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Discussion Paper

Land Parcel Identification Systems in the frame of Regulation (EC) 1593/2000

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Modifications in this document compared to Ver. 1.3, of 22 February 2001		
Chapter	**Subject**	**Content**
4.3.3	**Requirements of Accuracy**	Addition of a § 4.3.3.3, providing indication and practical recommendation on digitisation (accuracy, technical tolerances).
7.2	**Block characteristics**	Addition of § 7.2.2, explaining the role of the 2 parameters (size of the block, maximum number of parcels) and the modalities of block creation.

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Summary

1. Context and objectives of the present "Discussion paper"

1.1. The present discussion paper has been prepared by the DG JRC (MARS project, SAI) at the request of DG AGRI. Its purpose is to develop technical recommendations in the light of the recent Council Reg. 1593/00, for the implementation or the improvement of the LPIS (Land Parcel Identification Systems, defined by Reg. 3508/92 and 3887/92).

1.2. This document provides a basis for discussion to the Member States (and candidate Countries). It only expresses the technical point of view of its authors, and does not engage the Commission (and especially the DG AGRI).

1.3. Although this document tries to be inclusive in its description of existing situations in the various member states, it cannot be exhaustive in this respect. Adaptation to particular regional contexts or special conditions should follow the outlined recommendations as much as possible.

1.4. Figures given in this document are "indicative", unless they are quoted from the respective Regulations. Indicative values should be adapted to national /regional contexts.

1.5. Following the inputs and request of the Member-States, the Commission will decide upon the issuing of a more complete version of this document.

2. Main purpose of the Regulation (EC) 1593/00

2.1. The main purpose of the Regulation (EC) 1593/00 is that ***"provision should be made for the introduction of computerised geographical information system techniques for the identification of agricultural parcels"*** (cf. recital point 3)

2.2. The same introductory text mentions the rationale of this provision. It is expected to reduce the "*difficulties encountered"*

- …*"When carrying out Administrative checks";*
- and especially when "*clearing up of anomalies in declarations"*.

These expectations are logically implying both:

- an improvement of the quality of the declarations, due to the use of more adequate and /or updated information (e.g. reference parcels; documentation provided to the farmers);
- and, an improvement of the IACS administrative checks, due to the availability of digital graphical references.

These points will be developed later.

2.3. The same introductory text mentions that the present amendment is justified

- by the *"technical progress in digital ortho-imagery and geographical information systems"*;
- and *"In the view of the experience of a number of Member States"*.

These 2 justifications clarify that an overall improvement of the IACS is expected, together with further homogenisation between Member-States (in comparison to the present situation and with respect to the minimum requirements defined by Reg. 3508/92).

2.4. More generally, Reg. 1593/00 recalls that the LPIS is (for area based subsidies) a key element of the IACS and that the proposed amendments are also justified by:

- The *"decisions on the reform of the Common Agricultural Policy"* (point 1 of recital);
- The importance of the compatibility between IACS and the other Community Schemes (point 2 of recital).

This last point will not be addressed in the present document, which focuses only on the technical aspects of LPIS. It is however developed in article 1 and 9a of Reg. 1593/00.

3. The amendments of 1593/00 and comparison with 3508/92.

3.1. The amendments concerning LPIS are located in article 2 and 4 of the Reg. 3508/92. Both are listed for comparison in the following tables. This chapter presents and comments the differences between these two articles.

3.2. **General comments on the amendments to Article 2 :**

3508/92	1593/00
Article 2:	***Article 2:***
"The integrated system shall comprise the following elements:	*"The integrated system shall comprise the following elements:*
a. a computerised data base;	*a) a computerised data base;*
b. an alphanumerical identification system for agricultural parcels;	*b) an identification system for agricultural parcels;*
c. an alphanumerical system for the identification and registration of animals;	*c) a system for the identification and registration of animals;*
d. aid applications;	*d) aid applications;*
e. an integrated control system."	*e) an integrated control system."*

Digital geographical information comprises two types of data to be managed by GIS (Geographic Information Systems):

- ***Alphanumerical data***, describing the attributes of the geographic entities (for instance, a parcel could be described by the following attributes: reference number, area, perimeter, land use, mean slope, etc.)

- ***Graphical data***, i.e the maps, *stricto senso*, providing the location and a representation of the geographic entities according to a number of conventions: co-ordinates in a reference and projection system, scale, etc. In practice, a point will be defined by its co-ordinates (x,y [and z]); a linear feature will be defined by the succession of joined points (segments); and a parcel will generally be described as a polygon of closed segments forming its perimeter.

