Possibilities of Community-Encompassing Transborder Farming Using Zeilitzheim as an Example

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Virtual land consolidation in the form of transborder farming of entire community areas offers farmers in small-structured areas the possibility of using the advantages of larger field sizes both in the long and the short run without requiring field rearrangement, which is often difficult to accomplish. The reduction of time requirements, necessary operating resources, forecrop areas, and overlapping areas equally reduce the burden on the environment, the soil, and the farmer´s wallet. The use of automatic data acquisition allows all yields and expenditures related to the cooperatively used transborder fields to be attributed to the participating farmers according to their property.

Keywords
Transborder farming, virtual land consolidation, data acquisition, property-based validation

Introduction

Structural change in agriculture progresses faster than farm structures can and should be adapted. This leads to many farms (especially in southern Germany) farming a large number of small individual fields, which require disproportionately long times for set-up and transfer, as well as for turning processes during work. As compared with regions with a good agricultural structure, this results in high labour expenses as well as increased use of operating resources and, hence, an additional burden on the environment.

The Approach of „Virtual Land Consolidation“

The pro and contra of real and virtual land consolidation has already been discussed in detail by Auernhammer et al. [1]. Projects of regular field rearrangement often fail because many part-time farmers and landlords do not see the necessity of land consolidation since they do not derive the larger part of their income from agriculture. Thus, they often consider arable farming rather a hobby, for which sufficient time is available. For future-oriented full-time farms, however, this signifies increasingly more difficult work conditions. In any case, virtual land consolidation, which is also termed transborder farming, is a possibility of improving labour management and, hence, of saving time and expenses quickly and without greater planning requirements. In addition, intrusion into the landscape as well as the resulting costs and acceptance problems can be avoided. A lot enclosed by natural borders or farm roads is called a transborder field. With regard to possession or use, this lot is generally divided into several fields. Transborder farming is the cooperative farming of the area of a transborder field beyond the property borders of the individual fields so that the degressive worktime- and cost effects of increasing field sizes can be exploited without land consolidation. This virtual land consolidation requires that the farmers who share a transborder field agree on common crop rotation and carry out tillage, seeding, and cultivation measures at the same time. For cultivation, it is generally useful to turn the working direction on the transborder field in order to profit from the advantages of greater field length (**figure 1**). In the short run, the use of the best machinery available on the farms involved is recommended. If transborder farming is employed to a greater extent and not only on individual fields, mechanization should of course be adapted in the medium run, i.e. when machines are replaced or newly purchased. In this case, several farmers with different machines should share the cultivation tasks according to their personal interests.

Effects of Community-Wide Transborder Farming

In a planning project at the Technical University of Munich completed in the spring of 2001, the effects of community-wide transborder farming in the community of Zeilitzheim in Lower Franconia were calculated [4]. It was assumed that all farmers in the community participated in transborder farming while the current farm roads and landscape structures were retained. This resulted in an increase in the average field size from slightly more than one hectare to 4.8 hectares. However, this requires that grassland areas which were previously situated in the transborder fields be taken out and established as transborder grassland fields at other locations. If the current grassland locations are retained, this results in a slightly smaller average transborder field size of 3.8 hectares. As a planning basis for the community-wide formation of transborder fields, an erosion prognosis was developed in cooperation with the

