

Historical, environmental and socio-economic driving forces on land ownership fragmentation, the land consolidation effect and the project costs

Historické, environmentální a socioekonomické faktory ovlivňující vlastnickou fragmentaci půdy, efekt pozemkových úprav a projektové náklady

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Abstract: Land consolidation (LC) is an effective program for land ownership defragmentation. The main objectives of this study are: (i) to analyse the characteristics of 487 study areas before and after implementation of the LC; (ii) to evaluate these study areas according to the influence of historical, environmental and socio-economic driving forces on the pre-LC ownership pattern, on the consolidation effect and on the financial costs of the LC projects. In average, the plot size has been increased twofold and the plot shape has also achieved an evidently positive change, but the average owner still has a holding of 2.72 ha divided into more than three plots after the LC. Historical factors were found to be the key driving forces for the pre-LC fragmentation, while socio-economic drivers play the major role for the LC effect and in the formation of the LC project costs. In contrast, the effect of natural factors is considered to be the least significant of all.

Key words: land consolidation, rural development, fragmentation, land reform, land use planning, land market

Abstrakt: Pozemkové úpravy (PÚ) jsou účinným nástrojem defragmentace vlastnictví zemědělské půdy. Cílem této studie je: i) analyzovat charakteristiky 487 katastrálních území před a po pozemkové úpravě; ii) vyhodnotit tato území z hlediska vlivu historických, environmentálních a socioekonomických faktorů na strukturu vlastnických vztahů před PÚ, na efekt PÚ a na výši projekčních nákladů. V průměru se díky PÚ výměra parcely zvětšila dvakrát při současném pozitivním ovlivnění tvaru pozemku. Přesto činí držba vlastníka po PÚ stále ještě v průměru 2,72 ha, navíc je rozdělena do cca tří parcel. Historické faktory byly shledány klíčovými pro formování fragmentace vlastnictví zemědělské půdy před PÚ, zatímco socioekonomické faktory významně determinují konsolidační efekt PÚ i náklady na projekt PÚ. Oproti tomu přírodní faktory se ukázaly jako nejméně významnými z hlediska všech sledovaných charakteristik.

Klíčová slova: pozemkové úpravy, rozvoj venkova, fragmentace, pozemková reforma, trh s půdou

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Generally, land consolidation (LC) is a tool for ensuring the effective and rational cultivation of farmland. Depending on the political, socio-economic and environmental demands of the particular countries or regions, the LC places stress on land reclamation (Schwertmann 1982), nature and landscape conservation (Uhling 1989; Cudlinova et al. 1999; Nikodemus et al. 2005), or possibly it is a remedial platform for the social and economic development of the countryside (Hann 1993; Lapka, Cudlinova 1999; Swinnen 1999; Crecente et al. 2002; Miranda et al. 2006). Vitikainen (2004) defines land consolidation as a comprehensive reallocation procedure in the rural area consisting of fragmented agricultural or forest holdings, or their parts, and he offers an overview of the aims, legislation and procedures in various European countries. In addition, in the countries of the former East Block, the LC brings about land reform or de-collectivisation in response to a long period of suppression of the land use and ownership (e.g. Blaas 1995; Zietara 1995; Csaki and Lerman 1997; Borec 2000; Aligica, Dabu 2003; Gorton, White 2003). Lerman (2001) reveals more or less different approaches to land reform in 23 former socialist countries in the Central and Eastern Europe and in the Commonwealth of Independent States.

As in some other Central and Eastern European countries, an important issue for farmers in the Czech Republic is land ownership fragmentation when the non-contiguous plots of individual owners are scattered around the area of one or more cadastres. After forty years of interruption of farming based on land ownership, a significant number of plots are not accessible by field roads. Also the plot shapes and sizes are not suitable because they reflect the conditions before the World War II. These factors together with other driving forces, primarily the massive exodus of workers from agriculture to industry between 1950 and 1990, and the present-day mismatch between the small holding size and the large scale agricultural machinery, drainage and irrigation systems, are at the root of the sharp distinction between the land ownership and land use. However, the landownership fragmentation cannot be considered as a driver uniquely determining the land-use fragmentation (Sklenicka, Salek 2008). Swinnen et al. (2006) present some Central European countries (Slovak and Czech Republics, and Hungary) as the cases where farm land, in spite of (or rather due to) a high landownership fragmentation, is highly consolidated through rental agreements. Nevertheless, the LC not only deals with land redistribution, but also arranges optimal shapes and sizes in order to make the holdings viable (Gonzalez et al. 2004).

