Markus Demmel, Matthias Rothmund and Hermann Auernhammer, Freising,
as well as Jens Feldmann and Thomas Rademacher, Bingen

Infrastructure Planning for Optimising Sugar Beet Production with Transborder Farming

In coming years sugar beet production will be confronted with extensive changes. Especially in regions with unfavourable production structures the negative impacts of this development will heavily affect the earning capacity and the competitiveness of sugar beet production. Therefore, in these regions all measures to optimise the infrastructure have to be utilised. The alternatives of growing sugar beet on transborder fields and its capabilities are among these.

The publication is based on the diploma thesis of Dipl.-Ing.agr (FH) Jens Feldmann, his Professor was Dr. Thomas Rademacher at the University of Applied Sciences Bingen. The work was advised by the subject group „Crop production Engineering" (Prof. Dr. Hermann Auernhammer, assistant professor Dipl.-Ing.agr Matthias Rothmund) at the Technical University Munich.
Dr. Markus Demmel was assistant professor at the subject group till September 2003. Since October he is Program Leader Plant Production Engineering at the Institute for Agricultural Engineering, Farm Buildings and Environmental Technology at the Bavarian State Research Institute for Agriculture, Vöttinger Str. 36, 85354 Freising; e-mail: *Markus.Demmel@LfL.bayern.de*

Keywords

Sugar beet cultivation, transborder farming

Literature

Literature references can be called up under LT 04119 via internet http://www.landwirtschaftsverlag.com/landtech/local/literatur.htm.

Sugar beet production delivers the highest profit of all crops grown in Western Europe except speciality crops. However changes in the European sugar market regime must be expected and are already in discussion. It must be expected that the prices will be lowered and the quotas will be cut. Therefore it is critical to use all possibilities to reduce production costs, especially in regions with unfavourable production structures. The introduction of transborder farming in sugar beet production will be one possibility (LT 56, issue 3, pp136-137, LT 57, issue 1, pp10-11). This possibility was investigated at the example of the village Zeilitzheim in Lower Franconia, Bavaria. Zeiltitzheim stands representative for all regions with unfavourable production structures.

Situation of sugar beet production in Zeilitzheim

The fields of Zeilitzheim village are characterised by intensive crop production. The total acreage is 590 ha (100 %). On 293 ha (50 %) winter wheat, on 107 ha (18%) sugar beet, on 107 ha (18 %) maize for silage and on 83 ha (14 %) oil seed rape and spring barley are grown. On 70 % (410 ha) of the total acreage sugar beets can be cultivated. On this fields the rotation sugar beet - winter wheat - winter wheat is standard. There are 35 farmers living in the village, 25 of them are part-time farmers. With a number of 540 fields the average field size is 1.1 ha (mean field length 150 m, mean field width 70 m). The average sugar beet yield is 60 t/ha. Planting, harvesting and transport is organised and implemented by the machinery ring (self propelled six row tanker harvester (338 kW), self propelled cleaner loader (190 kW), four wheel driven trucks with trailers).

Problems of sugar beet growing in Zeilitzheim

The main problems of sugar beet production in Zeilitzheim are caused by the unfavourable structures of the fields:

- The high theoretical harvesting capacity of the self propelled six row tanker harvester (up to 1.5 ha /h) cannot be realised on the small fields.
- The high theoretical loading capacity of the self propelled cleaner loader (up to 300 t/h) cannot be realised with the high number of small beet piles (about 100 piles with average capacity of 66 tons).
- Transport needs a high number of transport units because of the high number of small beet piles at changing locations (fields).
- The field road structure and quality make the use of four wheel driven trucks with trailers necessary.

These already existing problems will be intensified by the following changes expected in the future:

- The number of beet processing factories will decrease, therefore the distances to the factories will increase.
- The beet processing factories will demand a reduction of the number of transport vehicles to reduce the traffic around the factories.
- Technical help for unloading the transport vehicles in the factory will not be available in future.

Consequences for sugar beet growing

Based on the existing problems and requirements expected in the future the following consequences for sugar beet production in Zeilitzheim and in other regions with unfavourable structures can be derived:

- The structures have to be changed - the field sizes have to be increased to optimise the use of the high capacity self propelled harvesting and loading equipment.
- The number of transport vehicles has to be reduced and transport capacity has to be increased. This can only be reached by changing from four wheel driven trucks with trailers to two wheel driven trucks with tipper semi trailers built from aluminium (increase in pay load from 24.5 t to 28.0 t by + 14.3 %).
- The farm road system has to be adapted to

Operation	Exist.-Situation Zeilitzheim	Scenario 1	Scenario 2
Sugar beet harvesting with self propelled six row tanker harvester (338 kW)	0.57 ha/h 100 %	0.63 ha/h 110 %	0.95 ha/h 166 %
Sugar beet loading with self propelled cleaning loader (191 kW)	87 t/h 100 %	159 t/h 180 %	209 t/h 240 %

Table 1: Capacity effects of sugar beet transborder farming

two wheel driven trucks or a system with interim storage places has to be installed.

