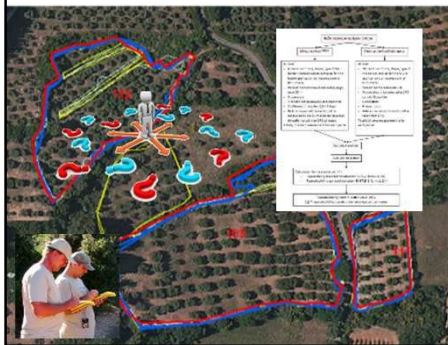


## State of play and methodologies

[www.jrc.ec.europa.eu](http://www.jrc.ec.europa.eu)



Serving society  
Stimulating innovation  
Supporting legislation

## Outline

### Sampling

- Random versus Risk
- CwRS Image use
- CwRS Zone selection

### Measurements

- Why, When, What, How?
- Technical tolerance - validated tools
- Use of the technical tolerance
- Single value buffer tolerance

### Conclusions

## Random vs Risk

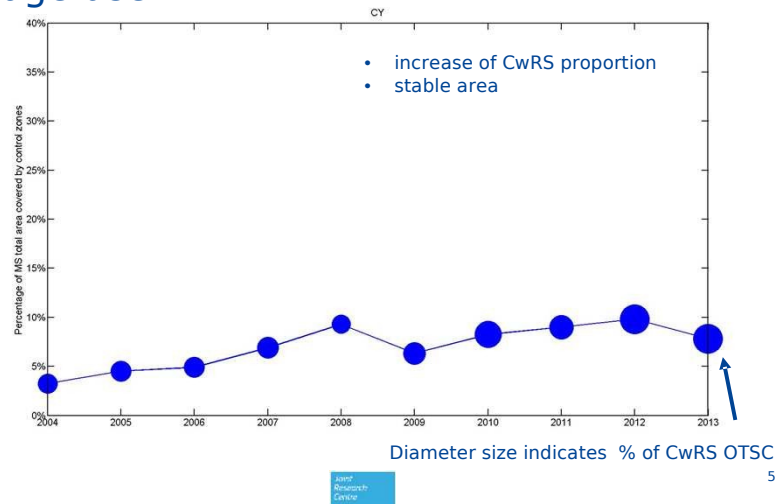
Attention to reliability of error rates  
some statistical considerations

- Currently:
  - Estimation of error rates (both random & risk)
  - Pure numerical comparison of the random and risk error rates  
...leads to unfounded conclusions e.g.  
“error rates are  $ER_{\text{random}}=1.5\%$  and  $ER_{\text{risk}}=1.51\%$ , risk analysis effective!”
- Future: maybe adapt approach (cfr LPIS QA1b !)
  - Estimation of variability of error rates (both random & risk)
  - Test on these error rates (e.g. “ $ER_{\text{random}} < 2\%$  ?”)
  - Compare statistically the random and risk error rates (e.g. “Can we consider them as being equal?”)

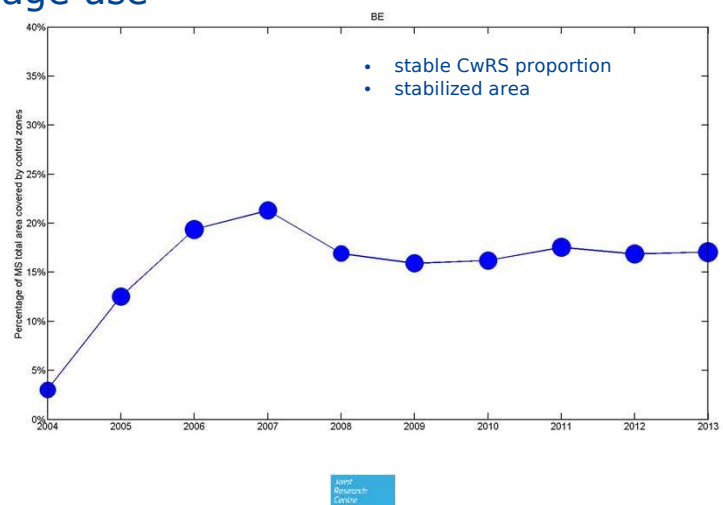
## Random vs Risk

- Other interesting questions
  - “Are the errors found inline with the RA?”
  - “Should sample size be increased to gain precision?”
  - “Are there differences between the zones?”
  - “Are there differences over time?”
- Methods to detect potential issues
  - Apply RA on the control data and check if the RA is indeed able to sort/estimate correctly the problems  
(assessments depend on the method that was used for the RA)
  - Known variability of errors should enable to assess the relevancy of the sample size
  - Geographically map the error found  
(see also CwRS zone selection hereafter)
  - Evaluate and compare the error rates between control zones  
(see also CwRS zone selection hereafter)