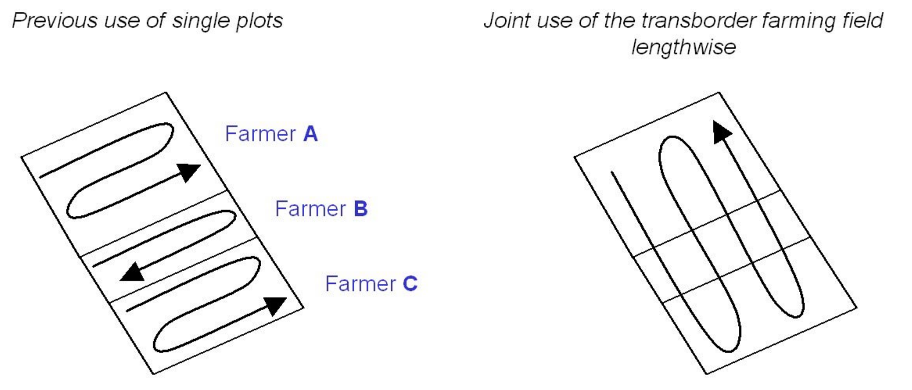

Figure 1: Alteration of cultivation due to the formation of transborder fields

Bavarian State Research Center for Agronomy. For this purpose, wind- and water erosion were calculated under different aspects, such as work direction and crop rotation, using the general soil erosion equation. **Figure 2** shows the danger of erosion in the case of field use and shows the maximum slope length for work in the direction of slope.

Based on information from individual farms, which was collected community-wide with the aid of a questionnaire on 6 out of 10 full-time farms and on 12 out of 15 part-time farms and which covers 497 of the total of 585 hectares of field area, a representative crop rotation was determined. On the basis of this information, worktime and expenses were calculated for the entire field area of the community of Zeilitzheim and the entire crop rotation using KTBL standard values. The expenditures for the current average field size of 1.1 hectares were then compared with those for an average transborder field size of 3.8 hectares. Effects which had already been established for individual transborder fields have generally been confirmed [5]. The time requirements for field work diminish by more than 30%. Labour expenses decrease by approximately 25% (**table 1**), and the average gross margin increases by about € 150 per hectare. The difference is composed of lower labour costs, lower variable machinery expenses, contractor discounts, discounts on the purchase of operating resources, greater market power, and fewer marginal areas.

In another planning scenario, it was assumed that cooperation among the farmers in transborder farming allows the best available know-how for the individual crop to be exploited and thus enables a higher total yield to be achieved as compared with the previous cultivation of individual fields. Averaged out over the crop rotation, which also comprises sugar beet, this effect may cause the gross margin to increase by up to an additional € 150 per hectare (**figure 3**). For the community of Zeilitzheim with a field area of 585 hectares, this means a potential increase in the total gross margin of between € 87,000 and € 175,000 per year.

Property-Based Validation through Production Data Acquisition

For transborder farming, different possible strategies are available [1]. The strategy with the lowest requirements consists in the uniform farming of the entire transborder field with regard to the application of seeds, fertilizer, and plant protection products. Variable application technology also allows site-specific farming to be realized. This technique enables the wishes of the individual farmers (property-

Table 1: Savings in worktime and variable machinery costs due to transborder farming

Crop	Worktime requirements			Variable machinery costs		
	Individual lot	Transborder field	Savings	Individual lot	Transborder field	Savings
WW	8.7 h/ha	5.6 h/ha	36 %	85 €	62 €	27 %
WG	8.2 h/ha	5.3 h/ha	35 %	81 €	60 €	26 %
SG	8.1 h/ha	5.3 h/ha	35 %	81 €	60 €	26 %
SM	12.2 h/ha	8.0 h/ha	34 %	115 €	85 €	26 %
ZR	8.9 h/ha	5.8 h/ha	35 %	92 €	69 €	25 %
WRa	8.8 h/ha	5.7 h/ha	35 %	84 €	62 €	26 %
Crop rotation	**9.3 h/ha**	**6.0 h/ha**	**35 %**	**91 €**	**67 €**	**26 %**

