LUCAS: A possible scheme for a master sampling frame.

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Area frames of square segments

Square segments on a classified image
Sampling farms through points

Drawbacks:
• Identifying the farmer linked to a point is not always easy
• Concept of “agricultural land”
  • A point is selected if it falls on agricultural land
  • The farmer is asked about the area of land he manages
  • Both concepts should coincide.

Advantages:
• An area frame has no problems with duplicated or missing elements
• The area of the tract (part of the farm inside the segment) does not need to be computed.
From Area Frames of Segments to points

In the late 80’s 90’s, the MARS Project of the EU worked mainly with Sampling frames of square segments.

- The area frame was cheaper to define than the USDA system of segments with physical boundaries.
- Similar accuracy

Since 2001 Eurostat launched LUCAS (Land Use/Cover Area frame Survey)

- Points instead of segments
LUCAS 2001-2003

One cluster every 18x18 km
Each cluster has 5 x 2 points 300m apart from each other.
And one transect of 1200 m that joins one row of points
It can be seen as an incomplete observation of a segment
The Italian experience AGRIT

• AGRIT was since the early 80’s conducted with the USDA-inspired segments with physical boundaries.
• Around 2000 they tested a method using unclustered points as sampling units.
• The number of points/day visited by each enumerator was substantially higher than we had foreseen in our cost function
• In 2005 we conducted a large scale test in Greece
• The Italian conclusions were confirmed.
LUCAS 2006 Sampling scheme

Adaptation of the “new” Italian AGRIT

• In 2005 we conducted a test in Greece adapting the Italian AGRIT based on point sampling
• AGRIT claims of a better cost/efficiency ratio were confirmed

First phase: Systematic sampling of unclustered points (single stage)

• A master or first phase sample (pre-sample): One point every 2x2 km
• Stratification by quick photo-interpretation
• Stratified sub-sampling
Two-phase systematic sample

LUCAS 2006 Pre-sample

Subsampling tuned to minimise spatial auto-correlation

Strata
- Arable
- Perm. crops
- Perm. Grass
- Wood and forest
- Rare vegetation
- Artificial
- Water

Final sample
A slight difference AGRIT-LUCAS: Second phase sampling in LUCAS is systematic with constraints.
In-situ data collection

The improvement of location accuracy with GPS has been a fundamental reason to move from segments to points. Still the image is necessary for the field work and should be prioritary if disagreement.

- But the image should be the one used for stratification
Landscape pictures

from each point:
- 4 landscape pictures,
- Point location
- Crop detail
Sampling efficiency

Relative efficiency between different point approaches

<table>
<thead>
<tr>
<th></th>
<th>Systematic random</th>
<th>Poststrat</th>
<th>Unequal prob</th>
<th>Total efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEREALS</td>
<td>1.11</td>
<td>1.40</td>
<td>1.26</td>
<td>1.95</td>
</tr>
<tr>
<td>Common wheat</td>
<td>1.11</td>
<td>1.16</td>
<td>1.42</td>
<td>1.83</td>
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<tr>
<td>Durum wheat</td>
<td>1.43</td>
<td>1.29</td>
<td>1.41</td>
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<tr>
<td>Barley</td>
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<td>1.17</td>
<td>1.40</td>
<td>1.88</td>
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<tr>
<td>Maize</td>
<td>1.21</td>
<td>1.19</td>
<td>1.43</td>
<td>2.06</td>
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<tr>
<td>Potatoes</td>
<td>1.09</td>
<td>1.06</td>
<td>1.36</td>
<td>1.57</td>
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<tr>
<td>Sugar beet</td>
<td>1.05</td>
<td>1.01</td>
<td>1.59</td>
<td>1.69</td>
</tr>
<tr>
<td>Sunflower</td>
<td>1.09</td>
<td>1.07</td>
<td>1.88</td>
<td>2.19</td>
</tr>
<tr>
<td>Rapeseed</td>
<td>1.07</td>
<td>1.10</td>
<td>1.50</td>
<td>1.77</td>
</tr>
<tr>
<td>TEMP. GRASS</td>
<td>1.20</td>
<td>1.21</td>
<td>1.28</td>
<td>1.85</td>
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<tr>
<td>Olive groves</td>
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<td>1.82</td>
<td>0.89</td>
<td>2.63</td>
</tr>
<tr>
<td>Vineyards</td>
<td>1.43</td>
<td>1.55</td>
<td>1.44</td>
<td>3.19</td>
</tr>
<tr>
<td>FOREST</td>
<td>1.00</td>
<td>1.74</td>
<td>0.38</td>
<td>0.66</td>
</tr>
<tr>
<td>PERM. GRASS</td>
<td>1.12</td>
<td>1.38</td>
<td>0.64</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Relative efficiency between Clustered and non-clustered sampling (non-stratified, systematic)

