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НОВЫЕ МЕТОДЫ И РЕЗУЛЬТАТЫ ИССЛЕДОВАНИЙ ЛАНДШАФТОВ В ЕВРОПЕ, ЦЕНТРАЛЬНОЙ АЗИИ И СИБИРИ

Монография в 5 томах

Том IV Оптимизация сельскохозяйственных ландшафтов

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NOVEL METHODS AND RESULTS OF LANDSCAPE RESEARCH IN EUROPE, CENTRAL ASIA AND SIBERIA

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Vol. IV Optimising Agricultural Landscapes

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This monograph shall inform you about up to date methodologies and recent results in landscape research. It is intended as a guide for researchers, teachers, students, decision makers, stakeholders interested in the topic of landscape science and related disciplines. It provides information basis for decision makers at various levels, from local up to international decision bodies, representing the top level of landscape science in a very short form.

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INTRODUCTION

A total of 14% of the arable land in Austria (approximately 190,000 ha) are cultivated by organic farming (OF) [1]. In contrast to conventional farming (CF), which uses chemical plant protection, organic farming is generally controlled by a combination of an appropriate crop rotation with mechanical weed control. According to various authors [2,3,4,5,6] crop yields from OF are generally lower than yields from CF. On the one hand this is a challenge in view of the increasing global demand of food [7]. On the other hand, however, the risk of environmental pollution (e.g., due to the application of pesticides) and the accumulation of hazardous substances in the environment and in the food chain is avoided with OF. This includes groundwater resources for drinking water from unconfined shallow aquifers as it is commonly explored in certain regions of Austria (e.g., in the state of Styria 58% or 39.8 Mio. m³/a [8]), which in addition provide best agricultural production conditions (e.g., the Murtal aquifer in Styria south of Graz [9]). This poses a contamination risk with significant potential for social and environmental damage.
Although there are generally higher crop yields for CF, the economic surplus for OF does not have to be lower. According to [5,6,10] the profit of OF is similar to CF. This is a consequence of higher market prices for organic products [4,6] and lower production costs for OF [3,5]. Also, environmental compensation payments from the government are generally higher for OF.

The objective of this paper is to assess the financial profit of both, the OF and the CF system, cultivated at the agricultural test site Wagna, Austria. This is done for the period from 2006 to 2014 and by neglecting governmental subsidies.

**AGRICULTURAL TEST SITE WAGNA**

The agricultural test site Wagna (Figure 1) consists of 32 test plots (1,000 m² each) and is located approximately 30 km south of Graz, Austria. Between 2005 and 2014 (2005 not considered in the assessment due to possible influence of previous cultivation) the difference between CF and OF (16 plots each) has been researched. The two crop rotations are cultivated in four variations (i.e., crop rotation starts with different crop in the same year) and four repetitions. A detailed description of the test site is given in [11].

**Conventional Farming**

Between 2006 and 2009 the crop rotation maize–maize–winter grain (barley or triticale)–oil pumpkin was cultivated. In 2010 the crop sequence changed into maize–oil pumpkin–maize–triticale. The fertilization strategy is based on a low nitrogen fertilization management according to a guideline for appropriate fertilization [12]. The mean annual average nitrogen fertilization rate applied at the conventionally cultivated test plots is approximately 120 kg N/ha/a for the period 2006-2014. The application of pesticides, herbicides and fungicides follows the common usage in the Murtal aquifer. The crop rotation is generally cultivated with hardy cover crops (e.g., forage rye after maize, ryegrass after pumpkin or a mixture of winter turnip rape, sunflower and mustard after winter grain); soil tillage is done by plough and harrow.