Planning alternatives for Zeilitzheim

To realise the above mentioned consequences on transborder fields two planning alternatives (scenarios) have been defined and implemented in model calculations:

1. Sugar beet production on transborder fields with traditional headland beet piles.
2. Sugar beet production on transborder fields with collaborative beet piles on two central locations.

Planning and modelling was implemented using spatial information available from the project „Transborder farming" of the integrated research project preagro.

Structure of the planning alternative 1:
Based on the existing roads the size and the location of the fields are determined in a way, that the beet piles are located on one headland along existing paved (concrete or asphalt) roads.

48 fields are generated with an average field size of 8.3 ha (mean field length 350 m, mean field width 250 m, 70 % of the fields >7 ha). Every year 13 piles will be needed (instead of 39). 3.7 km existing gravel farm roads have to be paved.

Structure of the planning alternative 2:
Based on the existing roads, the size and the location of the fields are determined in a way, that the self propelled six row tanker harvester is used to full capacity. To reach this aim a tractor (150 kW) plus tipping trailer (20 m^3) is needed.

17 fields are generated with an average field size of 18.9 ha (mean field length 532 m, mean field width 356 m, 60 % of the fields >12 ha). Existing paved roads must not be removed. Two places for collaborative beet piles beside the main road must be installed.

Results of the planning for improving the structure

For the existing situation and for both planing alternatives calculations of the capacity effects and the economic effects have been implemented. Regarding the capacity (harvesting and loading) both alternatives have advantages (*Table 1*).

The harvesting capacity is increased by 10 % in alternative 1 and by 66% in alternative 2. The increase of the loading capacity is still higher. In scenario 1 the bigger headland piles caused an increase of 80 % while the „infinitely" large collaborative beet piles resulted in an increase of 140 %.

The full costs calculations show for each process step as well as for the combined harvesting loading process a reduction of the costs of 10 % in scenario 1 and of 20 % in scenario 2, compared to the existing situation (*Table 2*).

Conclusions and outlook

The conducted model analyses and model calculations regarding the optimisation of the structure of sugar beet production on transborder fields showed the following results:

- Sugar beet production on transborder fields is not only able to realise the well known advantages of transborder farming but will also give the opportunity to optimise the utilisation of high capacity self propelled harvesters and cleaning loaders and therefore reduce harvesting and loading costs.
- Changes in sugar beet processing will force farmers to adapt transport technology with severe impacts to the field road system. Transborder sugar beet production will make contributions to solve this upcoming problem.
- The enlargement of the sugar beet fields from an average size of 1.1 ha to 8 ha will decrease harvesting and loading costs by 10 % (scenario 1).
- Changing from headland beet piles to centralised collaborative beet piles and to average field sizes of 19 ha will decrease harvesting and loading costs by 15 % (scenario 2).
- Running the system with the collaborative beet piles (scenario 2) on fields with an average size of 8 ha (scenario 1) instead of 19 ha will still reduce harvesting and loading costs by 15 % (modified scenario 2).
- A number of further advantages like reduced expenditures for field road systems, easier transport logistics with a lower number of beet piles and optimised service for larger beet piles to reduce mass and quality losses of the beets are possible, but cannot be monetarily calculated.

The analyses and calculations have shown that by growing sugar beets on transborder fields severe handicaps and problems of sugar beet production in regions with unfavourable structures can be reduced or eliminated. The same effects can also be reached by other measures of structural changes. The different effects of the two planing alternatives / scenarios make clear that increasing the field size must not be the only step. The change to central interim beet storage locations (collaborative beet piles) resulted in positive effects which are generated not only with an average field size of 19 ha but also with 8 ha.

Operation	Exist.-Situation Zeilitzheim	Scenario 1	Scenario 2
Sugar beet harvesting with self propelled six row tanker harvester (338 kW)	299.26 €/ha 4.99 €/t 100 %	281.03 €/ha 4.68 €/t 94 %	205.04 €/ha 3.42 €/t 69 %
Sugar beet loading + transport in the field (from harvester to coop pilee (Scenario 2)	299.26 €/ha 4.99 €/t 100 %	281.03 €/ha 4.68 €/t 94 %	261.95 €/ha 4.37 €/t 88 %
Sugar beet loading with self propelled cleaning loader (191 kW)	87.37 €/ha 1.51 €/t 100 %	67.51 €/ha 1.16 €/t 77 %	59.18 €/ha 1.02 €/t 68 %
Total harvesting and loading operation	**386.63 €/ha 6.40 €/t 100 %**	**348.54 €/ha 5.84 €/t 90 %**	**321.13 €/ha 5.39 €/t 84 %**

Table 2: Economic effects of sugar beet transborder farming