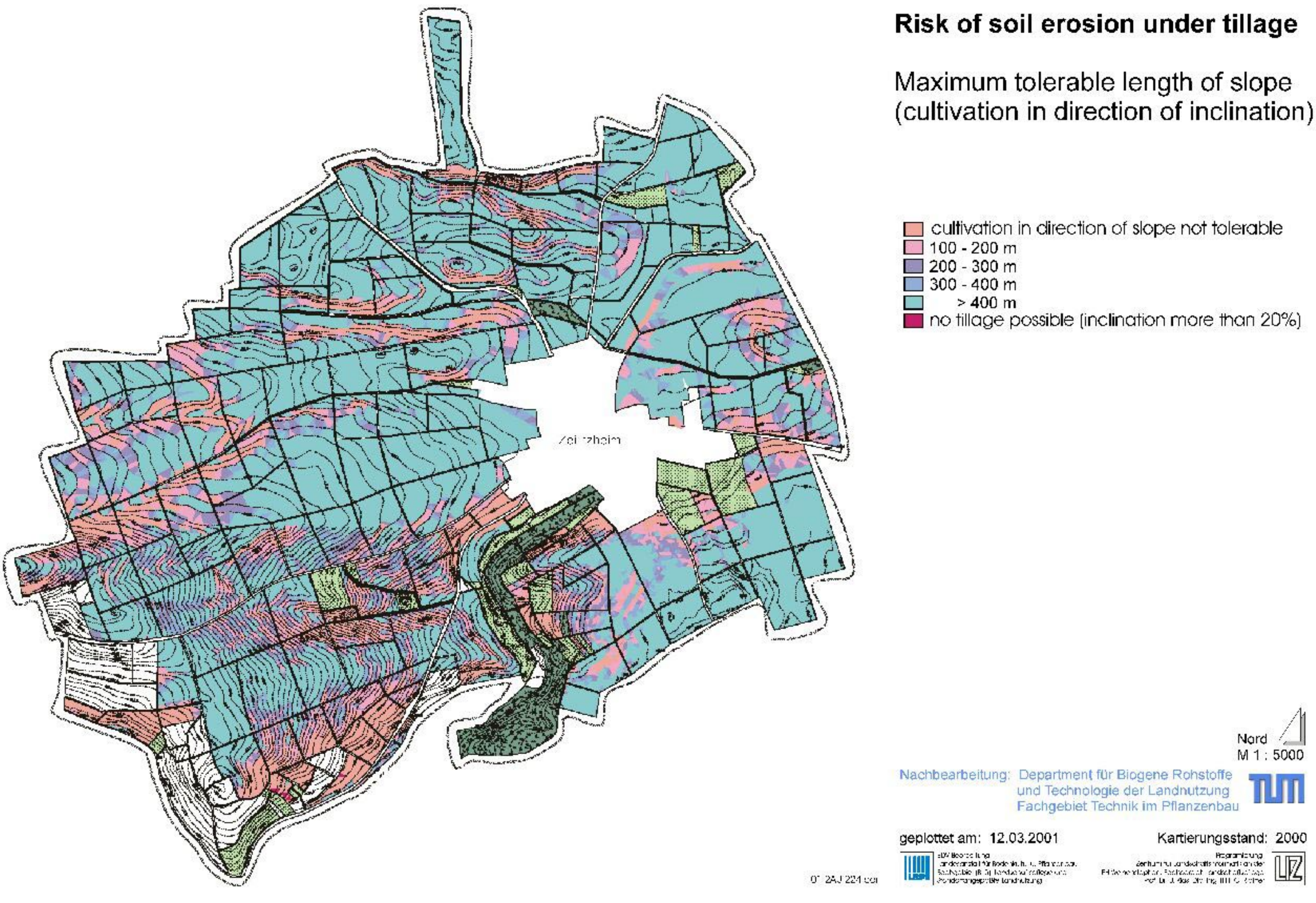

Figure 2: Justifiable maximum field lengths for work in the direction of slope in Zeilitzheim [4]