<table>
<thead>
<tr>
<th></th>
<th>Variance ratio: cluster 10 points/ 8 unclustered points</th>
<th>Equivalent points of a 10-point cluster</th>
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</thead>
<tbody>
<tr>
<td>Artificial land</td>
<td>1.76</td>
<td>4.56</td>
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<tr>
<td>Total Cereals</td>
<td>2.45</td>
<td>3.27</td>
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<tr>
<td>Common wheat</td>
<td>1.65</td>
<td>4.86</td>
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<tr>
<td>Durum wheat</td>
<td>2.86</td>
<td>2.80</td>
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<tr>
<td>Barley</td>
<td>1.70</td>
<td>4.70</td>
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<tr>
<td>Maize</td>
<td>2.12</td>
<td>3.77</td>
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<td>5.93</td>
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<td>Sunflower</td>
<td>2.97</td>
<td>2.69</td>
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<tr>
<td>Rapeseed</td>
<td>1.24</td>
<td>6.45</td>
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<tr>
<td>Olive groves</td>
<td>3.17</td>
<td>2.52</td>
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<tr>
<td>Vineyards</td>
<td>2.59</td>
<td>3.09</td>
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<tr>
<td>Forest</td>
<td>4.46</td>
<td>1.79</td>
</tr>
<tr>
<td>Perm. Grass</td>
<td>1.96</td>
<td>4.09</td>
</tr>
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LUCAS 2009/2012

- **Continuity with LUCAS 2006**
- **Priority moved from agricultural to environmental**
  - Different sub-sampling rates per strata
  - More detailed nomenclature for non-crop land cover
- **Introduction of a soil component**
  - 20,000 soil samples taken and analyzed in laboratory.
- **Re-introduction of transects**
  - Landscape complexity
  - Estimating the total length of linear elements
Main parameters observed

- Land cover (1 & 2)
- Land use (1 & 2)
- Land Cover percentage
- Area size
- Height of trees
- Width of features
- Transect (250 m to east) with Land Cover and linear features
- Land management (grazing)
- Water management
Transect

<table>
<thead>
<tr>
<th>C01</th>
<th>B43</th>
<th>C01</th>
<th>B75</th>
<th>02</th>
<th>02</th>
<th>B43</th>
<th>15</th>
<th>B16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broadleaved forest</td>
<td>Other vegetables</td>
<td>Broadleaved forest</td>
<td>Other fruit trees</td>
<td>Herb fringes</td>
<td>Road</td>
<td>Herb fringes</td>
<td>Other vegetables</td>
<td>Woodland margins</td>
</tr>
</tbody>
</table>
LUCAS as Master sampling frame

The 2-km purely systematic grid is a master frame for the land cover survey.

- It can be used as master frame for other surveys if the information available (simple photo-interpretation) is useful.
- Example: specific survey on permanent crops

The LUCAS Field survey sample can become itself master frame

- Example: Soil survey to monitor the organic carbon content of (mainly) agricultural land
Requirements and challenges:

Building and maintaining a data base of the farms linked to each point.

Including common pastures?

Combining with list frames (of large farms?)
  - For a point in a (sub-) sample being able to determine if it belongs to the list frame

How to deal with farms or households that do not own/manage any land (only livestock)

How sensitive are the results to wrong data on the area of the farm.

Linking a farm to a point in a ‘mini-census” makes it easier to identify double counting and missing units.