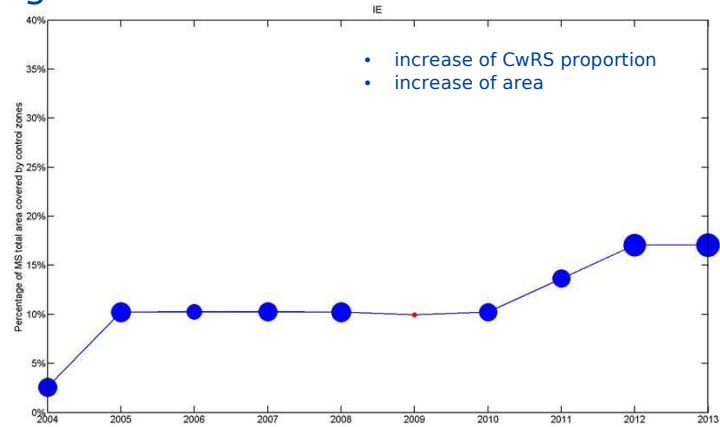
## Image use



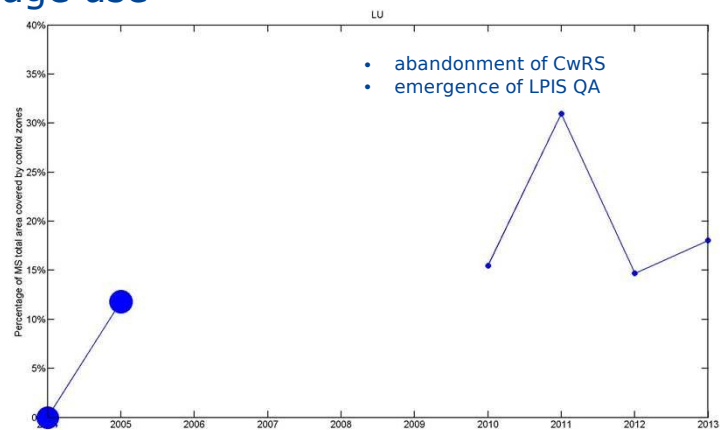
## Image use



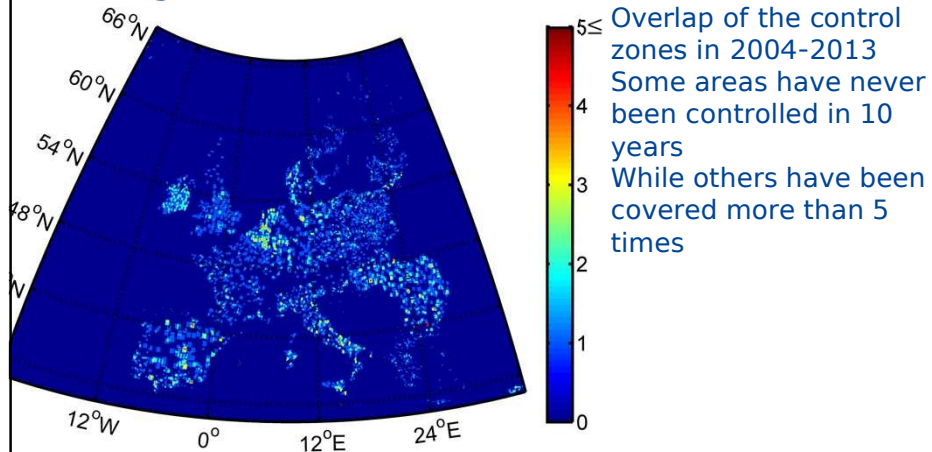
## Image use



## Image use



## Image use



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## Image acquisition

Different

- trends among MS
- intensity of CwRS
- zone sizes
- zone boundary types
- temporal cycles

What are the right choices?

A.k.a. what are the statistical drivers to have an effective but efficient sample?

or: how to select CwRS zones?