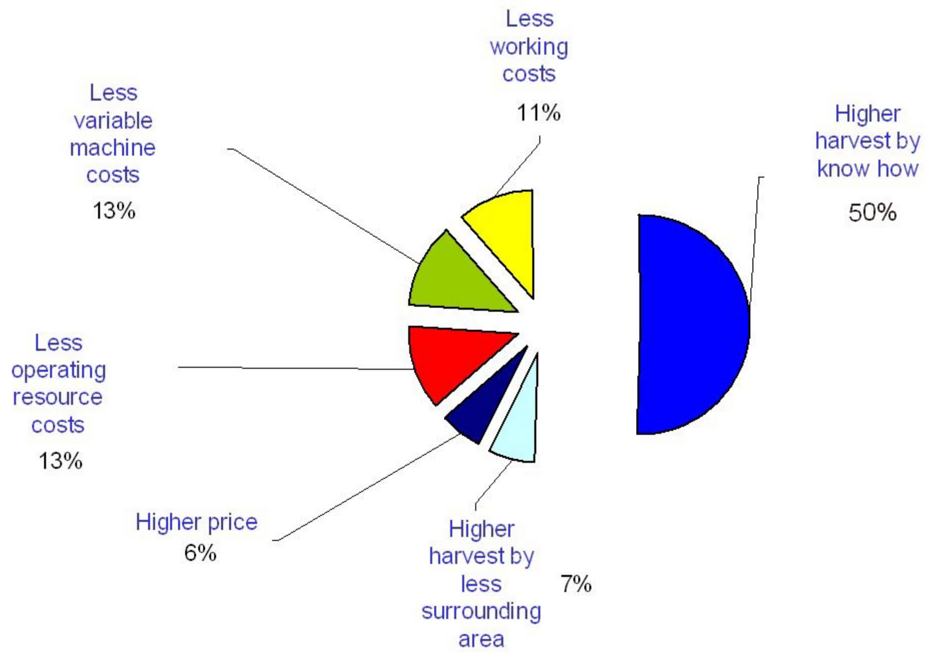

Figure 3: Percentage of the individual effects in the increase in the gross margin due to transborder farming [4]

oriented farming) or the heterogeneities of the yield potential of the transborder field (precision farming) to be taken more into account. These farming variants have been implemented on the three existing transborder fields in Zeilitzheim and are being examined in the collaborative research project "preagro". The validation of harvest quantities, the amounts of operating resources used, and the time required for farming, however, should be property-based in all cases because simple validation based on the size of the individual lots could lead to financial inequities and social tensions among the farmers involved. Therefore, a continuous data acquisition system was installed for the transborder farming project in Zeilitzheim. It consists of yield registration systems in the harvesting machines and automatic process data acquisition systems in the tractor-implement combinations used (**figure 4**) as well as software based on Microsoft Access® for data evaluation and invoicing. For automatic process data acquisition on tractor-implement combinations, the system developed at the Department of Process Technology in Plant Cultivation in Weihenstephan as part of the research project "Information System for Small-Area Crop Management" (IKB-Dürnast) was used. This system is based on the Agricultural Bus System (LBS) as an open communication system for all connected electronic systems, the Global Positioning System (GPS) for the continuous determination of the position and the Implement Indicator IMI® [2,3,6,7]. The latter serves to identify work implements which do not feature their own LBS-compatible job computer. When a tillage implement is mounted to the tractor, for example, its Implement Indicator (IMI®) is connected to the LBS socket of the tractor. The IMI® connects the work implement to the system so that, in connection with the GPS data, the precise location and the kind of work which is being performed can be recorded at any time. In addition, other recorded values, such as the position of the rear hydraulics and the tractor speed on the field allow worktime, turning-, and standing time to be distinguished, which is later important for work validation. While a commercially available system could be used for yield registration in the combine, a corresponding system for yield registration in the sugar beet harvester had to be developed [8]. Through the process data acquisition on all machines used and the adapted software solution, the acquisition and evaluation of operating data are largely automated so that in practice the property-based validation of all measures can be carried out on the transborder fields without significant additional time requirements.

All field data are collected with the aid of GPS so that the evaluation software is able to attribute the individual sets of data established during field work to the individual lots using the stored outlines of the lots on the transborder field and the GPS coordinates, which are recorded as well. This attribution forms the basis of the property-based validation of all yields and expenditures which result from farming (**figure 5**).