The Czech Republic has been striving to remedy the relationships between owners and land since immediately after the democratic changes in 1989. The LC projects are the basic form of this remediation. In order to speed up the process of land privatization, two basic forms of the LC projects were implemented initially. Simple land consolidation deals mostly with the provisional land use, while the comprehensive land consolidation deals with the changes in land ownership, landscape conservation, land reclamation, anti-flooding control, field road systems, etc. Once the initial demands of the farmer are satisfied, the comprehensive LC takes the key role. Since 2002, about 100 LC projects per year have been completed, and the form of the provisional land use has been discontinued. By the middle of 2005, the comprehensive LC had been completed in 487 cadastres, and in 350 other cadastres, it is now in various stages of development. The principles and methodology of the LC in the Czech Republic have been described by Sklenicka (2006).

Since the annual budget for the LC is not in accord with the current demands, the LC offices should prioritize funding according to the anticipated effects. Models based on the multidisciplinary ex ante evaluation approach are the appropriate methods for selecting the preferred areas (Coelho et al. 2001; Yaldir, Rehman 2002), and the consolidation effect is a key criterion in such decision processes in countries with a highly fragmented land ownership. At the same time, evaluations of the implemented LC projects provide a very important feedback for developing more effective approaches (e.g. Coelho et al. 1996).

Our hypothesis is that the recent high land ownership fragmentation has been strongly catalysed by some of the drivers that are regionalized in our study. Likewise, we hypothesize that these factors also influence the effectiveness of the LC projects, expressed by both the consolidation effect and project costs. Based on identifying the relevant driving forces and data homogenization, we are able to build up more exact models for the decision making process in order to predict the benefits of the LC for individual areas and to focus the available financial resources on to areas with a high potential for achieving the defragmentation at a low cost.

Based on our hypothesis, we defined two basic aims. The first objective of this study is to analyse the essential pre- and post-LC characteristics for the period from 1989 to 2005, as the general information about the effectiveness of the LC projects that have been implemented. The second objective is to evaluate an extensive set of 487 study areas where the comprehensive LC projects have been implemented according to the influence of historical, environmental

and socio-economic driving forces on the pre-LC ownership pattern, on the consolidation effect and on the financial costs of the LC projects.

MATERIAL AND METHODS

In the Czech Republic, LC projects were completed in 487 cadastres between 1990 and 2005. The total area of 1 948 km² was readjusted among 70 thousand landowners. The cadastre is an elementary administrative unit, and also a basic landscape unit for the LC. The Czech Republic (78 870 km²) comprises 13 015 cadastres. Farmland, which is a major object of the LC sharing 54% of the total area, is categorized

as arable land (39%), grassland (12%), hop fields + vineyards + gardens + orchards (3%).

The basic parameters of the LC process were collected together in a form distributed by the Czech Ministry of Agriculture. These forms were completed in the process of the LC by the project managers (LC offices). The form contains comprehensive information about the process, the parameters of the changing ownership structure, the parameters of the structure of the parcels, cost information, etc. The implementation of the LC is typically spread over a long period of time, and consequently the system of annual controls of the reported information was applied. Any extreme values in the completed forms were investigated and analysed.