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## CwRS zone selection

- Pay attention at the cluster effect of CwRS's applications !
- Map the error found from previous controls to foresee this effect
- "Salt 'n pepper" errors distribution are truly random
- Spatial trends must be tackled adequately
- One can play with number and size of zones:  

$$\text{Total Area} = N_{\text{zone}} * \text{Area}_{\text{zone}}$$

## Area cover as f(#zone, zone size)

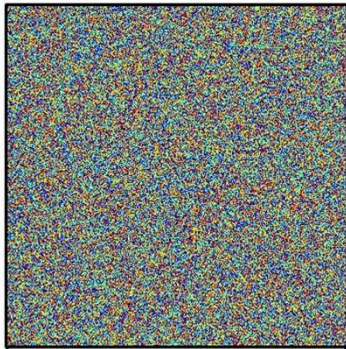
- apparent effect
- + benefits regarding sample representativeness
- disadvantages

% area covered



- |   |   |  |
|---|---|--|
| <ul style="list-style-type: none"> <li>• Lots of small zones</li> <li>• Exhaustive controls within the zones</li> <li>+ ~simple random sampling</li> <li>- dispersed RFV</li> <li>- application parcels out of zone?</li> <li>- many images to order/process</li> </ul> | <ul style="list-style-type: none"> <li>• Small + large zones</li> <li>• Control rates within the zones decrease</li> <li>+ fewer images</li> <li>- cluster effect?</li> <li>- more expensive</li> </ul> | <ul style="list-style-type: none"> <li>• More large zones</li> <li>• Control rates within the zones still decrease</li> <li>+ ~simple random sampling</li> <li>+ concentrated RFV</li> <li>- even more expensive</li> <li>- zone overlap?</li> </ul> |
|---|---|--|

## Cluster effect with “pepper-and-salt” relative errors ?



Simulation 500x500

Simulation of % deduction (= relative error) in farmers (random location)

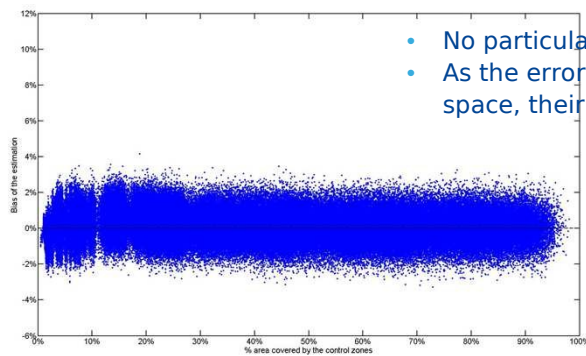
- Relative errors of this simulation run have a “pepper-and-salt” aspect (see left)
- Multiple random selection of a target 1% sample size (i.e. 2500) to study effect of
  - control zones size
  - control zones number

## Bias(#zone,zone size)

	# zones									
	1	5	10	15	20	25	30	35	40	45
0.2%		0%	0%	0%	0%	0%	0%	0%	0%	0%
0.7%		0%	0%	0%	1%	1%	0%	0%	0%	0%
1.5%	-1%	0%	1%	0%	0%	0%	0%	0%	0%	0%
2.6%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%
4.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
6.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

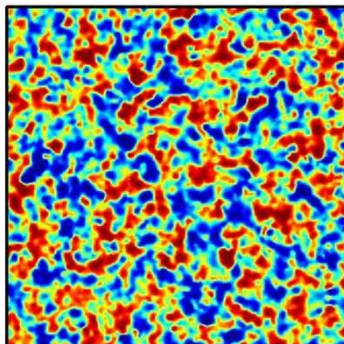
zone size Area covered

## Bias(%area covered)



- No particular trend
- As the errors are randomly spread over space, their clustering is not an issue !