The developed database application for site-specific validation also comprises algorithms for the consideration of non-site-specific effects caused by the formation of transborder fields. After the turning of the working direction, for example, the process data acquired on lots situated centrally on the transborder field will include no turning time, whereas the entire turning time would be attributed to the lots situated on the sides. The central lots also no

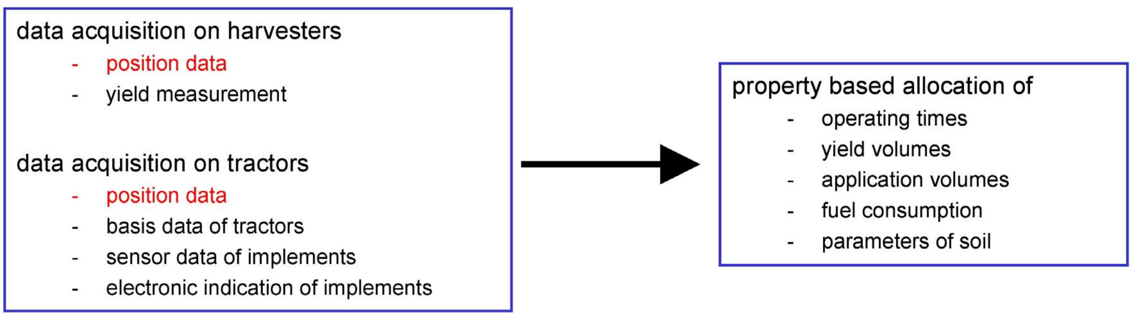

Figure 4: Continuous data acquisition with GPS during field work

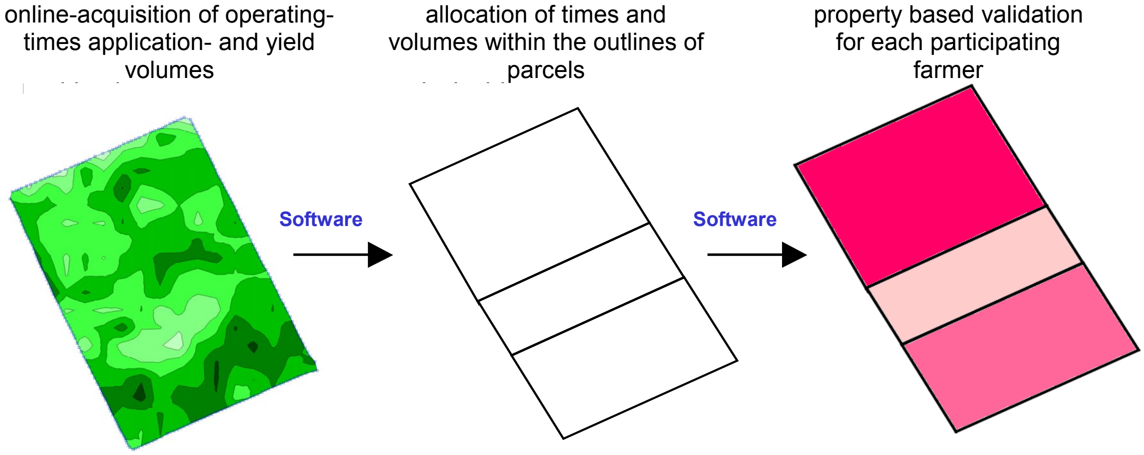

Figure 5: Property-based attribution of the field work data to the lots

longer contain forecrops, whereas the forecrop area, where lower yields may have to be expected, is disproportionally large on the outer lots as a result of transborder field formation. The previously made assumptions regarding the extent of these effects and their validation require further observation and examination. Thus far, it has been impossible to carry out detailed examinations of the expenses for this data acquisition because transborder farming in Zeilitzheim is currently limited to a few trial areas and because parts of the system used are not yet commercially available.

Outlook on Future Transborder Field Farming

The formation of transborder fields comprising large areas within a community or the area of several communities opens up new perspectives for more adapted land use. Depending on the suitability of the location, for example, this provides the possibility of more or less intensive crop rotation on larger lots. Sensitive areas of nature can be farmed in a gentle way without limiting the individual farmer with regard to crop rotation on the entire farm. It would also be possible to realize landscape-oriented ecological farming at a multifarm level instead of the previous farm-oriented cultivation of splinter areas. Of course, this requires the necessary conditions to be fulfilled by the associations.

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