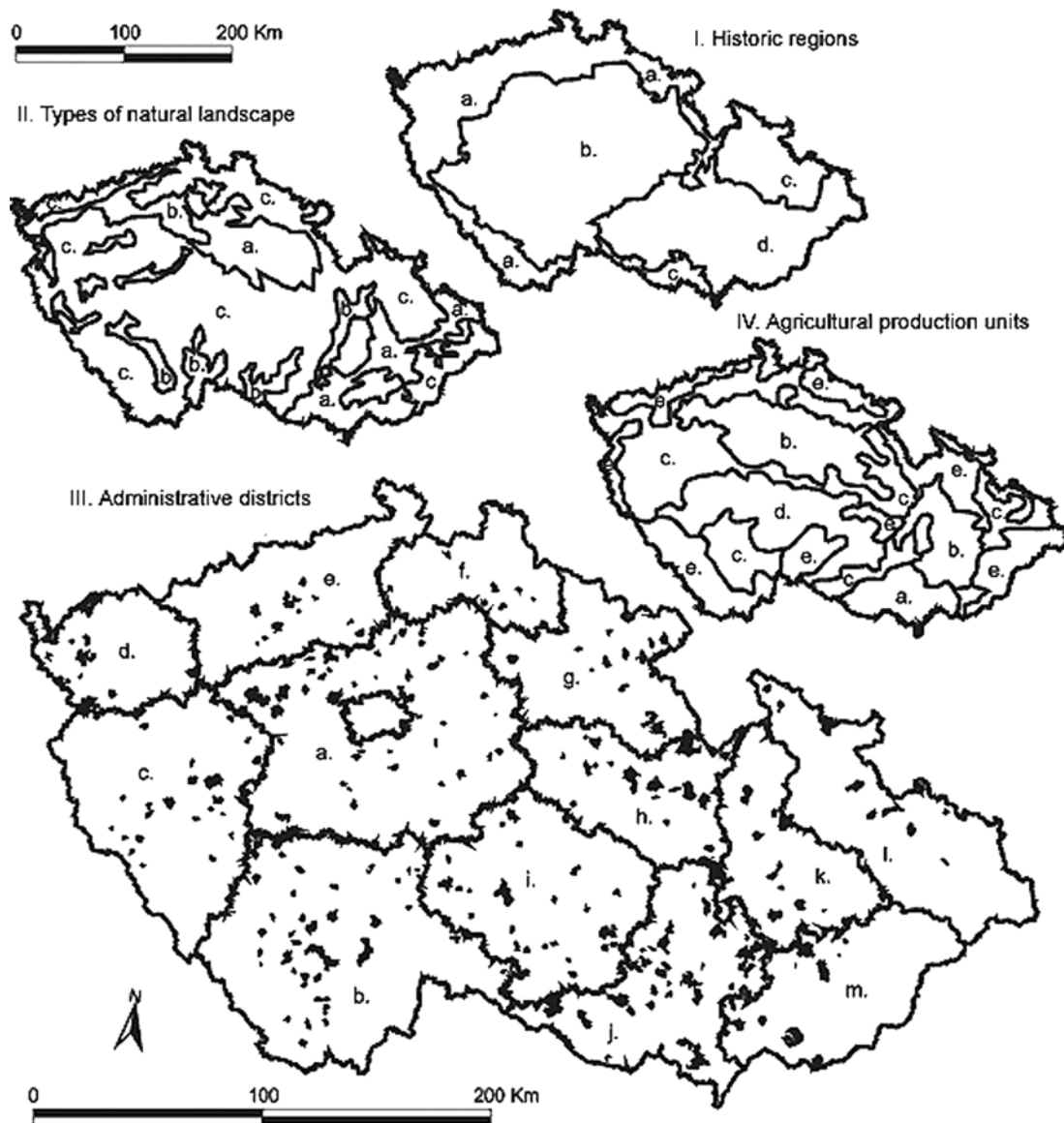


Figure 1. Four patterns of regionalization of driving forces with the location of 487 study areas (small black polygons). The labels of the map units correspond with their nomenclature in the chapter Material and methods.

Regionalization of driving forces (independent variables)

Regionalization can be seen as a simultaneous process of classification and mapping, with the objective of identifying the internally homogeneous map units. The area of the Czech Republic was regionalized according to the historical, environmental and socio-economic driving forces that can be relevant for the development of the recent land ownership and for the effect and costs of the LC (Figure 1).

- (I) Historical regions – This regionalization works on various traditional forms of farming (large estates in Bohemia, small family farms in Moravia) and on the diverse principles of inheritance according to historical territories from the 16th century (Kubacak, personal communication). It also takes into account the former Sudetenland region, where the estates of the original German landowners were confiscated by the Czechoslovak state, and part of the land was redistributed among Czech settlers after the World War II. These factors determine the delimitation of four historical regions with profoundly different conditions for the land ownership formation: (Ia) Bohemia – Sudetenland 26.9%, (Ib) Inland Bohemia 45.5%, (Ic) Moravia – Sudetenland 10.4%, and (Id) Inland Moravia 17.2%
- (II) Types of natural landscape (Viturka 1992) – This regionalization exclusively reflects the conditions independent of human action that characterize the natural factors, mainly natural relief, climate and geology. Three major units were distinguished: (IIa) Lowland landscapes 17.7%, (IIb) Landscapes of basins 15.4%, (IIc) Landscapes of mountains 66.9% in order to test the significance of these essential natural factors to land ownership arrangements.
- (III) Administrative districts – From the administrative point of view, the Czech Republic is divided into 14 regions (IIIa) Central Bohemia, (IIIb) South Bohemia, (IIIc) Pilsen Region, (IIId) Karlovy Vary, (IIIe) Usti, (IIIf) Liberec, (IIIg) Hradec Kralove, (IIIh) Pardubice, (IIIi) Vysocina, (IIIj) Southern Moravia, (IIIk) Olomouc, (IIIl) Moravia-Silesia, (IIIm) Zlin. The Prague region was not taken into account, because no LC project has been completed there yet. The administrative districts define the human environment that can affect the land ownership fragmentation. They traditionally reflect especially the spatial settlement, ethnic, population, political, social and cultural variations of the individual regions – the drivers which are known to be the important factors

influencing agricultural strategies (Christopher 1995; Reenberg, Paarup-Laursen 1997).