## Cluster effect with patchy relative errors ?



Simulation 500x500

Simulation of % deduction (= relative error) in farmers (clustered location)

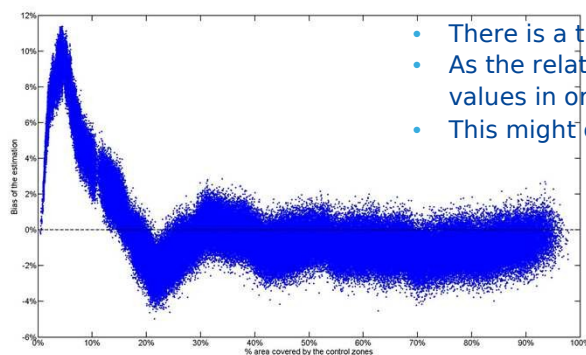
- Relative errors have a patchy aspect (see left)
- Multiple random selection of a target 1% sample size (i.e. 2500) to study effect of
  - control zones size
  - control zones number



## Bias(#zone,zone size)

zone size Area covered	#zones											
		1	5	10	15	20	25	30	35	40	45	
	0.2%		2%	6%	8%	9%	9%	9%	8%	6%	5%	
	0.7%		9%	6%	4%	2%	1%	-1%	-2%	-2%	-1%	
	1.5%	4%	5%	2%	-2%	-1%		0%	0%	-1%	-1%	-1%
	2.6%	7%	2%	-2%		0%	-1%	-1%	-1%	-1%	-1%	
	4.0%	9%	-1%		0%	-1%	-1%	-1%	-1%	-1%	-1%	
	6.0%	8%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%		

## Bias(%area covered)



- There is a trend
- As the relative errors are patchy, few values in or out make a difference !
- This might cause an issue !

In this example,  
optimal combination (i.e. minimal bias and cost) is  $\pm 30$  control zones of  $\pm 1\%$  of the total area  
Rule of thumb: zone size slightly larger than the patch size

## Remedial actions

Random selection: if Heterogeneity (a.k.a. high variability) between

1. control zones increase zone number
2. deductions increase sample size

If random error similar to risk error:

1. Review RA (e.g. new model, new risk factors,...)
2. Review random selection (e.g. control zone design/selection, spatial/temporal clusters,...)

Design of the control zone

For your territory, if spatial clustering occurs

1. Increase zone size to optimum (> patch size)
  2. Increase zone number until sufficient
- =>zone density requirement has been removed from CTS 2014 !

## Additional considerations

1. Dealing with possible budget constraints:

Avoid overlap with aerial photographs of LPIS update campaign

usually planned well in advance

sufficient quality for eligible hectare determination

possible ancillary HR imagery if taken outside the "acquisition window"

Could cover 1/3 of the territory annually 50% extra zones.

2. Reminder: CwRS is only effective when:

the inspector is skilled

the procedure is followed

image quality and processing is appropriate

## Outline

### Sampling

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- CwRS Zone selection

### Measurements

- Why, When, What, How?
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- Use of the technical tolerance
- Single value buffer tolerance

### Conclusions

## Measurements

Elements to be checked:

The declared area of the agricultural parcel;

The area eligible for payment;

The minimum area of the agricultural parcel where applicable.



DETERMINATION OF AREA  $\neq$  MEASUREMENT OF AREA

- IF**
- Changes visible in the declared agricultural parcel when compared with reference parcel
  - Identification of ineligible features (temporary or permanent)
  - .....



MEASUREMENT OF THE AREA

## What to measure ? - 1

Agricultural parcel - areas

Relative measurement

( > < LPIS  $\equiv$  absolute measurement)


tools "proven" to assure measurement of quality at least equivalent to applicable technical standard"

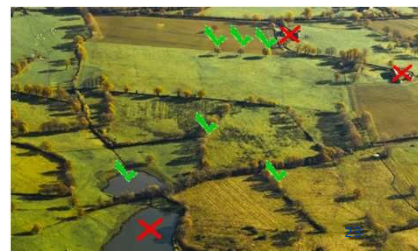
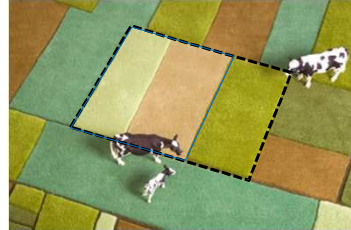
Areas not taken up by agricultural activities are to be excluded from this area

Grassland, arable 

House, rocks 

Trees (density) 

Trees, ponds, hedges 



## What to measure ? - 2

EFA elements - "linear features"

Orthoimage

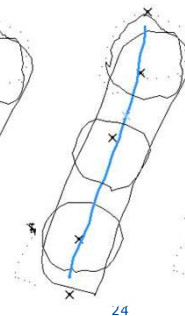
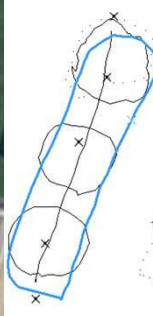
Area

Line

Area  
(global)

GNSS  
Area  
(individual)

Line



Complete and clear definition of the object to be measured !!!

