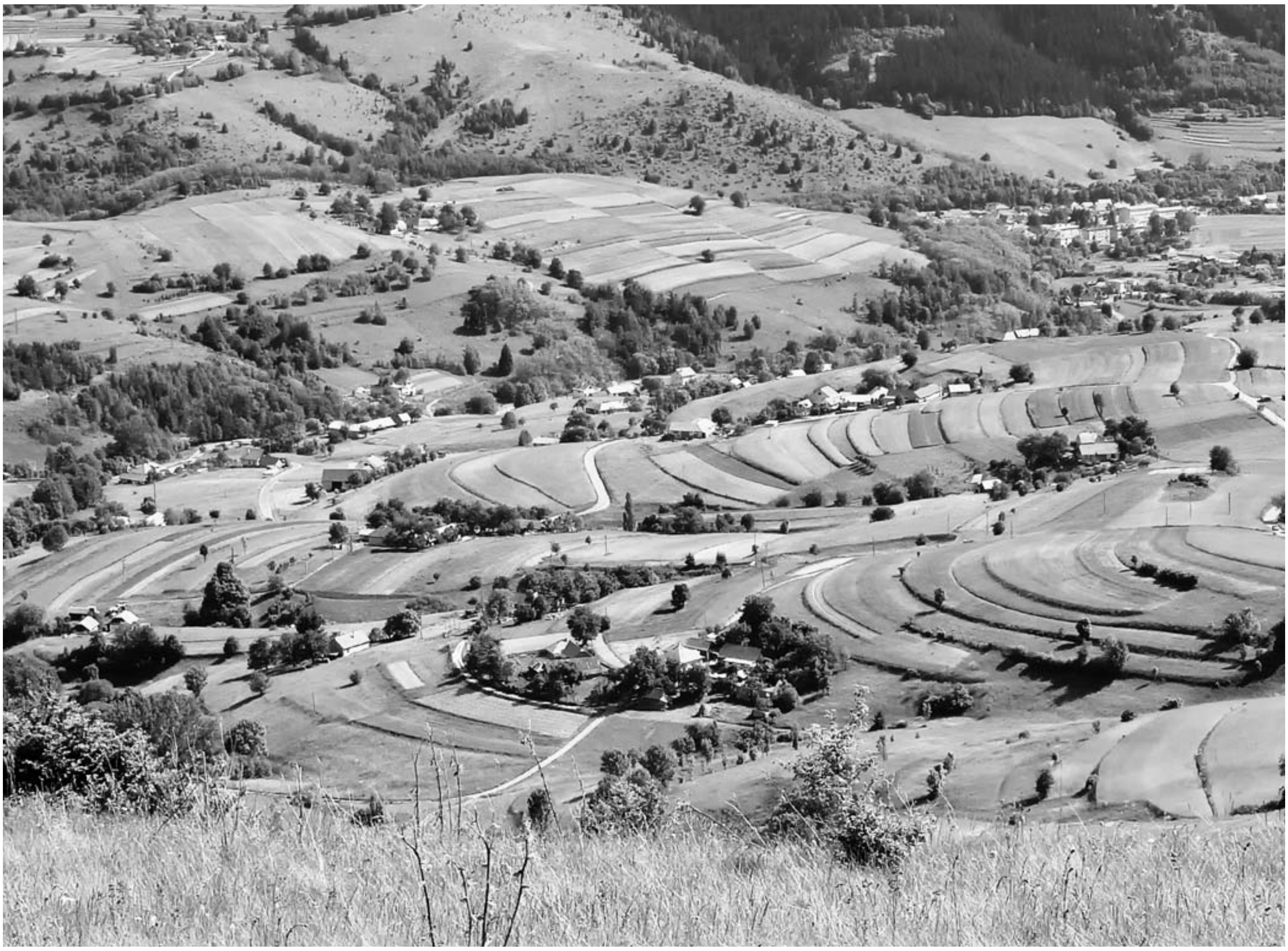

Fig. 26. *Central Slovakia, Hriňová. Dispersed settlement of Hriňová is situated on the southern slopes of Poľana stratovolcano. Photo: M. Hajnalová.* — ***Obr. 26.*** *Střední Slovensko, Hriňová. Roztroušené usedlosti jsou situované na jižních svazích zaniklé sopky. Foto: M. Hajnalová.*

the first plot was burned, and the second and new plot left to dry. In the fourth year, another plot was cut down, the second plot burned, the third and the new plot left to dry and the first plot hoed and planted with crops. If the new plot was to be used for meadow or pasture the tree stumps were left in place. Soil quality at new fields was maintained in first years by moving sheep pens directly within field boundaries and later farmyard manure was used. Manure was transported to the fields by carts, or poorer farmers, to spare their animals, carried it on their shoulders.

Osturňa has very bad soils and rather hilly terrain. Consequently, a specific crop system was developed, adapted to forest soils on the edges of possible arable cultivation. Parcels of arable land formed strips climbing from the valley bottom up the slopes. Lower plots were manured once every four years under potatoes, followed by barley, oat and finally clover/alfalfa.

Upper, less fertile parcels were farmed under a two-field cropping system. During the first fallow year, sheep pens were circulated around them in order to manure the plot and, during the second year, the plots were sown with cereals, mostly oats. Yields were extremely low, sometimes with a 1 : 1 seed ratio. The most important commodity was oat straw which served as winter fodder. Apart from the previously mentioned crops, rye was grown for grain and straw (for filling of mattresses) and flax for textiles. Fields were worked by cows. Soil fertility was so low that it was necessary to farm 7 ha of land to feed three people. As in earlier times in Transylvania, almost nothing was purchased at the market (with the exception of sugar, salt, soap and kerosene) and farmers were self-sufficient. New iron tools were obtained from wandering craftsmen, usually Gypsies, who usually repaired or re-forged old or found iron. Except for the plough, the majority of farming tools (carts included) were made of wood (this passage is based on *Chalupecký — Harabin 2004* and on a personal interview with J. Harabin sen.).

3.2.2. Central Slovakia

Hriňová

The dispersed settlement of Hriňová is situated on the southern slopes of Poľana stratovolcano (*Fig. 26*). Average temperatures, rainfall and soil fertility correspond to those in Romania. The family of Mr. Krahulec farms 11 ha (2,5 ha of arable land, 4,5 ha of meadow, 5 ha of pasture). Despite the fact that his fields are situated at

Fig. 27a, b. *Central Slovakia, Hriňová. Cereal harvest of the fields situated in 720 m a.s.l. Photo: M. Hajnalová. —* ***Obr. 27a, b.*** *Střední Slovensko, Hriňová. Sklizeň obilí na polích ležících v nadm. výšce 720 m. Photo: M. Hajnalová.*

over 720 m a.s.l., he successfully cultivates bread wheat, rye, oats and barley (*Fig. 27a, b*). The size of individual plots varies from 17 to 40 ares. Cereal grain is stored in the barn in wooden chests very similar to those in Romania or in textile bags. Part of good quality and abundant hay is also stored in the barn, but the rest is stored outside in the large hay "cones" placed near the house (*Fig. 28*). The fields as well as meadows and pastures used to be irrigated using a sophisticated network of artificial canals which diverted water from a distant stream. Individual sections of the canal network were maintained by a group of farmers, who also had an exact system of when and how long to irrigate individual plots. This irrigation system is now abandoned.