- (IV) Agricultural production units – These are delimited on the basis of the production characteristics of the soils (Czech Ministry of Agriculture 1996). Five principal production units were defined, with the names based on the predominant crops (in order from the most to the least productive unit): (Iva) Maize-growing area 5.3%, (IVb) Beet-growing area 20.3%, (IVc) Corn-growing area 33.2%, (IVd) Potato-growing area 13.9%, (IVe) Fodder-growing area 27.3%. These landscape units were used to test the role of natural productivity of the land in the development of land ownership.

Analysed LC characteristics (dependent variables)

The influence of the regionalized driving forces was analysed on the basis of three dependent variables. These represent three standard information sources which are relevant for the LC effectiveness assessment, i.e. the description of the initial state, the rate of consolidation (defragmentation), and the amount incurred. The basic parameters of the LC process were collected to calculate the following indices for each study area:

- (i) Landownership fragmentation before the LC, expressed by the number of plots per 1 landowner before LC – F_i (No.),
- (ii) Concentration Index, which expresses the effectiveness of the process – IC (%),

$$IC = 100 - \frac{N_f}{N_i} 100 \quad (1)$$

where: N_i = the number of plots in the study area before and N_f after the LC

- (iii) The LC Project Costs – P_{LC} (thousand CZK/ha), including costs for projecting and survey works, but not including costs for carrying out the proposed measures.

Analysis of the driving force

All analyses were carried out using the S-Plus software package (S-Plus 2000). General linear models based on the ANOVA were performed to test the effects of driving forces on (1) Plots per 1 Landowner before the LC, (2) Concentration Index and (3) LC Project Costs. Before analysis, the Plots per 1 Landowner and LC Project Costs data were log-transformed to

approximate normality. The models reported are the minimal adequate models (MAMs) resulting from a step-down model simplification procedure (Crawley 2002). First, we started with the fully saturated models which included all main effects (Historic Regions, Natural Landscape Types, Administrative Districts and Agricultural Production Units) and their first order interactions. Then we sequentially removed the non-significant terms ($p > 0.05$) to construct the MAMs eliminating terms with a low explanatory power. If the removal of a parameter led to a decrease in the predictive power of the model, the parameter was retained in the model.

RESULTS

Overall outcomes of the LC

Table 1 presents the essential pre- and post-LC characteristics in 487 study areas where the LC projects were implemented between 1989 and 2005. According to the *t*-test, there were significant differences (i.e., $p < 0.01$) between the values of all observed characteristics. Relatively large standard errors of the means for them reflect the inherent variation of such data. Furthermore, Table 1 stresses the following: While before the LC the holding of one owner had been divided into 6.3 plots with the average plot

size 0.43 ha, the LC modified these parameters to 3.1 plots and 0.88 ha. The (maximum) consolidation potential can be expressed as one plot with the size 2.72 ha per 1 owner. The LC also significantly reduced the density of plot boundaries to 58% of the original value. The average plot shape given by the area-to-perimeter ratio was also positively changed from the value of 18.5 to 32.0. The average total LC costs were calculated to the extent of 17 thousand CZK per hectare. The so-called projecting stage of the LC, which includes projecting, survey and investigation works, accounted for 55 per cent, while the implementation of the proposed measures accounted for about 45 per cent of the total LC costs.

Role of driving forces

Landownership fragmentation before the LC (F_i) is most strongly affected by the Historic Regions (Table 2, Figure 2). There is a greater fragmentation (+48%) in Bohemia than in Moravia, and the values for the Sudetenland parts of both historic countries were higher (Bohemia – Sudetenland $F_i = 1.6$; Moravia – Sudetenland $F_i = 8.1$) than for the inland parts (for Bohemia $F_i = 7.7$; for Moravia $F_i = 5.2$). Agricultural Production Units also showed a highly significant effect on the number of plots per 1 landowner before LC (Figure 3). The lowest fragmentation was found in

Table 1. Essential characteristics of LC projects for the period 1990–2005 presented as a mean per one study area

Indicator	<i>n</i>	Mean	Std
Processing time (year)	486	5.2	2.3
Area (ha)	487	400	321
Number of landowners (No.)	476	147	172
Number of plots before LC (No.)	483	931	860
Number of plots after LC (No.)	485	456	434
Length of plot borders before LC (km)	453	216.0	211.5
Length of plot borders after LC (km)	463	125.6	116.6
Total LC costs (thousands CZK)	475	6 803	5 798
– Costs for projecting works (thousands CZK)	475	2 867	2 540
– Costs for survey works (thousands CZK)	481	879	886
– Costs for realization of measures (thousands CZK)	481	3 013	4 539
– Field roads (thousands CZK)	486	2 513	3 856
– Land reclamation (thousands CZK)	486	227	779
– Flood control (thousands CZK)	486	213	871
– Ecological measures (thousands CZK)	486	44	56