**Organic Farming**

The OF strategy at Wagna test site complies with the regulations according to the European Council [13,14]. The nitrogen input is generally provided by nitrogen fixation of legumes. The nitrogen amount applied due to fertilization is less than 7 kg N/ha/a (one application of 50 kg nitrogen within an eight year period). The crop rotation for the OF system until 2009 was maize–winter grain (spelt or triticale)–oil pumpkin–alfalfa. In 2010 the crop rotation changed and maize–oil pumpkin–maize–triticale was cultivated. The OF management strategy generally cultivates an undersown cover crop consisting of an alfalfa/clover-mixture. A basic element concerning weed control is hoeing, either by hand or by machinery. For soil tillage, ripper, plough and harrow are used.

**ECONOMIC ASSESSMENT**

The economic assessment is based on the real operated cultivation and recorded crop yields of the agricultural test site Wagna, Austria, for the period of 2006 to 2014. This comparative assessment of OF and CF does not include any governmental subsidies. Herein, the following principle is applied for determining the economic profit:
Profit = Revenues from cash crops + Revenues of selling straw – Costs for seeds of cash crops – Costs for seeds of cover crops – Costs for fertilizers – Costs for plant protection and plant care – Machine costs (including tillage costs) – Harvesting and drying costs

**Revenues from cash crops**
Revenues from selling the harvest depend on crop yields and gross market prices for the different crops. Since market prices of crops are strongly variable, market prices based on statistical data [15,16] are used if available. Furthermore, market prices based on information from a contracting company [17] and based on expert opinion [18] are used. The average market prices are presented in Table 1.

**Table 1 Market prices for crops averaged between 2006 and 2014.**

<table>
<thead>
<tr>
<th></th>
<th>Maize</th>
<th>Oil Pumpkin</th>
<th>Triticale</th>
<th>Winter barley</th>
<th>Spelt</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CF</strong></td>
<td>0.1715</td>
<td>3.3264</td>
<td>0.1549</td>
<td>0.1444</td>
<td>-</td>
</tr>
<tr>
<td><strong>OF</strong></td>
<td>0.2788</td>
<td>4.3540</td>
<td>0.2593</td>
<td>-</td>
<td>0.3900</td>
</tr>
</tbody>
</table>

**Revenues from selling straw**
If straw of winter grain is not chopped and left on the field, a market price of 0.03 €/kg is used for calculating respective revenues. This price is an average usual market price based on expert opinion [18] and does not change significantly over the calculation period.

**Costs for seeds of cash crops, seeds of cover crops and chemical plant protection**
Amounts and sorts of cash crops, cover crops and chemical plant protection within this economical assessment comply with the real cultivation at the agricultural test site Wagna. The market prices used are provided from a local agricultural store [19].

**Costs for fertilizers**
Costs for mineral fertilizer and the organic farm fertilizer are provided by local agricultural stores [19,20]. Since a CF system in the region of the Murtal aquifer is commonly combined with pig fattening or pig breeding an average amount of 48 kg/ha/a slurry is produced [9]. Thus, it is assumed that the CF system must not buy liquid manure and, therefore, only the costs for manpower and machines for the application of liquid manure are considered.

**Tillage costs**
Tillage costs are entirely attributed to machine costs.

**Machine costs**
Machine costs have to be considered for all seeding-, fertilization-, plant protection- and tillage-steps (harvesting assumed by contractor). This information is available from the Austrian Institute for Agricultural Engineering and Development [21], where costs in €/h (Euro per hour) in combination with expenditures of time in h/ha (hours per hectare) are provided for single years. Machine costs also include costs for the driver of the tractor to implement an assessment quantifying the expenditure of time of the farmer [21]. Furthermore, due to some crops require also manual hoeing (especially oil pumpkin cultivation in the OF system), costs for respective operations are also considered in the calculation as machine costs.

**Costs for harvesting and drying**
Costs for harvesting and drying of maize and winter grain are calculated based on information from the Austrian Agency for Agriculture [16]. It is assumed that harvesting and drying (drying for winter grain is generally not required) is done by a contractor, where harvesting costs are dependent on the harvested yield and drying costs are dependent on the harvested moist yield and the percentage points to be dried.