The management of the graphical part within the GIS is much more specific and complex than for the alphanumerical data, in terms of logical structure (or topology), volume of data (e.g. disk space), and functionality (such as display, spatial queries, updating, etc.).

Article 2 of Regulation 3508/92 made compulsorily only the alphanumerical part. In consequence, the IACS implemented in some of the Member-States could be defined as *"half GIS"* or *"hybrid GIS"*, combining for the identification of the parcels:

- Computerised databases (alphanumerical data)
- With paper maps (graphical data).

However, this minimum requirement did not prevent any Member State to implement also a digital graphical part.

Indeed, a number of Member States (for instance, Belgium, Denmark, Netherlands, Italy, Sweden, Portugal) did implement more complete GIS solutions to manage their LPIS.

3.3. General comments on the amendments to Article 4 :

3508/92	1593/00
Article 4: *"The alphanumeric identification system for agricultural parcels shall be established on the basis of land registry maps and documents, other cartographic references or of aerial photographs or satellite pictures or other equivalent supporting references or on the basis of more than one of these elements".*	***Article 4:*** *"An identification system for agricultural parcels shall be established on the basis of maps or land registry documents or other cartographic references. Use shall be made of computerised geographical information system techniques including preferably aerial or spatial ortho imagery, with an homogeneous standard guaranteeing accuracy at least equivalent to cartography at a scale of 1:10000".*

The new formulation is much more complete than in 1992; It includes 4 important points which will be developed further in the following chapters (4.1 to 4.4):

1. The **possible use of existing maps** from different sources: land register, other cartographic documents or references, etc. (unchanged from Reg. 3508/92).

2. The **compulsorily use of computerised GIS techniques**.

3. A **recommendation to use ortho-imagery**, from both airborne or satellite data.

4. A number of **specifications for the LPIS**, i.e., characteristics and requirements of minimum accuracy.

In summary, the main consequence of Regulation 1593/00 is to make compulsorily, for all the Member-States, the use of computerised GIS techniques, or, in practice, the use of digital graphical data.

4. Detailed analysis and interpretations of Article 4

4.1. The possible use of existing maps from different sources:

The new text mentions the possible use of land register, other cartographic documents or references, etc. Although the formulation is slightly different/simplified compared to Reg. 3508/92, the principle remains unchanged:

a) **Using existing data is still valuable**, if it allows a reliable identification of agricultural parcels (cf. Article 3 of Reg. 3887/92).

b) It is therefore not specifically requested:

- to create a new specific LPIS and to abandon the present one;
- nor to maintain the present LPIS, if a more appropriate alternative exist.

Member States remain, as before, responsible for their technical choices, and should analyse the interests and constraints of the two options, considering their national / regional situation. This point will be developed later in Chapter 5.

4.2. **The compulsorily use of "computerised GIS techniques".** The formulation clarifies here that what is expected here is :

- Not only to modernise the production and/or updating of the paper maps;
- But a **real use of GIS techniques**, i.e. the on-line access to the digital maps at different levels of the Integrated System, using functionality and tools to fully benefit from the graphical information.

4.2.1. ***GIS functionality to be expected.*** The main functionality to be implemented is the following:

a) **Production of declaration support materials**: Besides pre-printed forms being sent every year to the farmers, functionality should be implemented to enable sending customised maps to the farmers. This does not necessarily mean sending maps every year to all farmers. Different strategies or methods will be suggested in § 5.5.

b) **Administrative checks**: Digital maps should be used in the administrative checks, but it seems rather unrealistic to expect this graphical information to be used in 100% of the cases.

The minimum requirement would be to consider that digital maps should be available in all the cases where specific anomalies are detected by the IACS administrative "normal" cross-checks (i.e. cross-checks performed on the alphanumerical data).

In such cases, display of the map will help the Administration to better identify the source of the errors, either in the declaration or from the data entry, for instance, to check adjacent parcels constituting an "îlot" (farmer block).

The GIS will also provide a support for the documentation of unclear cases after administrative checks: for instance, maps sent to farmers or to local offices. In practice, different strategies/ procedures can be identified and will be discussed later on.

c) On-the-spot checks: Digital maps should be used for all the on-the-spot checks. Control agencies and field inspectors should be able to prepare "traditional"1 controls and arrive to any farm with a printed set of customised maps locating the parcels, land-use declared and including relevant annotations (e.g. observations from administrative cross-checks). Digital LPIS maps, and possibly ortho-imagery, should also be systematically provided to the contractors for the sites controlled with remote sensing.

d) **Eligibility checks:** The systematic use of the graphical information from the LPIS to check the eligibility of each parcel is not evident in the use for the IACS (arable land).2

Such a checking could become relevant and feasible when the LPIS maps are combined with ortho-imagery, for instance, in order to assess the net arable area by subtracting all the non-eligible permanent land uses.