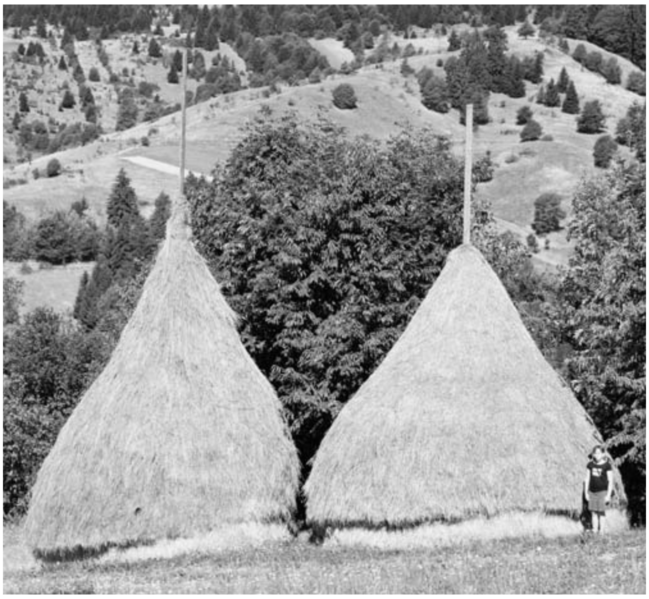

Fig. 28. Central Slovakia, Hriňová. Hay stored in the large hay "cones" placed near the house. Photo: D. Dreslerová. — **Obr. 28.** Střední Slovensko, Hriňová. Seno uskladněné na zimu v obrovských homolích vedle domu. Foto: D. Dreslerová.

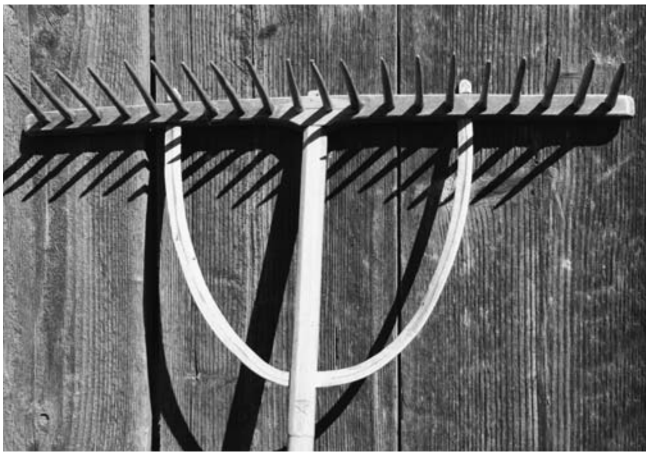

Fig. 29. Central Slovakia, Hriňová. Detail of the wooden rake made from three different species (made by P. Kralulec, photo: M. Hajnalová). — **Obr. 29.** Střední Slovensko, Hriňová. Detail dřevěných hrábí vyrobených ze tří různých druhů dřeva (výroba P. Krahulec, foto: M. Hajnalová).

Mr. Krahulec is absolutely self-sufficient in the production of all farming equipment. He makes for himself all the wooden implements he needs, and on a portable forge/smithy he makes and maintains all iron parts. He even makes for himself every part of a plough. The species of trees and shrubs from which a wooden rake (*Fig. 29*) is made is very interesting for anthracology (studies of charcoal from archaeological sites). The handle is made of maple (*Acer*) or hazel (*Corylus avellana*), the teeth from blackthorn (*Prunus spinosa*) or false acacia (*Robinia pseudoaccacia*) and the supports from pine (*Pinus sylvestris*) or willow (*Salix*). Thus, they are always made at least from three different species. If burned remains of a rake entered the archaeobotanical record, they would not represent the composition of woodland vegetation in the site vicinity, but selective choices of materials suitable for production of a particular object/tool.

Krupina

Late colonisation of this region, 20 km south of Zvolen, and very low land prices were (and still are) due to the scarcity of water sources on this volcanic plateau. The family of Ms. Fojtík, for instance, lives on a farm that has never had a source of water. Water for people as well as animals (4 cows and usually 4 calves, a pig and poultry) was carried on the shoulders in wooden buckets from a stream 2 km away. In winter, melted snow was used. Despite this, 10 hectares (5 ha of arable land with plot sizes from 30 ares to 1 ha, and 5 ha of meadows and pastures) was sufficient to support the household. Hay was harvested twice in a good year and, as in Romania, one ha of meadow gave 5 t of hay.

All three examples show that, if necessary, subsistence strategies and farming practices known already in prehistory support relatively successful adaptation and survival even in (extremely) harsh conditions. The fact that this did not happen in prehistory was rather a result of availability of so-called "better soils" in climatically favourable conditions, and not seemingly primitive prehistoric or early medieval agricultural practices.

4. Selected aspects of prehistoric and medieval farming in the light of ethnographic observations and experiments

4.1. Cultivation areas and field sizes

The extent of arable land and the sizes of individual fields found in Transylvania correspond to the generally accepted idea of the size of fields cultivated in prehistory. Intensive garden cultivation in the early Neolithic in the European loess belt is taken to imply cultivation areas as small as 1 ha per household of 5 (*Bogaard 2004*, 159). M. Beranová estimates field size in the Neolithic to be 60 x 120 m. The transition to larger cultivation areas and increased field sizes often proposed for the late Neolithic or Eneolithic (cf. *Beranová 2006*, 180) is not likely. It has been recently argued that, even if in this period some form of animal-drawn ard cultivation were practised with cows, bulls/oxen, it would lower human labour inputs per unit area but would not have led to a major increase in cultivated area compared to that which a household could cultivate by hand (*Bogaard 2004*, 33). Thus, deriving from the assumption that specialised plough animals were not widely used (*Pollex 1999*), the evidence of ard cultivation is seen only as an innovation of a limited significance (*Halstead 1995*). Extensive cultivation of larger areas with a possible production of surplus, for which trained plough oxen are required (*Halstead 1995*), probably did not start prior to the Bronze Age. We suggest that an increase in cultivated areas is also connected to increasing species diversity, and was most probably done through cultivating higher numbers of (still) small plots. Evidence for such a development can be seen in rare remnants of fossil fields in north-western Europe. Large complexes of "Celtic" fields dated from the late Bronze Age to Roman Iron Age (1100 BC – 200 AD) comprise of rectangular plots of 30 x 30 m or 20 x 40 m. These field systems cover an area from a few to a hundred hectares (*Spek et al. 2003*), though it is impossible to asses how many fields were used (farmed) contemporaneously. The same is true for so-called "block-shaped fields" from the Late Bronze and Early Iron Ages in the eastern Baltic. The system of block-shaped fields may cover an area of dozens of hectares, but individual plots are often only 20 x 20 m and less (*Lang 2007*). Use of smaller fields even in later periods document fossil fields from northern Europe. Remnants of Iron Age and early medieval field systems were recently studied at several locations in Finland. In Orijärvi several fields dated to 700 –1000 AD were excavated. Each field had a sequence of several horizons. Younger fields were larger than older ones, but their sizes are still very small and span from 120 m^2 to 400 m^2 or 850 m^2 (*Mikkola 2005*).

4.2. Manuring

Plots of einkorn in Transylvania were in most cases on manured soil, where manure was applied under other than cereal crops, usually crop preceding einkorn in rotation sequence. However, even on unmanured soil, the yield was considered satisfactory. This was most likely the result of a good crop rotation regime or the use of a fallow period. *J. L. Araus et al.* (*2003*, 691) argue that "in traditional agriculture, a decrease in the use of manure would not necessarily result in poorer soils due to the compensatory effect of the longer fallowing intervals and yields (in any one year) may have been maintained regardless of the amounts of manure applied".

