Local Yield Measurement in a Potato Harvester and Overall Yield Patterns in a Cereal-Potato Crop Rotation

by

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Introduction

Local yield detection is widely recognized as basic information for management decisions in site-specific plant production or for controlling the effects of spatially variable applications.

For yield measurement in combine harvesters commercially available equipment is on the market and has been evaluated under different practical conditions as well as on a test stand.

For determination of yield patterns into stable yield zones local yield data for more than two seasons are necessary.

To get the needed information as fast as possible local yield detection for non-combinable crops of typical European rotations is an indispensable requirement.

For forage choppers, different developments have been reported. Also for the yield monitoring of "conveyor harvested crops", like sugar beets, potatoes, onions and tomatoes, first technical solutions are available.

For yield measurement of sugar beet conveyor weighing systems a mass-flow system measuring the forces on a curved plate (side screen) at a rotating spinner or a laser based optical volume flow measuring system have been proposed.
For potato harvesters, only the application of a conveyor weighing technique has been reported. The systems have been installed into the trailer loading elevator of two- or four-row harvesters.

In Germany, single-row machines with a bunker-hopper are used. To get knowledge on the accuracy of a yield detection system under such conditions a measurement system for local yield detection was evaluated in the potato harvest seasons 1997 and 1998.
Material and Method

Based on the typically used harvester technology, the following mass-flow and yield measurement systems can be considered:
Yield maps potato fields experimental farm Scheyern 1997

Field A17
- Area [ha]: 6.0
- Mean yield [t/ha]: 31.0
- Max. yield [t/ha]: 43.0
- Data per grid: 113

Field A18
- Area [ha]: 6.5
- Mean yield [t/ha]: 38.8
- Max. yield [t/ha]: 60.7
- Data per grid: 87

Grid size: 24 m
Single correlations ($R^2$) of relative grid-yields

$R^2_e = 0.42$  ***

Multiple correlations ($R^3$) of relative grid-yields

$R^2_m = 0.00$

$R^2_m = 0.65$  ***

Rel. Yield Patterns Scheyern"A17" 1995 - 1998

(6.0 ha; Grid-Size 24 x 24 m; n = 81)
Yield < 85 %
85 - 95 %
95 - 105 %
105 - 115 %
> 115 %

180 kg N / ha uniform
Harvest 1995
Winter wheat avg. yield 7.3 t/ha

168 kg N / ha uniform
Harvest 1996
Corn avg. yield 6.8 t/ha

180 kg N / ha uniform
Harvest 1997
Winter wheat avg. yield 6.1 t/ha

Agria
50 kg N / ha
Solaro
40 kg N / ha

Harvest 1998
Potatoes avg. yield 39.7 t/ha

Single correlations ($R^2$) of relative grid-yields

$R^2_s = 0.28$ ***

$R^2_s = 0.65$ ***

$R^2_s = 0.55$ ***

Multiple correlations ($R^2_m$) of relative grid-yields

$R^2_m = 0.79$ ***

$R^2_m = 0.06$

Rel. Yield Patterns Scheyern "A18" 1995 - 1998
(6.5 ha; Grid-Size 24 x 24 m; n = 88)
Accuracy of mass-flow and yield measurement systems for potatoe and sugar beet harvesters

<table>
<thead>
<tr>
<th>measurement principle</th>
<th>Harvester typ, crop</th>
<th>author</th>
<th>evaluation extend</th>
<th>measured accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>mass accumulation System “Silsoe”</td>
<td>Trailer Sugar beet, potatoes</td>
<td>Godwin et al.</td>
<td>1 field 15 loads</td>
<td>avg. = 1.1 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1997</td>
<td></td>
<td>s.d. = 4.0 %</td>
</tr>
<tr>
<td>basket weighing System “Tifton”</td>
<td>Trailed two-row baske combine, peanuts</td>
<td>Durance et al.</td>
<td>2 field 40 loads</td>
<td>avg. = 0.2 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1998</td>
<td></td>
<td>s.d. = 3.1 %</td>
</tr>
<tr>
<td>conveyor weighing “Harvestmaster”</td>
<td>trailed two-row side loading, potatoes</td>
<td>Rawlins et al.</td>
<td>1 field 48 loads</td>
<td>avg. = n.c.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1995</td>
<td></td>
<td>s.d. = 4.9 %</td>
</tr>
<tr>
<td>conveyor weighing “Harvestmaster”</td>
<td>trailed six-row side loading, potatoes</td>
<td>Hall et al.</td>
<td>1 field 99 loads</td>
<td>avg. = 0.97 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1997</td>
<td></td>
<td>s.d. = 2.2 %</td>
</tr>
<tr>
<td>conveyor weighing “Harvestmaster”</td>
<td>trailed six-row bunker hopper, potatoes</td>
<td>Demmel et al.</td>
<td>2 field 77 loads</td>
<td>avg. = 1.3 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1998</td>
<td></td>
<td>s.d. = 4.1 %</td>
</tr>
<tr>
<td>conveyor weighing “Harvestmaster”</td>
<td>self-propelled six-row side-loading, sugar beet</td>
<td>Demmel et al.</td>
<td>2 field 39 loads</td>
<td>avg. = 1.0 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1998</td>
<td></td>
<td>s.d. = 3.7 %</td>
</tr>
<tr>
<td>conveyor weighing system “Rottmeier”</td>
<td>self-propelled six-row tanker, sugar beet</td>
<td>Demmel et al.</td>
<td>5 field 23 loads</td>
<td>avg. = 2.1 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1998</td>
<td></td>
<td>s.d. = 5.6 %</td>
</tr>
<tr>
<td>force curved plate system “Leuven”</td>
<td>self-propelled tanker loader, sugar beet</td>
<td>Broos et al.</td>
<td>1 field 19 loads</td>
<td>avg. = 0.4 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1998</td>
<td></td>
<td>s.d. = 1.6 %</td>
</tr>
<tr>
<td>laseroptical volume system “Bonn”</td>
<td>self-propelled cleaner loader, sugar beet</td>
<td>Kromer et al.</td>
<td>2 field 15 loads</td>
<td>avg. = n.c.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1998</td>
<td></td>
<td>s.d. = 4.0 %</td>
</tr>
</tbody>
</table>
Conclusions

Local yield detection using conveyor weighing technique on a one-row trailed potato harvester with offset-lifting and bunker-hopper using DGPS for positioning worked without any technical problem during two harvesting seasons.

The reached accuracy was comparable to the accuracy of yield measurement in combines and to other measurement systems for "conveyor harvested crops".

Errors difficult to estimate arise from contaminants (halm, clods, stones) which are collected and "weighed" together with the crop. A post-harvest data correction with an estimated or calculated "average" contaminant content will not be able to solve that problem, especially if the proportion of the contaminants is changing within the field.

Additional measuring systems to determine the contaminant content will be needed in future, also to automatically control the cleaning process in the harvester.

First comparisons of potato yield maps to those of combinable crops show deviating yield patterns. Further analysis on whole rotations, more fields, over several years and at more locations are needed to confirm this observations.
Acknowledgements

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