1 EUR \cong 27 CZK

the Maize-growing Areas ($F_i = 5.0$), while the highest fragmentation was identified in the Fodder-growing Areas ($F_i = 11.5$). In general, the fragmentation increases from the most to the least productive regions. The Administrative Districts (Figure 4) also showed a significant influence. The highest fragmentation was indicated in the Liberec district ($F_i = 13.2$), and the lowest in the Zlin district ($F_i = 4.4$). Although the intermediate fragmentation values oscillate among the districts, generally higher values were identified in the districts in the Bohemian part of the Czech Republic than in the Moravian part. A significant interaction between the Administrative Districts and the Agricultural Production Units indicates that the association of the area under study with Agricultural Production Units has a positive effect in some Administrative Districts, and a negative effect in others. Similarly, the significant (though less powerful) interaction between Natural Landscape Types and Administrative Districts demonstrates a

contradictory effect of the Natural Landscape Types on F_i , depending on the given Administrative Districts. No other phenomenon was found to be statistically significant. This model explained 48.9% of the variance in the land ownership fragmentation values.

The Concentration Index (IC) was primarily affected by the Administrative Districts (Table 2, Figure 4). The highest defragmentation of the LC was recorded in the South Bohemia district (IC = 61.0%), while the lowest appeared in the Zlin district (IC = 23.1%). Generally, the IC values vary among the individual administrative districts, regardless of whether they belong to the Bohemian or Moravian part of the country. Moreover, there was a significant interaction between the Administrative Districts and the Agricultural Production Units. In some Administrative districts, the growth of the IC was observed to be positively influenced by the current Agricultural Production Units, while in other districts, the type of the Agricultural Production Unit played an inhibiting role. No further

Table 2. Predictors (driving forces) of Plots per Landowner before LC, Concentration Index and LC Project Costs retained in minimal adequate models (MAMs) and ordered with decreasing F values. The F values represent the ratios with numerator degrees of freedom (ndf) and denominator degrees of freedom (ddf). The statistical significances of the main effects are based on Type III Sum of Squares derived from ANOVA models. Significant terms are presented in bold

	ndf	ddf	F	P
Plots per landowner before LC				
Historic regions	2	448	15.2	< 0.0001
Agric. production units	4	448	5.1	0.0005
Administrative districts	11	448	4.6	< 0.0001
Administrative districts*Agric. production units	20	428	2.5	0.0004
Administrative districts*Natural landscape types	15	413	1.9	0.025
Natural landscape types	2	448	2.3	0.103
Concentration Index				
Administrative districts	11	429	8.6	< 0.0001
Administrative districts*Agric. production units	17	404	1.8	0.021
Historic regions*Agric. production units	8	421	1.7	0.096
Agric. production units	4	429	1.4	0.228
Historic regions	2	429	0.7	0.490
LC Project Costs				
Administrative districts	11	450	6.2	< 0.0001
Agric. production units	4	450	4.2	0.0023
Administrative districts*Natural landscape types	16	420	2.2	0.0044
Natural landscape types	2	450	1.9	0.145
Historic regions*Administrative districts	6	444	1.8	0.107
Historic regions*Agric. production units	8	436	1.0	0.467
Historic regions	2	450	0.8	0.437

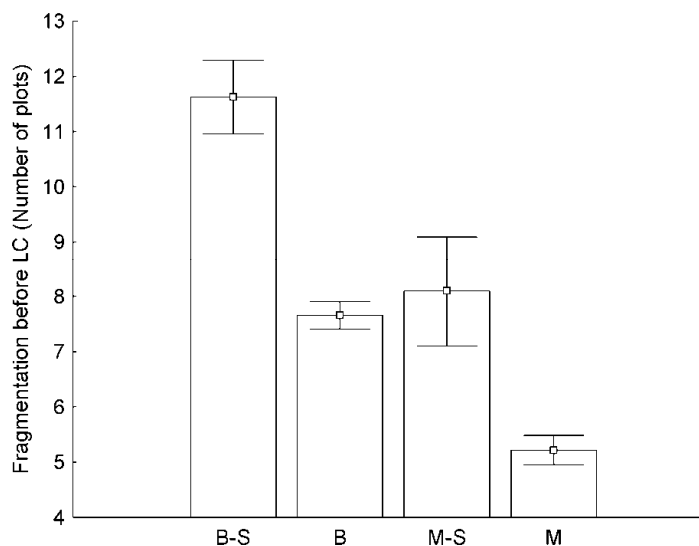


Figure 2. Landownership fragmentation expressed by the number of plots per landowner before LC in the defined Historic Regions: Bohemia-Sudetenland (B-S), inland Bohemia (B), Moravia-Sudetenland (M-S) and inland Moravia (M). The error bars represent the standard errors of the means.