Even though today it is generally accepted that manuring was practiced since the Neolithic and continued throughout the whole of prehistory (*Bogaard 2004*; *Bakels 1997*; *Zimmermann 1999*), it appears that in some cases it was not necessary. In a long-term experiment of wheat production without manure on black soils (chernozems) at Ivanovice Na Hané in Moravia, yields remained continuously good and did not decrease with time. This experiment demonstrates a high and a long-term stable natural fertility of the black soils. The concentration of plant-available P, K and Mg was still optimal for winter wheat production even after 50 years without any fertilizer input. However, the effect of the preceding crop (categorised into legumes, root crops and cereals) on the grain yield was significant. The best preceding crops for cereals were legumes followed by root-crops. The excellent value of legumes as a preceding crop especially in the absence of a fertilizer was recognized on various soils and climatic conditions worldwide (*Kunzová — Hejcman 2009*). The yield limiting factor was water supply rather than P, K or Mg depletion. Evidently, the sustainability of the system was enhanced by a rotation of cereal, legume and root crop, as wheat monocultures generally give lower grain yields than when rotation is used (*Kunzová — Hejcman 2009*). Long-term experiments with monoculture in Rothamsted, UK, in which the same cereal was grown on the same field, found a significant decrease in yield over time, both in manured and unmanured fields (*Čvančara 1962*, 334).

4.3. Winter versus spring sowing

The first appearance of spring-sown (spring growth habit) glume wheats and barley is often discussed in the European archaeology.[40] Understanding how and when the spring growth habit was adopted is important when dealing with (1) evolutionary and (2) economy concepts.

As for evolutionary concepts (1), it is claimed that spring sowing (or adaptation to different day-lengths: *Lister et al. 2009*; *Jones et al. 2008*) was a critical innovation for spreading farming practises to areas with less favourable climatic conditions in temperate Europe – beyond "climatic bottleneck" – (*Butzer 1972*, 580; *Barker 1985*; *Bogucki 1996*). It is argued that damage to crops from the harsh winters of temperate Europe could be avoided by sowing crops in spring. There are, however, alternative opinions[41]. A. Bogaard, for example, argues that in the Neolithic LBK there is strong archaeobotanical evidence for autumn sowing (of einkorn and emmer), which she suggests was possible due to a warmer climate during the Atlantic period in Central Europe (for further reading see *Bogaard 2004*, 163).

Considering economic concepts (2), autumn sowing of cereals may have been considered advantageous for farmers in two ways: first, autumn sowing involves a longer growing period and hence higher yields; second, autumn sowing may have enabled farmers to divide the tasks of soil preparation and sowing over two seasons if other crops (not cereals) were spring sown (cf. *Bogaard 2004*, 164).

The difference between winter, spring or facultative varieties (lines, cultivars or land-races) of the same genus is genetic, and does not show in cereal grain morphology. It is impossible to distinguish the growth habit of cultivated species from the recovered archaeological remains. Therefore, in archaeobotany, weeds (and their autecological, phytosociological or physiological characteristics) from the crop assemblages are used to define whether on a particular site or in a certain archaeological period cereal crops were sown in autumn, spring or both (*Wasylikowa 1981*; *Van der Veen 1992*; *Bogaard 2004*).

Literature on the ecological characteristics of wild plant taxa is rather limited. There is a general understanding that the ecology of species varies with geography and climate and use of local ecological studies is advised. Despite this, and probably due to the absence of the latter, archaeobotanists use only limited number

[40] The first domesticated wheats (and barley) had, similarly as their wild progenitors, a winter growth habit and required vernalization. Spring growth alleles evolved independently through various types of spontaneous mutations or deletions. Spring type mutants should have been selected for cultivation in regions where winter coldness is too mild to vernalize winter type wheat or where winter coldness is too severe. Cultivation of wheat grown from spring to summer enables the spread of wheat cultivation to less favourable climatic regions (*Kato 2006*, 27; *Liuling et al. 2004*).

[41] Some recent works propose additional mechanisms, which could explain the reduction of crops: the removal of adaptive pressure for crop diversity in the Mediterranean and pre-LBK, and cultural preferences for glume wheats, possibly because of their advantages over free threshing wheats in storage and transport (*Conolly — Colledge — Shennan 2008, 2803*; *Kreuz et al. 2005*).

of sources, sometimes from very distant regions.[42] The results of our survey of Transylvanian and Slovakian einkorn fields sown both in winter and spring (*Hajnalová — Eliáš in prep.*) will, apart from other data, provide information on weeds response in the Carpathians to the two einkorn sowing times.[43]

4.4. Weeds and weeding

The role of fossil weeds in studying former agricultural practices has been discussed by various authors (for a detailed discussion see *Bogaard 2004*, 7–9, 21–49). However, there are many problems with the application of modern plant species characteristics to the past. For example *K. Wasylikowa* (*1984*) describes how the tillage/weeding of field crops changes the composition of weeds and how this effects the archaeobotanical assemblage. She states that weeding or tilling of winter crops in the spring (once or repetitively) eliminates winter weeds in favour of spring weeds. Thus, in the harvested grain of winter cereals, spring weeds will dominate. Among other problems (cf. *Van der Veen 1992*, 105–109) is, first, use of ecological indicator values from distant climatic regions (this is incorrect as behaviour of plant species changes with climatic gradients), and second, using information on weed communities growing among crops which have not grown in the past (like winter rye and spring oat which has not altered cultivation in Europe before the turn of the eras) and which developed under the application of a different range of agricultural operations than had been used in the past (like deep mouldboard ploughing or specific crop rotations).

Here we discuss observations on the presence or absence of weeds in the harvested crop, as observed in Transylvania and present some implications for archeological interpretation of archaebotanical evidence.

In the studied region all cereals are almost never weeded and harvested low to the ground. If cereal straw is being used further in the production (e.g. basketry, hats, thatching), abundant weeds are cleared from the sheaf in the field by a specific but simple procedure described earlier in the text. Weeds are left in the field and home is transported weedless crop. Rarely a few weeds – mostly those which cling to the straws – are still present. At home ears are separated from straw (before or after threshing). Straw and threshed ears (grain for free-threshing cereals or spikelets for glume wheats) are stored separately, straw in the barn and spikelets in the house. If such material is found in archaeological context, following interpretations may be drawn. Grain or spikelet store free of weeds would correctly be interpreted as final product, i.e. fully cleaned (grain) or semi-processed (spikelet) store. However, the absence of weeds in the waste of final spikelet processing could be seen as a result of harvest of ears by plucking, harvesting very high on the stem, or elimination of weeds from fields by intensive weeding. As documented by our fieldwork, such interpretations would all be incorrect.

Accordingly, we suggest keeping this ethnobotanical observation in mind when evaluating some of the weed-poor assemblages. It is possible that in the past just as in the observed case straw had been a valued commodity and cereals had been processed in a similar way.

In the archaeobotanical literature it is commonly mentioned that (repetitive) tilling and/or weeding (by hand or hoe) positively effects the cereal crop. This we believe to be correct, but it is interesting to note that farmers in Romania had a different opinion on the subject. In general, weeding or hoeing of cereal fields is rarely done (see above). The majority of farmers when interviewed at their weed abundant fields mentioned that weeding is unnecessary, that weeds are actually good as they keep the soil moist. We have also seen a few fields overgrown by weeds to such an extent that at first glance we thought they were fallow. Those, usually more distant plots, were reported to be used only as animal fodder. Moreover, in central Hungary one of the authors had been very surprised to hear that weeding is actually bad for the plants, as it "disrupts the calm life of the plants".