## What to “measure” ? - 3

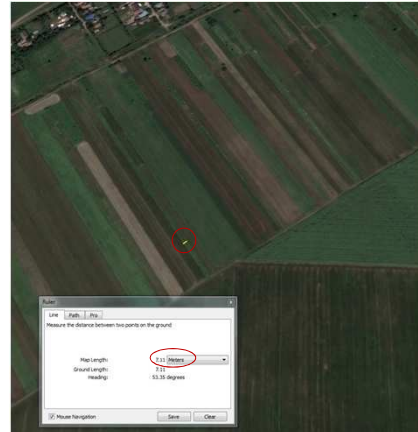
Position of EFA elements or specific parcels

Geo-location of the features (DGNSS, ...)



PL, RO  
Very narrow shape for parcels  
L ± 200 - 1000 m  
W 10 (5) - 20 (50) m

Joint  
Research  
Centre



## How to measure areas?

Well known protocols:

1. Stop and go
2. Continuous mode

Joint  
Research  
Centre

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## Determine area of linear features

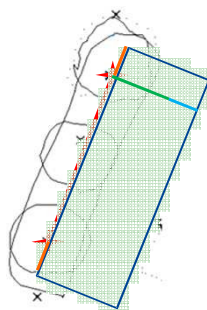
Precondition: the designated EFA features have been defined =>

- they are detectable as feature on the field or on the image (specific)
- where applicable, have maximum dimensions, e.g. width and height (selective)

Proposed feature mapping and calculation rules

1. Select begin and end of the measurement, ensuring that the intended line complies with minimum continuous length ( either standalone or as connected extension) represents continuity (consider maximum gap between two parts, minimum width) respects maximum dimension ( e.g. verify base/crown/undergrowth) starts and ends with a physical ground point ( e.g. last trunk, connection, not canopy extension)
2. Map only "primary" (physical) intermediate vertices (~~zigzag~~, no individual trees/bushes)
3. Delineate axially from one end to the other (centerline)
4. Add one (1) conversion factor [m] to the resulting length ( i.e. for both ends combined)
5. Multiply result with conversion factor and weighting factor to obtain area [m<sup>2</sup>].

## How to measure linear feature



1. select begin end point
2. in this case: no intermediate points
3. map axially
4. add one (i.e. 2 halves) / conversion factor
5. multiply result with conversion and weight factor (1.5).

## How to measure linear feature ( cont'd )



1. select begin end point
2. in this case: one intermediate points
3. map axially
4. add one (i.e. 2 halves) conversion factor
5. For EFA area: multiply result with conversion and weight factor (1.5).

## Topology

### Adjacent in its simplest form (not nested)

- Directly connected (without non-CAP element) with outer border of Agricultural Parcel
- AP contains agricultural area plus adjacent GAEC-7 features
- interior GAEC-7 feature can be EFA-element on its own right
- Linear features need different begin and end point (no T-configuration)

### Parallel

- Adjacency between the agricultural parcel and outer land cover border of the related feature
- Rivers, ditches, taluds: AP also ends where ground-level is disturbed
- Relative angle at begin and end:  $<30^\circ$
- Between border and axis (cartographic scale 1/5.000))
- perpendicular either @axis or @border

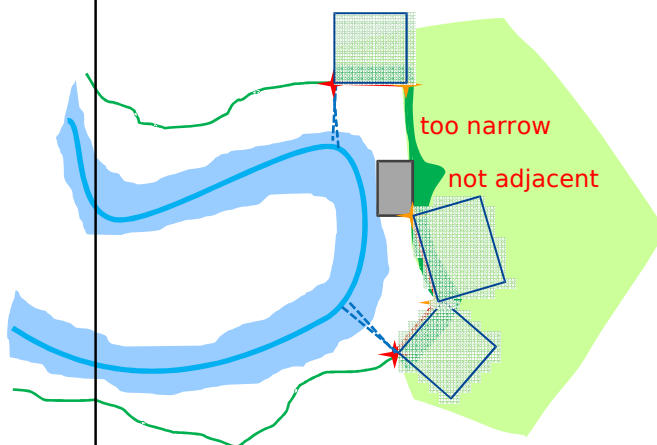
## Determine area of adjacent strips

Precondition: the approximate location is provided by the farmer

Proposed strip mapping and calculation rules

1. Select begin and end on the AP border, so that the intended strip respects parallelism at strip begin and end (consider maximum angle) starts and ends with a physical ground point
2. Interrupt mapping/measuring when the strip no longer complies with border adjacency respects dimensions (i. e. verify buffer width)
3. Map only "primary" (physical) intermediate AP vertices (~~zigzag~~, no continuous mode)
4. Connect the retained points
5. Multiply result with conversion factor and weighting factor to obtain area [m<sup>2</sup>].