**RESULTS AND DISCUSSION**
Crop yields from OF are on average 19% lower for maize (CF: 9.5 t/ha; OF: 7.7 t/ha), 20% lower for oil pumpkin (CF: 0.6 t/ha; OF: 0.48 t/ha) and 44% lower for triticale (CF: 6.4 t/ha; OF: 3.6 t/ha) compared to CF.

The overall profit for CF and OF is 169 and 298 €/ha/a, respectively. Highest mean profits are achieved for maize of OF; lowest for triticale at CF (not considering alfalfa between 2006-2009 at OF, which is no cash crop). The fluctuation of annual profits is rather high from year to year, which mainly depends on varying annual crop yields and market prices. In Table 2 an overview of annual average revenues and costs for itemized in- and output processes is given. Machine costs are already charged to the appropriate processes. The table shows that revenues are slightly higher for OF. Costs for fertilization, harvesting and drying are higher for CF than for OF. Costs for seeding of cover crops and plant protection and care are
higher for OF. Costs for seeding of cash crops as well as tillage costs are similar for both cultivation strategies.

Table 2 Economic profit for conventional and organic farming at the agricultural test site Wagna, Austria, itemized by in- and output processes (machine costs charged to appropriate processes)

<table>
<thead>
<tr>
<th>Item</th>
<th>Conventional Farming</th>
<th>Organic Farming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues from cash crops</td>
<td>€1519</td>
<td>€1548</td>
</tr>
<tr>
<td>Revenues of selling straw</td>
<td>€13</td>
<td>€0</td>
</tr>
<tr>
<td>Costs for seeding of cash crops</td>
<td>€244</td>
<td>€253</td>
</tr>
<tr>
<td>Costs for seeding of cover crops</td>
<td>€115</td>
<td>€156</td>
</tr>
<tr>
<td>Costs for fertilization</td>
<td>€216</td>
<td>€63</td>
</tr>
<tr>
<td>Costs for plant protection and care</td>
<td>€119</td>
<td>€192</td>
</tr>
<tr>
<td>Tillage costs</td>
<td>€263</td>
<td>€272</td>
</tr>
<tr>
<td>Harvesting and drying costs</td>
<td>€406</td>
<td>€314</td>
</tr>
<tr>
<td>Profit</td>
<td>€169</td>
<td>€298</td>
</tr>
</tbody>
</table>

Results show that, on the one hand crop yields of CF are generally higher at Wagna test site, but on the other hand OF achieves a higher economic profit. The financial advantage of OF is due to higher market prices and lower total management costs, which goes along with results of other authors [3,4,5,6]. Most significantly is the difference in fertilization costs, which amounts to €153/ha/a lower for OF. Because of lower yields also costs for harvesting and drying are €92/ha/a lower for OF. OF does not use any chemical plant protection causing costs, but organic weed and pest control is rather cost intensive. Especially mowing and chopping operations of alfalfa as main crop between 2006 and 2009 are the most expensive plant protection and care measures within the OF system. But also mechanical plant protection by hoeing is costly. This difference is visible in Table 2, where organic plant protection and care is €73/ha/a more expensive (including also manual hoeing operations for oil pumpkin) than chemically based plant protection.

Because subsidies are generally not considered within this paper, real profits are higher than presented here. On the one hand, subsidies from the basic fund for market regulation issues would increase the CF as well as the OF profits to same amounts. On the other hand, environmental compensation payments would be different for each management strategies.

The crop rotation cultivated in Wagna is representative for most parts of the Murtal aquifer; soils predominant at the test site are also common for the lower terraces of the Murtal. Thus, results of this work are not only significant for the location of the test site, but also for large parts of the Murtal aquifer.

CONCLUSIONS
1. Crop yields are significantly lower with OF than CF (especially for winter grain).
2. The economic profit of the OF strategy is generally higher than for conventional farming.
3. Results are strongly dependent on crop yields and market prices, which may vary significantly from year to year.
4. Highest differences of costs between CF and OF come from fertilization.
5. Costs for plant protection and care are higher for OF than for CF.

REFERENCES