4.5. Yields

Cereal yields and productivity are the most important and highly discussed points in assessments of palaeoeconomic models. The questions of diet, subsistence, famine or surplus are frequently connected to the cereal/plant production, albeit in some cultures it did not play a leading role. Cereal yield is often taken as a measure of the degree of progress of a society. Therefore, we discuss this theme in more detail than other aspects of farming.

One of the most frequently used sources of evidence for crop productivity in the agricultural systems of the past few millennia are the records of the present-day crop productivity. However, the use of modern yields to estimate ancient and early medieval yields is based on assumptions, some of which seem not to be valid. Thus, to estimate yield in the past using the modern data has its pitfalls (cf. *Araus et al. 2003*, 683).

(1) *The potential yielding capacity of the cultivars currently grown is far higher than that of ecotypes and land races of the past*

We think that this is disputable and most likely untrue for einkorn, emmer and old land races of other cereals. As already mentioned above, these almost disappeared from cultivation before the Middle Ages and since then have been cultivated only as a marginal crop. Consequently, they have not been genetically manipulated towards higher yields. Therefore, yields of these crops, recorded in areas with surviving traditional agriculture are most likely close to those of the past.

[42] E.g. the use of Ellenberg's indicator values for the study of Neolithic weed assemblages from the Balkans (*Kreuz et al. 2005*).

[43] In Transylvania, apart from 98 plots of einkorn, we also surveyed plots of bread wheat (17), rye (10), two-rowed barley (10), oat (14), Triticale (1) and two-year fallow (1); in Slovakia, the weed data from fields of bread wheat, rye, barley and oat come from over 100 plots farmed with a low level of mechanization.

(2) *Environmental conditions of any region differ from the past*

Environmental conditions of any region differ from the past as a consequence of two major environmental factors, which remarkably affect cereal yields. The first is the level of atmospheric CO_2 and the second is drought. According to *J. L. Araus et al.* (*2003*) the present situation is quite different from that in prehistoric times.

As a new approach to crop yield estimation of ancient agriculture *J. L. Araus et al.* (*2003*, 684–689) developed a model based on carbon isotope discrimination from fossil (and modern) grains. Because concentrations of atmospheric CO_2 affect the growth and yield of cereals (higher CO_2 values – higher yields), and its current values are believed to be higher than they were in prehistory, they decided to use correction factor 0.6 (40 %). This value derives from difference in yield calculated between plants grown at 275 $\mu l\ l^{-1}$ (stabile Holocene CO_2 concentration prior to 1958 measured from ice cores) and 350 $\mu l\ l^{-1}$ (modern value). They estimated the yields of naked wheat (*Triticum aestivum/durum*) ca. 1450 ± 280 kg ha^{-1} for Neolithic Tell Halula (ca. 9000 BP.). This is lower than modern yields in the region under irrigation (5360–6020 kg ha^{-1}), but it is higher than yields for rainfed cereals in this region (500 kg ha^{-1}).

The studies on density of leaf stomata from buried soil and peat deposits show, that the concentrations of CO_2 in Holocene were not as stable and low throughout the Holocene as it is suggested by values measured in ice cores. On the contrary, they considerably varied, and in some periods reached even modern levels (*Van Hoof et al. 2008* – for medieval period and modern times; *Wagner — Aaby — Visscher 2002* – for early Holocene 9000–6500 cal BP). This might have affected the productivity of cereals in some periods of prehistory both positively and negatively. It could be of interest to correlate the archaeological or archaeobotanical data (e.g. on assortment of plants) with the peaks in fluctuation curve of CO_2 concentration.

Drought is an important factor mostly in Mediterranean part of Europe. It perhaps was not crucial in temperate Europe with its relatively high annual rainfall. According to the climatic model of R. Bryson (*Bryson — McEnaney DeWall 2007*) for Bohemia, rainfall patterns throughout prehistory did not differ much from the present. However, there are areas in Central Europe (like the south-western Slovakia, the territory occupied by LBK), where in some periods of the Neolithic and Bronze Age was rainfall so low and temperatures so high that potential evaporation exceeded precipitation, what could cause droughts (according to R. Bryson, modelled by M. Hajnalová). Accordingly, each region should be evaluated individually taking into account the time period under investigation.

(3) *Soil fertility today and in the past is different*

Soil fertility[44] usually expressed by highly abstract and subjective terms such as “good soil”, “soil of lower quality” or “soil more difficult to till”, is one of the few factors almost impossible to model. Soil with its attributes in prehistory may have been different from the present situation in both directions; it may have been subjectively “better” as well as “worse”. Some specialists in agriculture believe that under the suitable soil management regime soil is not being exhausted, but on the contrary, nutrients content increases. Thus, the modern soil condition would be a result of natural soil development as well as previous human impact (cf. *Gerlach et al. 2006*).

If we are going to compare yields of einkorn from traditional farming on brown soils in Transylvania, they will be most probably similar to yields on brown soils in climatically similar, even if geographically distant regions.

(4) *Tillage methods and arable practices are different*

As for the critique of different tillage methods and farming practices between prehistory and low-mechanised traditional agriculture today, we do not see a fundamental difference here. As innovations we understand (only) modern plough, iron harrow and system of crop rotation.[45] In Transylvania the einkorn yields obtained from a field worked only by hand (hoe) or by animal drawn plough were very similar (when comparing the number of harvested sheaves from a unit of land). Moreover, long-term experiments with spring barley at Ivanovice Na Hané have shown that shallow ploughing (max. 15 cm) has a positive effect on the yields. Very satisfactory is also sowing of spring barley to unworked soil. This works well mainly in areas with favourable edaphic-climatic conditions (like chernozems with sufficient rainfall) and after a suitable fore-crop. Further it has been assessed that the best yields of spring barley were when stubble of previous crop has been burned before sowing (*Badalíková — Hrubý 2006*).[46] *V. Vallega* (*1992*) states that under traditional farming and “adverse growing conditions (harsh climate and poor soils) in Italy, einkorn selections produced protein and yield equal to or higher than barley or durum wheat. (...) However the einkorn yields were significantly lower than modern wheats when grown under intensive cropping”. These results are in support of “primitive” cultivation techniques against modern deep ploughing.

4.6. Estimates of cereal yields based on experiments, ethnographic or historic sources or their combination

Amy Bogaard collected a variety of experimental, historical and ethnographic data on cereal yields and ar-

44 Soil fertility is an ability of providing plants with living conditions which would satisfy needs of plants (for water, nutrients, air and anchor during the whole vegetation season securing the harvest). It is not an absolute, but relative value with regard to given (abiotic and climate) conditions, cultivated crop and human inputs to soil during the tilling process. Soil fertility is a cumulative attribute of a whole set of physical, biological, and chemical characteristics of the complete soil profile.

45 In prehistory modified branches or wooden harrow could have been used, and since La Tène period also with iron teeth (*Pieta 1996*, 40 – Tab. II: 6–9).

46 Other tested variables were: stubble ploughed under, freezing intercrop, combinations of the first two, burned stubble and 10 t ha^{-1} FYM.

chaeological estimates of crop and cultivated area requirements (*Bogaard 2004*, Tab. 2.1, 24–25). Further supplemental data are listed in Tab. 5, 6 and 7.

