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A comparison of two modes of dairy farming intensification and their potential impact on water quality in two adjacent watersheds in Ohio, USA

Alexandre Joannon, Richard Moore, Jacques Baudry

INRA SAD Paysage, FRANCE - Ohio State University SENR

International Amish Conference - June 2013
PLAN

1. Context - Material and Method

2. Results

3. Discussion and Perspectives
Figure 2-2. Land use and land cover within the Sugar Creek watershed.
Two modes of agricultural intensification

Amish intensification

- When? Started during the mid 90’s
- Which event? Debate in church districts about social and economic values of milking machines
- Which changes? Milking machine - bulk tank - 1/3 increase in herd size
Two modes of agricultural intensification

Amish intensification

- When? Started during the mid 90’s
- Which event? Debate in church districts about social and economic values of milking machines
- Which changes? Milking machine - bulk tank - 1/3 increase in herd size

English intensification

- When? Started during the mid 70’s
- Which event? Agricultural vocational education teacher recommended scale increase for profit
- Which changes? Dairy parlors and 2 to 3 times herd increase
2007 Survey outline

Farmer interview topics

- General characteristics of the farm: area, crop and animal productions, etc.
- Spatial organisation of fields and land use: creation of a GIS database
- Crop and livestock management: rotations, tillage practices, grazing management.
2007 Survey outline

Farmer interview topics
- General characteristics of the farm: area, crop and animal productions, etc.
- Spatial organisation of fields and land use: creation of a GIS database
- Crop and livestock management: rotations, tillage practices, grazing management.

Survey coverage
- 28 farmers: 17 Amish and 11 English
- 8,455 ac surveyed: 1,215 ac in Amish farms and 7,240 ac in English farms
Spatial distribution of farms surveyed
Farm characteristics

Production orientation

- Dairy (milking cows or replacement heifers) : 68%
- Cash crops or hay business in 4 English farms : up to 100% of the farm
- Poultry operations in 3 Amish farms : around 100,000 broilers per year
- Part-time farmer with a full time off farm job : 20% on Amish farms vs 35% on English farms

Average level of production

- Farmed land : 80 ac (Amish) / 46 ac (Part time English) and 863 ac (Large English dairy)
- Tillable land : 47 ac (Amish) / 17 ac (Part time English) and 804 ac (Large English dairy)
- Milking cows : 23 (Amish) / 310 (English)
- Production per cow : 15,800 lbs/y (Amish) / 25,200 lbs/y (English)
## Dairy cows feeding

### Herd feeding (% are related to fodder crops)

<table>
<thead>
<tr>
<th>Pasture</th>
<th>Amish (11 farms)</th>
<th>English (5 farms)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All farms – 39%</td>
<td>4 farms - 4%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Animals grazed</th>
<th>Amish (11 farms)</th>
<th>English (5 farms)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>Dry cows and heifers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of grazing</th>
<th>Amish (11 farms)</th>
<th>English (5 farms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensive (5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotational (4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanent N-D (2)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hay fields grazing</th>
<th>Amish (11 farms)</th>
<th>English (5 farms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td></td>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Silage corn</th>
<th>Amish (11 farms)</th>
<th>English (5 farms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All farms – 4%</td>
<td></td>
<td>All farms – 28%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hay</th>
<th>Amish (11 farms)</th>
<th>English (5 farms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>31%</td>
<td></td>
<td>51%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of hay</th>
<th>Amish (11 farms)</th>
<th>English (5 farms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mainly dry hay</td>
<td></td>
<td>Mainly chopped silage hay</td>
</tr>
</tbody>
</table>

- **Amish farms**: complementarity between grazing, dry hay and silage
- **English farms**: more than 80% from silage (hay and corn)
Organic nutrients load to the stream (Phosphorus)

Average values of organic phosphorus produced per farm
(in lbs of P2O5 per acre)

<table>
<thead>
<tr>
<th></th>
<th>Amish (17 farms)</th>
<th>English (11 farms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All farms together</td>
<td>39</td>
<td>32</td>
</tr>
<tr>
<td>Min</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Max</td>
<td>132</td>
<td>55</td>
</tr>
</tbody>
</table>

Calculation based on French standards
(1 cows = 38 kg of P2O5 excreted per year)

Breakdown for all farms

- 0-6 lbs/ac : 2 English (cash crop)
- 15-42 lbs/ac : 21 English and Amish
- 52-55 lbs/ac : 2 English (livestock with no cash crop)
- 104-132 lbs/ac : 3 Amish (off farm + chicken house)
Crop rotations and their spatial organisation

Rotations in Amish farms
- Regular rotation: corn – oat – (spelt/barley/wheat) – hay 4 years
- Usual variations: 2-3 years of corn / 2 to 7 years of hay
- More corn in fields near the silo or in bottom land on clay soil
- Longer hay duration on hills with sandy soil

Rotations in English farms
- On bottom land with drained clay soil: continuous corn (soybean)
- On steep slopes: continuous hay (pasture if really too steep)
- On intermediate hill: Corn several years – (wheat) – Hay several years
Spatial aggregation at the landscape scale: English site
Spatial aggregation at the landscape scale: Amish site
### Discussion: potential consequences for water quality

A qualitative assessment of both farming systems

<table>
<thead>
<tr>
<th></th>
<th>Amish farms</th>
<th>English farms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic nutrients outflow</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Level of production</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Landscape heterogeneity</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Manure storage facilities</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Hay and pasture use</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Conservation practices</td>
<td>=</td>
<td>=</td>
</tr>
<tr>
<td>Fields spatial heterogeneity</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

\[\rightarrow \text{Water quality?}\] ?? ??

*No evidence that one system is better than the other regarding nutrient transfers to the streams*
Conclusion and perspectives

Two rather different types of intensification

- English dairy farms intensification leads to very large farms with very small remaining part-time non dairy farms
- Amish dairy farm intensification is more homogeneous among farmers leading to small scale dairy farms
- However, both resulting farming systems have potential negative impacts on nutrients loading to streams

Monitoring water quality

- In upper parts of both watersheds where Amish and English farms are not mixed
- Using continuous flow and sampling devices
- Started in spring 2013 and scheduled for the next 5 years
Amish landscape heterogeneity

English landscape heterogeneity

Thank you for your attention!