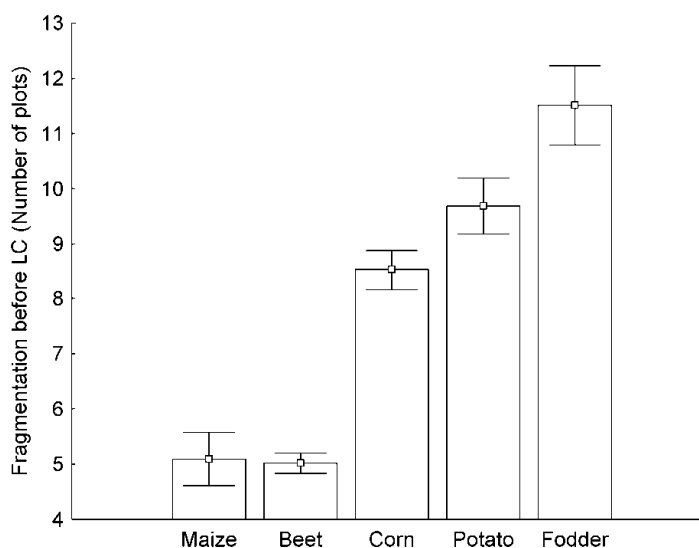


Figure 3. Landownership fragmentation expressed by the number of plots per landowner before LC in the five principal Agricultural Production Units (ordered from the most productive to the least productive units). Error bars represent the standard errors of the means.

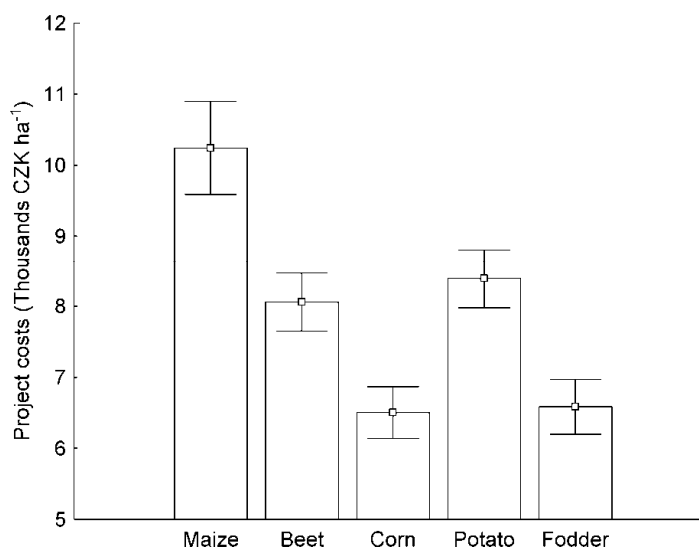


Figure 4. LC Project Costs in the five principal Agricultural Production Units (ordered from the most productive to the least productive units). The error bars represent the standard errors of the means.

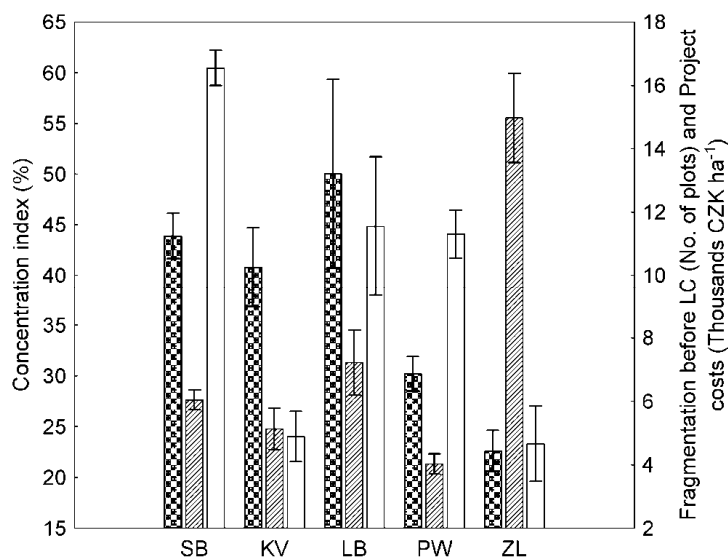


Figure 5. Variation of the three LC attributes in selected administrative districts (SB – South Bohemia, KV – Karlovy Vary, LB – Liberec, PW – Pardubice, ZL – Zlin) showing the most contrasting values or combinations of values. Dark bars – Plots per landowner before LC; Crosshatch – LC Project Costs; White bars – Concentration Index. Error bars represent the standard errors of the means.

term was observed to be statistically significant in this analysis. The model explained 29.7% of the variance in the values of the Concentration Index.