From this overview and from other observations it is clear that under experimental conditions the cereal yields are generally higher (e.g. 0.45–4 t ha^{-1}) than recorded from ethnographic or historical data. It is most probably due to higher energy input, individual approach to plants, harvest at the best time and low post-harvest losses. On the other hand, suggested practices for prehistoric farming, especially for the Neolithic intensive garden cultivation (*Bogaard 2004*) with manuring, tilling and weeding, could have secured the cereal yields as high as the experimental ones. Ethnographic observations are also relatively high (0.8–2.5 t ha^{-1}). The lowest yields are recorded by historical sources, mostly for the medieval or post-medieval periods. *A. Bogaard* (*2004*) mentions for medieval and post-medieval Europe the cereal yields with the seed-yield ratios only between 1 : 2.5 and 1 : 5. According to M. Beranová (*1980,* 302) feudal farmers could have produced, on average soils and application of three-field system with fallow, yields 1 : 3 to 1 : 4. In the 18th century Habsburg Empire, yields in Lower Austria were for barley maximum 1 : 5 – 1 : 8 and for (bread/macaroni) wheat 1 : 10. Only in fertile areas of Moravia may have reached 1 : 15 – 1 : 20. Elsewhere within the Empire wheat and barley was hardly more than 1 : 5 (Hermann 1782, according to *Kunz 2004*, 123). The cause of such low yields was most probably the widely applied three-field system. The soils were under intensive use and unsufficiently manured. Therefore, they rapidly exhausted and yields decreased. Under long fallow system (often considered for prehistory and early medieval period) or under rotation system the yields are far higher. Data from parts of Russia, where long-fallow system was applied, show average yields from 1 : 7 to 1 : 12/14, while from the central Russia the yields of cereals grown under three-field system were only 1 : 2.5/3.5 for winter crops, and 1 : 2.5 for spring crops (*Beranová 1980*, 311–312).

Prior to the second half of the 20th century, before artificial fertilisers and genetically modified cereals, yields were the most dependent on edaphic and climatic conditions of the region. Farming practices, such as tilling, cultivation methods and post harvest processing also played a significant role. That is why the yields may have significantly varied even between seemingly similar regions. On the other hand as shown in *Tab. 5*, yields of glume wheats from various parts of Europe and the Middle East are similar, better phrased, they move within the same boundaries with similar average values.

4.7. Regimes of cultivation

Apart from vegetables rarely preserved in archaeobotanical assemblages and apart from potatoes and sweet-corn which came to Europe in modern times, the assortment of field and garden crops cultivated in Romania today is similar to those cultivated in the later prehistoric periods. There are fourteen crops known to date from the Bronze and Iron Ages in Slovakia (*Hajnalová 1989a*), in Moravia and Bohemia the widest spectra of fifteen crops is known from La Tène period (*Kočár — Dreslerová 2010 this volume*) or sixteen crops respectively (together with a unique assemblage of *Medicago* spp. *Bouby — Hajnalová in prep.*).

In this context, we hypothesise about possible rotation cultivation of crops in prehistory, similar to rotation observed in Romania. A sort of rotation had to be, at least to some extent, practised, if cultivated plots were not left fallow after each harvest for a longer period of time. However, this is contradicted by the majority of recent analyses of weeds suggesting very brief annual or biennial fallow periods. Some crops do not stand continuous cultivation at the same plot (they yields decrease, unless some soil improvement technique is practiced). Modern agronomy suggests that some of the crops can only appear at the same plots after a few years. Intolerant to continuous cultivation are wheat, barley, pulses, and highly intolerant are flax and oat (*Čvančara 1962*, 529). In the prehistory the crops could alternate as this: winter cereal/fallow – spring crop/fallow – pulse crop.

If this assumption is valid, then medieval innovation and adaptation of three-field system, which is understood by many scholars (cf. *Vašků 1995*) as the revolutionary agricultural improvement, has been – in comparison to the prehistoric agriculture – a historical dead end. It enabled cultivation of cereals on relatively larger plots (as areas of fallow increased) and fed more people, but the whole system was fragile and resulted in famines which swept Europe in High Middle Ages and post-medieval times. In fast rotation of winter crop – spring crop – one year fallow, crops with low mutual tolerance may have followed, for instance, winter cereal and spring cereal (cf. *Čvančara 1962*, 334). One year fallow with low manure input did not enable sufficient regeneration of soil, which continuously degraded. Insufficient manure has been a result of keeping low numbers of animals, due to insufficient areas of pastures and meadows. However, the lands convertible to pastures were Royal or private hunting grounds. This drawback was removed only with changes in farming practices, mostly with improved sowing regimes. For example, in the Netherlands of 14th–16th century AD sowing of beet after wheat or flax as fore-crops in the same year was an innovation, which led to doubling of wheat yields during the three centuries (*Petráň — Petráňová 2000*, 154).

5. Conclusion

The article presents results of ethnographic and ethnobotanic survey of some elements of traditional farming in geographically similar regions of central and south-eastern Europe.

Even if our findings are modest, they are a fortiori valuable; because by the time this article is published many of the Transylvanian einkorn fields will have ceased to exist. Individual observations are compared or confronted with knowledge and ideas about prehistoric farming. We came to the conclusion that there are no major differences between aspects of traditional and ancient forms of arable farming and that they perhaps differ less than prehistoric and high- or post-medieval agriculture.

Generally, in the regions with soils of mediocre quality (as in Dobó in Transylvania, central Slovakia and most Bohemia) 1 ha of land (field, meadow and pasture) is needed to support one person. In sub- and mountainous areas this has to be larger. The family needs to seek also other forms of income (craft or selling labour), if it does not have enough land.

Albeit there are disadvantages of ancient glume wheats to other species (mostly to bread-macaroni wheat), i.e. smaller grain sizes, lower harvested volumes per unit area and time consuming dehusking process, the glume wheats are undemanding on soil and climate, resistant to pests and diseases, and if needed, (some varieties) cultivable both in winter and spring. Cultivation of the ancient species does not have to be the sign of underdeveloped agricultural practices. On the contrary, this may very well indicate the conservation or maintaning of highly valued traditional elements of the life of society, as the excellent traditional taste (emmer pearl) or traditional crafts (einkorn straw).

As a rule, the medieval agriculture serve as a "prototype" for modelling farming practices in prehistory. There are no proofs to demonstrate that the prehistoric farming systems were as inefficient as the medieval three-field system. We have to recon with the fact that prehistoric population growth was only very gradual (*Neustupný 1983*; *Kooijmans et al. 2005*) and due to high yields of intensive, fallow and swidden farming or farming with rotation of the well-chosen crops (see *above*), the area of suitable arable land was still sufficient. There is a reason to believe that in prehistory, thanks to variability of cultivated crops and availability of land, which enabled flexible fallow system, scarcity of suitable arable land was not a case.[47]

As we have shown on the example from Romania, some of the traditional practices probably well-tried already in prehistory are universally valid, same as yields that can be similar for millennia. It is necessary to note that soil is not exhausted under the *right* farming practice and on the contrary it can improve, especially if manured. However if the heavy machinery is used and artificial fertilisers, which change the physical soil characteristics are massively applied, then soil losses its ability to absorb water and manage the soil humidity. Intensive use of plots of arable land, where under extreme rotation the surface is for the most of the year opened and subjected to the massive wind and water erosion, results in floods as we have increasingly witnessed in the last few years. For the price of minimal input of human labour and maximal momental yield, we are getting to a similar dead end, as was the case of the three-field system.