## How to measure strip area?



1. select strip begin+end point
  - ★ On AP border
  - Check parallelism -----
2. Interrupt measuring where
  - Not adjacent
  - Too narrow
3. intermediate point ★
4. connect retained vertices —
5. multiply resulting length with conversion and weight factor





## General concept of error

The statistical meaning of « errors » is « the discrepancy between an observed value of a feature and its unknown true value »

It can be caused by many different sources:

- Inherent tool error
- Inappropriate tool
- Inappropriate tool use
- Interpretation of the definition of the feature
  - From the farmer
  - From the controller
- ...

Accurate tool

Training  
Guidance

## Error versus tolerance

« The purpose of the **technical tolerance** is to account for the uncertainty specific to any measurement technique. »

In statistical jargon, it is thus the **Inherent tool error + Object error + Protocol error.**

In the OTSC context, it means **not "error"** but rather '**acceptable discrepancy**' due to the specificity **of the tool in use !**



Error:

Everything that is not taken into account in the technical tolerance !

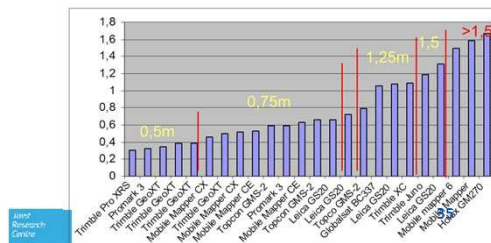
## The technical tolerance AP

≡ area value based on a perimeter buffer

$\text{area}_{\text{determined}} = \text{area}_{\text{declared}}$  where  $\text{area}_{\text{declared}} < \text{area}_{\text{measured}} + \text{tolerance}$

Buffer width established by tool\_\_ reproducibility test  
(test in "laboratory" condition, ISO 5752)

In five classes (0.5m, 0.75m, 1.00m, 1.25m, 1.50m)



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## Tolerance(s)

### 1. Tool and measurement method

Area :

- perimeter approach in all cases ?

Linear :

- Absolute or % of length (?)
- validation ?

### 2. System stability

- small areas (?)





## One buffer tolerance value for area measurement ?

Request of DE, FR, LU ...

Advantages?

Equity between farmers

- Better acceptance

Simplification of administration

- Sometimes 2 tolerances on same CwRS site
- Sometimes 2 tolerances on same parcel (image + GNSS)

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## Comments after proficiency tests (test in 'real' conditions)

Even with knowledge minimum threshold value  
0.4m - 0.5m (current value 0.5m)

Often shift of only 1 class of buffer tolerance value  
3 classes left (0.50m, 0.75m and 1.00m)

Strong impact of expert skill of inspector

Strong impact of parcel border physical condition



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## Towards a single tolerance for area measurement

Pre-requisite

Tools with @1.00m validation



Which validated tool(s)?

GNSS, Ortho image

Which conditions?

Tools validated for 1 or 2 classes less

e.g. @0.50m and @0.75m to apply a 1.00m buffer  
or @.50m, @0.75m or @1.00m for a 1.25m buffer

@1.25m to apply a 1.50m buffer is NOT an option!



## Summary OTSC

To perform appropriate measurements for OTS checks

Sounds maybe trivial but one should:

- Use accurate tools (Validated tools)
- Use appropriate tool
- Use tool appropriately
- Define correctly the limits of parcels, features
- ...

## Conclusion

Analyze your sampling challenges

- Remediate potential issues

Define your elements with administration and control in mind

- Reference parcels matching agricultural parcels
- Landscape features which are simple to select and measure
- EFA elements that are simple to understand

Tolerance

- Design for fewer measurements and less uncertainty
- EFA areas are 2 orders of magnitude smaller than BPS areas



Thank you