LC Project Costs (P_{LC}) was most powerfully affected by the Administrative Districts (Table 2, Figure 4). The lowest project costs were detected in the Pardubice district ($P_{LC} = 4.0$ thousand CZK/ha). The large variation in costs may be illustrated by the highest project costs, found in the Zlin district ($P_{LC} = 16.0$ thousand CZK/ha), which are four times higher than the minimal costs. Agricultural Production Units showed a significant effect (Figure 5); the highest costs were recorded in the most productive Maize-growing Areas ($P_{LC} = 10.2$ thousand CZK/ha) while the lowest project costs were observed in the moderately productive Corn-growing Areas ($P_{LC} = 6.5$ thousand CZK/ha). The only significant interaction between Administrative Districts and the Natural Landscape Types points to the contrasting effects of the Natural Landscape Types in different Administrative districts. No other phenomenon was statistically significant in this analysis. This model explained 42.3% of the variance in the values of the LC project costs.

CONCLUSION

General outputs

Our results, based on the ex post evaluation of 487 study areas, show that the LC projects implemented in the Czech Republic between 1990 and 2005 led to a more rational use of land, to an increase in labour productivity and a reduction in production costs. However, this study also demonstrates the significant

but still unsatisfactory contribution of the LC to reducing the land ownership fragmentation and also to improving the production parameters of the land pattern. The average plot size has been doubled and the plot shape has also achieved an evidently positive change. Both key plot attributes were changed to create a higher efficiency of the farming operations for which the agricultural plot is used. The economic effect due to the reduced tillage time per hectare (Gonzales et al. 2004) will be quantified in future studies at the level of the individual plots. Although the LC has markedly contributed to the defragmentation, its potential has not been fully exploited. There are still more than three plots per 1 owner in the cadastres where the LC projects have been implemented, so that the plot size could theoretically be enlarged threefold. This reality is influenced by many factors, among others by the heterogeneity of soil conditions, by the unwillingness of some owners to lose their traditional family plots, by different land-use types, by the tendency of farmers to spread risks of the crop failure over several sites, by the high value of land close to villages, highways, etc. A strong relationship between the fragmentation and the decisions of landowners is mentioned by van Dijk (2002). We used the characteristic of Plots per 1 Landowner to express the landownership fragmentation before the LC, because it provides a good expression of the “consolidation potential” of the area, while the difference between the number of plots per 1 landowner after the LC and the consolidation potential can be referred to as the “unfulfilled consolidation potential”. Other expressions of the landownership fragmentation, e.g. Plots per Hectare or Area per 1 Landowner, do not take this important information into account.

Likewise, the landownership fragmentation and the relatively low effect of the LC are also issues in other countries (e.g. Vranken et al. 2004; Lazur 2005; Ravnkar, Tanko 2005; Zadura 2005; Sengupta 2006). The authors agree on one main cause, i.e., an excessive number of landowners with very small holdings per 1 owner. Our findings lead us to conclude that the LC is an important planning tool for land reform, but it can not be the sole tool. Generally, LC has no way to reduce the number of landowners. It is therefore suggested that an appropriate measure will be to improve the land market. However, the land market in the Czech Republic and other post-communist countries cannot be fully developed yet. First reason is the long-term low price of agricultural land, and the presumption that there will be a big increase in the future to balance agricultural prices in Western Europe. Landowners are therefore unwilling to sell their land now. The second impediment is that recent farmers, who are the most probable potential buyers of the land, are short of money. Third reason is the land ownership fragmentation itself. Potential buyers are not eager to purchase land belonging to a single person but broken down into many small patches (multiplicity of parcels), or consisting of many shares held by different people in a single piece of land (multiplicity of owners), often inaccessible by field roads. While the first two impediments may be only temporary, the third is a long-term barrier to the development of the land market. It can be eradicated only by the simultaneous land market and LC measures.

While some authors (e.g. Swinnen et al. 2006) consider the land rental superior to the sale of land, at least in the transitional and developing countries, to solve the land ownership fragmentation, we interpret the hegemony of the land rental market as an only a temporarily effective measure. Generally, a sharp distinction between the large number of landowners and the small number of land users, together with the preference for renting land rather than trading, are the factors that markedly complicate the sustainable land use. Providing the full and permanent security of rights to the new user (Binswanger et al. 1995), the sale of land provides better conditions for long term investments in soil fertility and landscape restoration, and thus it helps to reconnect the relationship between the generations of new farmers and their land. However, the transition economies in the Central and Eastern Europe should avoid seeing land simply as a commodity, in spite of the need to privatize land ownership and to individualize land use. Mather (1999) presents the view that land is a heritage relating more to the communal ownership, and emphasizes the benefits of compromise as a system

of the regulated private ownership, where public controls are imposed through legislative instruments, such as the planning system.

Moreover, the LC programme and the land sales market to remedy the recent land ownership fragmentation should be supplemented by measures aimed at preventing the continuation of this trend. The recent system of inheritance, which distributes equal shares among the heirs leading to the breakup of farms, should be replaced by a system that prevents land ownership fragmentation and miniaturization of farms, with compensation for the other heirs.