We think, that the traditional agriculture we were able to observe and document will unfortunately cease in the forthcoming years. We hope, that the work we have done would help to preserve the knowledge of the past agricultural practices and traditional rural life. At the same time, we think that ethnographic research of living culture is needed, even at the beginning of the 21st century and in the environment of developed unified Europe. It can still enrich prehistoric and historic knowledge of small, but no negligible information, useful for understanding and modelling of extinct economic and social forms. It further helps us to understand; that not all what is considered progressive today is better than that what is named ancient or archaic.

English by M. Hajnalová

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Souhrn

Článek přináší výsledky etnografických pozorování určitých prvků tradičního zemědělství, které byly prováděny v letech 2004–2008 v rumunském Sedmihradsku a podhorských oblastech Slovenska (*obr. 2, 3, 24*). Účelem výzkumu bylo shromáždit materiál, který by pomohl osvětlit fungovaní pravěkého zemědělství. Zvláštní pozornost byla věnována pěstování pšenic jednozrnky *(Triticum monococcum)* a dvouzrnky *(Triticum dicoccon)*. Tyto u nás nejstarší pěstované obilniny hrály důležitou roli přinejmenším po celý starší zemědělský pravěk. Jednozrnka je stále ještě v minimální míře pěstována na malém území v podhorských oblastech hnědých půd v rumunských provinciích Hargita a Maros; zdejší osídlení spadá již do neolitu. Pěstování dvouzrnky na Slovensku zaniklo teprve zcela nedávno. Získané poznatky byly srovnány s dosavadními názory, týkajícími se určitých aspektů pravěkého až středověkého zemědělství, které se objevují v archeologické a historické literatuře.

Etnobotanický a etnografický výzkum v Rumunsku

Etnografická pozorování navazovala na předcházející etnobotanický výzkum společenstev plevelů na jednozrnkových polích, který sloužil jako metodický základ vyhodnocování archeobotanických souborů v archeologických situacích a k řešení otázek spojených s praktikami pěstování a zpracování obilnin v pravěku. Následně byl výzkum rozšířen o ty aspekty tradiční zemědělské výroby, jejichž analogie lze hledat v pravěkých zemědělských systémech. Je to pěstování a zpracování dalších zemědělských plodin, rozloha a velikost polí a způsoby jejich obdělávání, členění zemědělské krajiny a její produkční schopnosti v závislosti na rozdílných klimatických a půdních vlastnostech a formách tradičního obdělávání. Současná pozorování jsou konfrontována s dosavadními názory na pravěké a středověké zemědělství, zejména s odhady velikosti úrody obilnin.

Pěstování jednozrnky v Rumunsku se děje v rámci běžného zemědělského hospodaření malorolníků, i když je dnes pěstována

[47] The extreme example of prehistoric "perpetum mobile" based combination of all known systems: small field on chernozems with simple rotation of cereal-pulse crop and grazing by animals including pigs immediately after harvest. Field would "weed and manure itself". Eventually remaining weeds could be destroyed by occasional stubble burning.

již jen ke specifickému účelu vedlejšího výdělku vedle vlastního výnosu zemědělské produkce. Její sláma je totiž používána na výrobu klobouků a slaměných ozdob. Proto jednozrnku pěstuje již jen hrstka rolníků (většinou přesáhli sedmdesátku), kteří dožívají na malých hospodářstvích s průměrnou výměrou asi 4,5 ha. Po zrušení kolektivizace před dvaceti lety dostali rolníci zpět pozemky, ale žádnou zemědělskou techniku. Obdělávají pole tradičním způsobem pomocí zvířecího zápřahu k orbě a vláčení, někteří malovýrobci pole zpracovávají rýčem. Hnojí se nepravidelně maštalním hnojem. Seje se ručně rozhazováním v průměru kolem 0,17 t ha^{-1} zrna. Jednozrnka se pěstuje jak ozimina i jako jařina, i když více rolníků dává přednost podzimní setbě, pokud jim to čas a počasí dovolí. Pro obě setí se používá stejné zrno. Někteří rolníci pole plejí, jiní nikoliv, ale většinou odstraňují z pole selektivně bodláky (*Cirsium* spp., *Cardus* spp). Setkali jsme se i s názorem, že pletí škodí, protože narušuje přirozený klidný život rostlin a nadto přítomnost plevelů zabraňuje vysychání půdy. Sklizeň je prováděna výhradně ručně srpy, většinou se zubatým (vroubkovaným) ostřím (*obr. 10*). Jednozrnka se sklízí těsně nad zemí, aby se uchovala co nejdelší stébla, která dorůstají až 150 cm (*obr. 1*). Úroda se suší doma (*obr. 13 a, b*) a zrno se vytlouká malými dřevěnými prkénky (*obr. 17*).

Zvláštní pozornost byla věnována sledování úrody, která bývá často v archeologické literatuře považována za jakýsi ukazatel pokroku nebo stupně vývoje společnosti. K výpočtu úrody bylo použito měření ze čtyř metrových čtverců na čtyřech různých políčh obhospodařovaných různým způsobem. K tomuto kroku jsme přistoupili, protože údaje dotazovaných rolníků týkající se výnosů, byly velmi nejednoznačné. Úroda je většinou vyjadřována pojmy dobrá, dostačující, špatná a udávána v množství snopů nebo v násobku zasetého množství, které je odhadováno na šesti- až desetinásobné. Výsledky experimentu obsahuje *tab. 4*; průměrná úroda jednozrnky byla stanovena na 2 t ha^{-1}.

Výsledné množství obilí, které zbyde po vymlácení a uskladnění však odpovídá pouze části teoretické úrody, kterou odhadujeme na poli podle zasetých zrn nebo vzrostlých stébel a klasů. První ztráty vznikají již tím, že nevyklíčí všechno zaseté zrno; u tzv. primitivních pšenic může být tento handicap do jisté míry kompenzován tím, že při dostatečném množství místa ostatní zrna víc odnoží. Pozorované množství odnoží se pohybovalo mezi pěti až dvanácti. Další ztráty vznikají na poli kvůli hlodavcům, okusu vysoké nebo divokým prasatům. Jednozrnka jako pluchatá pšenice okusu odolává, na druhou stranu je velmi ohrožena ptáky, zejména v době sušení, pokud probíhá venku. Jestliže se námi odhadovaná průměrná úroda pohybuje kolem 2 t ha^{-1} a rolníci uvádějí šesti až desetinásobek úrody, tj. 1,2 t ha^{-1} a 2 t ha^{-1}, vychází odhad posklizňových ztrát na 0–40 % úrody. *E. Rozsypalová* (*2000*, 69–70) odhaduje ztráty při sklizni, převozu a výmlatu na 17–20 % na 1 ha. Zdá se tedy, že naše pozorování ztrát je realistické.

Způsob obdělávání polí je rotační, většinou ve sledu obilnina – okopanina – kukuřice/luskovina/pícnina, někdy bývá do rotace zařazen úhor. Na polích je dnes pěstováno 17 druhů plodin (včetně několika druhů zeleniny). V Čechách a na Moravě dosáhl počet známých pěstovaných plodin v mladším pravěku 14 (halštat), resp. 16 druhů (latén). V této souvislosti se neubráníme úvaze o možném rotačním způsobu pěstování plodin v pravěku, ke kterému muselo nějakým způsobem docházet, pokud by nebyl po každé sklizni zařazen úhor. Některé rostliny se totiž samy po sobě nesnášejí a mohou se na témž honu opakovat až po jistém počtu let. Místo současné rotace obilnina – okopanina – kukuřice/luskovina/pícnina mohly v pravěku teoreticky alternativně rotovat tyto plodiny: ozim/úhor – jařina/úhor – luskovina.

Pole, louky a pastviny tvoří pestrou mozaiku okolí vesnic. Pole jsou vždy umístěna nejblíž intravilánu, všechna maximálně do půl hodiny chůze, pak jsou považována za nerentabilní. Odlesněná půda je rozdělena na pole – louky – pastviny přibližně v poměru 2 : 1 : 0,8 (*obr. 21*; platí to ovšem za situace, že část krmiva skotu a koní je pěstována na polích ve formě pícniny). I když dnešní krajinný model nemůže být transformován do pravěku, rozdělení odlesněné půdy koresponduje s některými odhady pro pravěk, kdy přílohová část polí byla využívána jako pastvina (*Dreslerová 1995*).

Velikost polností (polí, luk a pastvin) námi sledovaných usedlostí se pohybovala mezi 1–16 ha (*Tab. 7*). Rolníci, kteří vlastní méně než 1 ha na jednoho člena rodiny, si přivydělávají řemeslem nebo námezdní prací; přebytky zemědělské produkce jsou stále ještě směňovány na trhu, především vejce, drůbež, sýr nebo zvířata. Prodej zrna nebyl překvapivě nikdy zmíněn.

Etnografický výzkum na Slovensku

Podhorské regiony moravsko-slovenského pomezí, jihovýchodního Polska a Slovenska byly až do poslední třetiny 20. století oblastmi, kde se nejdéle uchovávalo tradiční zemědělství. Druhá z nejstarších pěstovaných plodin u nás, pšenice dvouzrnka (*Triticum dicoccon*), se pěstovala v severní části východního Slovenska a na Krupinskej pahorkatině ještě do 70. letech 20. stol. („skrytá" pod lidovým označením tenkel, gengel, *Tempír 1963*; *1976*), i když se obecně soudilo, že její pěstování zaniklo nejpozději ve vrcholném středověku. Archaické pšenice se však udržely v hospodářství kvůli svým kvalitám – především nenáročnosti a specifické chuti. Dvouzrnka byla ve 20. století vysévána především na podhorské písčité nebo kamenité půdy na kopcovité pozemky nejčastěji na lazech jako jařina. Netrpěla chorobami, nepoléhala. Vysévala se na nehnojená pole a v neúrodných polohách, kde jiné plodiny dávaly nízké hektarové výnosy. Dvouzrnka se také vysévala na čerstvě vyrubané místo, upravené jen motykami, nikoliv pluhem. Podle některých pěstitelů však vyčerpávala půdu a proto bylo potřebné po ní hnojit nebo nechat půdu úhorem. Výnosy dvouzrnky se pohybovaly mezi 2–2,5 t ha^{-1}.

Na počátku 21. století jsou již stopy tradičního zemědělství na Slovensku takřka neznatelné. Nicméně, při průzkumu lazů Krupinskej pahorkatiny, Hriňové na středním Slovensku a oblasti Pienin (*obr. 24*) jsme shromáždili některé zajímavé údaje, důležité pro pochopení dalekosáhlé variability a přizpůsobivosti zemědělské výroby podmínkám, které jsou často pro podobný způsob obživy nevhodné.

Obec Osturňa (*obr. 25*), jedna z nejchudších slovenských obcí vůbec, byla založena kolem poloviny 16. stol. Zemědělská půda se získala z lesní půdy. Odlesňování půdy trvalo čtyři roky. První rok se vyrubala část lesa, užitkové dřevo se odvezlo a zbytek se nechal sušit na pasece. Druhý rok se vyrubala další část lesa a předchozí část se nechala dále sušit. Třetí rok se na první ploše dřevo spálilo, druhá a třetí plocha se sušila a vyrubala se další část lesa. Čtvrtý rok se první plocha překopala ručními nástroji a osadila se plodinami, druhá plocha se spálila, další se dosoušela a další vyrubala. Nově vyrubané pole se zpočátku hnojilo košárováním ovcí a dobytka přímo na poli, později maštalním hnojem, který se na pole vyvážel buď na kárách nebo ho chudší farmáři nosili na zádech, aby ušetřili zápřah.

Velmi špatné zemědělské podmínky byly příčinou vzniku svérázného osevního postupu adaptovaného na polnohospodářskou půdu na okraji lesního pásma. Na dolní, úrodnější části parcel se hnojilo jedenkrát za čtyři roky pod brambory, po nich přišel ječmen, po něm oves a nakonec jetel. Horní méně úrodné části parcel se obhospodařovaly dvojpolním osevním postupem. Jeden rok se úhorovaly a hnojily košárováním a na druhý rok byly tyto plochy oseté obilím, obyčejně ovsem. Výnosy byly přirozeně velmi nízké, někdy bylo zmnožení výsevku dokonce jen 1 : 1; hlavní význam však zde měla sláma jako zimní krmivo pro dobytek. Úrodnost půdy byla tak nízká, že k obživě tří lidí bylo potřeba až 7 ha půdy (*Chalupecký — Harabin a kol. 2004* a podle vyprávění J. Harabina st.).

Obec Hriňová (*obr. 26*) leží poblíž středoslovenské Detvy. Průměrné teploty, srážky i půdy na sopečném podkladě v této oblasti odpovídají úrodností sledovaným územím v Rumunsku. Pan Krahulec s rodinou hospodaří na 11 ha (2,5 ha pole, 4,5 ha louky, 5 ha pastviny). Přesto, že jeho pole leží v nadm. výšce kolem 720 m, bez obtíží pěstuje pšenici i další plodiny. Velikost obdělávaných ploch (*obr. 27*) se shoduje s poli v Sedmihradsku. Pole byla dříve zavlažována pomocí několik km dlouhého umělého zavlažovacího kanálu, který odváděl po úbočí vodu z potoka pod Poľanou. Kanál byl udržován skupinou rolníků, kteří podle určitého systému odpouštěli vodu na své pozemky. Nyní je zavlažovací systém zpustlý.

Co se týče výroby zemědělských nástrojů, je p. Krahulec plně soběstačný. Vyrábí všechny dřevěné nástroje a na přenosné příruční kovárně si sám ková všechny kovové součásti nářadí. Sám vyrábí kompletně i pluh. Z hlediska analýzy uhlíků v archeologických nálezech je velmi zajímavé, jaké materiály používá při výrobě hrábí (*obr. 29*). Rukojeť je vyrobena z javoru nebo lísky, pstružka z vrby nebo borovice a zuby z akátu nebo trnky; každé hrábě jsou tedy vyrobeny minimálně ze tří druhů dřeva. Pokud by se zuhelnatělé zbytky hrábí objevily v archeologickém výzkumu mezi uhlíky, neodrážely by složení porostu kolem lokality, jak to bývá často interpretováno, nýbrž selektivní výběr materiálů vhodných pro výrobu určitého předmětu.

Rodina paní Fojtíkové z Krupinských Lazů hospodařila donedávna na celkové rozloze 10 ha (5 ha polí s parcelami od 30 arů do 1 ha, 5 ha luk a pastvin, pole obdělávaná kravami). V dobrém roce se kosilo 2x, produkce sena byla kolem 5 t/ha, tedy stejná jako v Rumunsku. Zvláštností tohoto hospodářství je fakt, že nemělo zdroj vody. Proto byla oblast dlouho neosídlená a cena půdy nízká. Voda pro domácí zvířata (v počtu 4 ks dospělých krav a většinou 4 telat) se nosila na zádech v dřevěných putnách z potoka vzdáleného 2 km.