In spite of the efforts of the LC offices to intensify the process, the pace is still not adequate to the requirements of the society. In order to make agriculture viable, it is necessary to accelerate the process in the Czech Republic and to make it more efficient. Similarly, other former socialist countries have to undergo a massive land consolidation to make their agriculture competitive with farming in the EU (Dadak 2004). In addition, a greater linkage among the LC, urban development and other forms of spatial planning would be beneficial to all parties.

The role of driving forces

Our study shows the variable role of driving forces for the observed LC characteristics. Land ownership fragmentation before the LC was found to be most strongly influenced by historical factors. As expected, the traditionally different farm sizes, the diverse development of inheritance principles have been very significant historical drivers of the variability in the pre-LC fragmentation. The liberal inheritance laws and the traditions that provide equal shares for all heirs to the estate are the major driving forces that have led to the fragmentation in some other countries, too (Kopeva 2003). Our study has also proved an important effect on the land ownership fragmentation of the resettlement of some parts of the country after the World War II. This process has led to a much higher fragmentation in both parts of the Czech Republic (Bohemia +51%, Moravia +56%). The findings from our analysis of the Agricultural Production Units confirm the rule that “the more fertile the region, the lower the level of land ownership fragmentation”. This may be due mainly to the long-term emergence of richer farms, whose owners could gradually incorporate the adjacent plots by land trading, or due to more homogeneous soil conditions in the fertile regions.

Among the driving forces that we tested, the Administrative Divisions were found to be an important driver for all studied LC characteristics.

The influence of administrative divisions on the three LC characteristics revealed some results that can be ascribed to a questionable LC process in the given district. We refer especially to the cases where extremely high project costs were incurred while only a very low LC effect was achieved (e.g. the Zlin district), or where a very low LC effect was achieved in the areas with a highly fragmented land ownership (e.g. the Karlovy Vary district). These findings will help the Central LC Office to exercise the effective supervision and management of the individual district LC offices. However, the causes of these abnormalities should be discussed on the level of the given district LC office, which are able to obtain all relevant local factors which could complicate the LC process in the individual cases.

In contrast, the effect of natural factors is considered to be the least significant of all, playing a more important role only in the interactions with the Administrative Districts for the pre-LC fragmentation and for the LC Project Costs. In spite of a lack of other relevant studies, this result was surprising, because especially the land ownership fragmentation was expected to be determined by the natural relief and other natural factors.

In addition to the pre-LC fragmentation (mentioned above), the typological characteristics of the Agricultural Production Units also have a significant influence on the Project Costs. The decrease in the Project Costs from the most productive units to the least productive units may be due to the requirement to involve the additional planning activities into the process of the LC, especially designing new ecological and erosion control measures. This requirement reflects the current issues of more productive rural landscapes, typically characterized by a low proportion of the ecologically valuable landscape elements (Sklenicka 2002) and by high soil erosion risks from water and wind, due to the large blocks of arable land and a higher percentage of crops that catalyse soil erosion (maize, beet) in the crop rotation systems (Janecek 1995).

Generally speaking, historical factors were found to be the principal driving forces for the pre-LC fragmentation, and socio-economic factors for the LC effect. Socio-economic driving forces also form a major part of the LC project costs. It was first necessary to regionalize the driving forces in order to make it possible to test them statistically throughout the country, despite some weaknesses of this method. Regionalization cannot include just a single, simple factor, and thus some inter-correlation between the Historical Regions and the Administrative Districts and also between the Natural Landscape Types and the Agricultural Production Units may be identified.

Nevertheless, the regionalization of the joint influence of the relevant driving forces combined into four general groups was an appropriate technique for the role of this regionalization in the construction of the further decision support models.

Many authors have discussed the influence of various drivers on the land ownership fragmentation, but their arguments often border on speculation. We have found very few studies that analyse these factors reliably, mostly with a view to constructing multi-criteria decision support systems (Coelho et al. 2001; Yaldir and Rehman 2002; Sklenicka 2006). Our study provides an important theoretical background for recognizing the role of driving forces in the development of the land ownership fragmentation. Based on these findings, we will be able to define the approaches for a more effective defragmentation using an LC programme and other additional tools, mainly by supporting the land sales market. The demonstrated significance of historical driving forces may be considered as a strong argument for the relevant changes in the inheritance laws and systems to prevent further landownership fragmentation. Unlike the generally valid findings on the pre-LC fragmentation of land ownership, two other LC characteristics are related closely to the Czech Republic. Nevertheless, the mutual comparison of initial conditions given by the landownership fragmentation, with the defragmentation effect of the LC projects, and with the amount incurred for projecting and survey works is supposed to be an appropriate method for the LC management elsewhere.

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