Všechny tři uvedené příklady ukazují, že v případě nezbytnosti se dá zemědělskými metodami známými již v pravěku celkem úspěšně hospodařit i v (extrémně) nevhodných podmínkách. To, že k tomu zřejmě v pravěku nedošlo, bylo spíše způsobeno dostatkem tzv. lepší půdy v klimaticky vhodnějších oblastech a nikoliv zdánlivou primitivností pravěkých nebo raně středověkých zemědělských systémů.

Poznámky k archeologickým a historickým interpretacím tradičního zemědělství

Obecně platí, že v podmínkách průměrných půd (jako je region v okolí Dobeni, na středním Slovensku a na velké části Čech) je potřeba k obživě jednoho člověka asi 1 ha zemědělské půdy. V podhorských a horských podmínkách musí být tato rozloha větší. Pokud rodina nevlastní dostatečnou rozlohu, musí být income doplněn řemeslem nebo námezdnou prací.

Až do zavedení průmyslových hnojiv a geneticky upravených druhů obilnin ve druhé polovině 20. stol. závisel výnos z polí především na půdně klimatických podmínkách regionu. Nemalou úlohu hrál i způsob hospodaření, zejména péče při zpracování půdy a následném pěstování a zpracování plodin. Tak se mohou ve výsledném výnosu lišit i zdánlivě velmi podobné regiony. Na druhou stranu, jak ukazuje tabulka výnosů obilnin z různých částí světa (*tab. 5* a *7*), zjištěné výnosy jsou si velice podobné nebo lépe řečeno, pohybují se ve stejných hranicích s podobnými průměrnými hodnotami. Rozhodně zajímavé je srovnání výsledků našich etnografických pozorování ve vztahu k uváděným výnosům pšenice z císařských velkostatků v Čechách v letech 1886–1895 a 1896–1900. V prvním časovém intervalu byl průměrný výnos pšenice 1,4 t ha^{-1} a ve druhém 1,39 t ha^{-1} (*Křivka 1989*). I když průměrné výnosy se dají používat ke srovnání jen s obtížemi, přece tento údaj naznačuje, že při tzv. primitivním, maloplošném obdělávání dosahovaly archaické druhy pšenic jednozrnky a dvouzrnky výnosů srovnatelných s „vyspělým" zemědělstvím druhé poloviny 19. stol., zatímco středověké a raně novověké výnosy byly (mnohem) nižší.

Archaické pšenice jednozrnka a dvouzrnka sice v porovnání s ostatními druhy (před *T. aestivum*) představují nevýhodu ve formě menších zrn, menšího objemu sklizně a většího objemu práce při odpluchování zrna, na druhou stranu jsou tyto odrůdy velmi nenáročné, co se týče půdních i klimatických podmínek, jsou odolné proti škůdcům i chorobám a dají se podle potřeb pěstovat jako ozimy i jako jaře. Pěstování tzv. archaických plodin nebo plodin, které tzv. vyšly z módy, nemusí být známkou zaostalosti společnosti, ale udržováním určitých výborných tradičních chuťových (kroupy z dvouzrnky) nebo technických vlastností (sláma z jednozrnky).

Zavedení trojpolního systému hospodaření ve středověku je řadou badatelů (např. *Vašků 1995*) vnímáno jako revoluční pokrok ve výživě obyvatelstva; ve skutečnosti, zdá se, to byla spíše historická slepá vývojová ulička. Trojpolí umožnilo sice pěstovat obilniny současně na relativně větší ploše (protože se zmenšila rozloha úhorů) a uživit tak mnohem víc lidí, ale celý systém byl křehký a přispěl k hladomorům, které ovládly Evropu ve vrcholném středověku/novověku. V rychlé rotaci ozim (obilnina) – jař (obilnina) – jednoletý úhor se na poli vystřídaly plodiny, které se po sobě netolerují (tedy obilnina po obilnině viz např. *Čvančara 1962*, 334). Jednoletý úhor a špatné vyhnojení polí způsobené nedostatkem hnoje (při nedostatečném počtu domácích zvířat způsobeném nedostatkem pastvin, které se nemohly dále rozšiřovat na úkor lesů v královském nebo jiném soukromém držení) neumožňovaly dostatečnou regeneraci půdy, která se stále víc vyčerpávala. Tento nedostatek byl odstraněn až změnami zemědělských technologií, zejména zlepšením osevních postupů. Kupříkladu nizozemští farmáři zlepšili osevní postupy tím, že po ozimech a lnu jako předplodinách ještě v témže roce vypěstovali krmnou řepu pro dobytek. Výnosy tržní pšenice se tak během dvou století (od sklonku 14. do 16. stol.) zvýšily téměř na dvojnásobek (*Petráň — Petráňová 2000*, 154). Bývá ustáleným zvykem, že středověk slouží jako předobraz pravěku, protože je mu časově blíže než současnost. Neexistují však žádné důkazy o tom, že by pravěké zemědělské systémy byly podobně nevýkonné jako středověké trojpolí. Musíme počítat s tím, že pravěký počet obyvatelstva rostl jen velmi pomalu (*Neustupný 1983*; *Kooijmans et al. /eds./ 2005*) a při vysokých výnosech žárového, intenzivního přílohového nebo dokonce rotačního systému (viz *výše*) byl přiměřeně vhodné orné půdy zřejmě stále dostatek i v případě, že se stávající pole vyčerpala.

Závěr

Jak jsme viděli na příkladě Rumunska, určité, zřejmě již od pravěku vyzkoušené zemědělské postupy mají universální platnost, stejně tak jako velikost úrody, která může být po tisíciletí podobná. Je třeba si uvědomit, že při *správném* způsobu hospodaření se zemědělská půda časem nevyčerpává, ale naopak obohacuje, zvlášť, pokud je hnojena. Jestliže ale dochází k masivnímu používání průmyslových hnojiv, které mění fyzikální vlastnosti půdy a těžké zemědělské techniky, ztrácí půda schopnost zadržovat vodu a hospodařit s půdní vláhou. Intenzivní využití polních ploch, kdy se při rotačním způsobu vystřídají dvě, někdy i tři plodiny ročně, neustále odkrývá půdní povrch a přispívá k masivní erozi, jak jsme tomu stále častěji svědky při povodních a podobných katastrofách minulých let. Za cenu minimálního vkladu lidské práce a maximálního momentálního výnosu se dostáváme do podobně slepé uličky, jako tomu bylo s trojpolním hospodařením.

Tradiční zemědělství, které jsme měli možnost pozorovat a dokumentovat, podle našeho názoru bohužel v několika příštích letech zanikne. Doufáme, že naše práce pomůže zachovat alespoň zlomek znalostí zanikajících zemědělských metod a tradičního venkovského života. Zároveň se domníváme, že i na počátku 21. století má etnografický průzkum živých kultur i v podmínkách vyspělé unifikující se Evropy význam; ještě stále může obohatit pravěké a historické bádání o sice malé, ale nezanedbatelné informace důležité pro porozumění a modelování zaniklých hospodářských a sociálních forem. V neposlední řadě tato bádání přispějí k pochopení, že ne vše, co dnes považujeme za moderní a progresivní, je lepší, než to, co je nazýváno starodávné či archaické.

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