But such a checking is more a part of a comprehensive strategy of improvement and/or updating of the LPIS itself, rather than a yearly control procedure using the graphical information on line.

The use of the LPIS for eligibility checks should be decided by the national and/or regional administrations, depending on the quality of the maps and the regional context.

4.2.2. Possible further developments and uses. More generally, the availability of digital maps facilitates the development of further enhancement to the IACS, such as:

a) **Eligibility checks using GIS** will be of prime importance for any regulation (EU or national/regional) where eligibility is defined for a specific geographic area and not simply for an administrative unit, as in particular agri-environmental measures (based on soil class, risk category, economic area, etc.).

b) Further increase of the use in "**rapid field visits**", i.e. on-the-spot checks carried out initially without contact with the farmer, even in the case of "traditional" inspections.

c) Development of new or complementary **risk analysis**, taking into account geographic information. Same for the control of geographic sampled area.

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1 I.e., "traditional" inspections, carried out outside "remote sensing controls".

2 In the OLISIG regulations, however, the orthophotos are systematically used to control all the parcels and olive trees declared

d) possible **extension of the use of the LPIS**

- to other, national or regional, schemes or regulations;
- for the development of alternative monitoring and assessment applications as well as spatial statistical analysis.
- For any other applications where a registration at parcel level is foreseen, for traceability purposes (GMOs) or certification (origin appellation).

4.3. Characteristics and minimum accuracy requirements of the LPIS:

4.3.1. The formulation of the regulation ***"with an homogeneous standard guaranteeing accuracy at least equivalent to cartography at a scale of 1:10000"*** requires two general clarifications:

- This statement addresses both LPIS maps and ortho-imagery (and not only ortho-imagery).
- This is a minimum requirement: better accuracy will, naturally, be acceptable, for instance, equivalence to cartography at a scale 1:5000.

4.3.2. The terms ***"homogeneous standard"***, refers to a number of state-of-the-art characteristics, such as:

a) **Reference and projection systems:** The LPIS maps should be produced in a unique coherent reference and projection system[3], in agreement with the national standards in this field.

This is important to allow compatibility with other geographic information to be integrated or exchanged. National Administration should take into account issues such as:

- Projection systems already /previously used in the LPIS or for other GIS systems to ensure compatibility (e.g. olive tree, vineyard register);
- Present and future use of GPS (Global Positioning System) at the stage of the declaration or for the on the spot controls. The possibility to integrate digital records from measurements without complex transformations or extra sources of error;
- The on-going, medium term, implementation of a European Reference System (ETRS 89), which should allow seamless exchange of GIS data sets across borders.

These issues are rather complex and should be addressed in relationship with national mapping agencies, taking into consideration that compromises will have to be taken between short-term measures and medium /long-term improvements of the standards.

b) **Regular coverage:** The LPIS should constitute a continuous and regular coverage, without any overlaps or blanks[4]. Arbitrary limits such as map sheets or co-ordinate grids should not generate artificial entities, for instance divide

3 Note that a unique system may comprise several projection zones

4 Except for large non-agricultural areas, such as cities, large infrastructures or very high mountains

parcels or blocks. Irregular cadastre map sheets should be merged in a continuous and regular coverage.

In practice, this coverage will generally be stored in a hierarchical (e.g. tiled) structure but the GIS functionality should still render seamless and transparent access for the user.

4.3.3. ***Accuracy "at least equivalent to cartography at a scale of 1:10000***". This minimum requirement is coherent with the experience of the Member-States and the previous recommendation or specifications of the Commission[5].

The equivalence to a scale of cartography refers to international standards[6].

4.3.3.1 The following table indicates the corresponding **minimum requirements of geometric accuracy** for ortho-imagery and maps. More information is available in the technical documents listed in footnotes.

Table 1. Minimum geometric accuracy parameters at scale 1:10000

Absolute RMSE (maps and ortho images)	Pixel size (ortho-images)
≤ 2.5 m	≤ 1 m

"Accuracy" may refer also to the detail of information provided by the document. The requirements in this respect are much more indicative. They should be adapted to the type of system (îlots, block) but take into consideration the regional context and the land-use concerned (non-arable)[7].

4.3.3.2 The following table provides a suggestion of the **smallest mappable objects**, which could be integrated in a 1:10 000 or 1/5 000 coverage, without risks of exaggerating their area or displacing their graphical boundaries.

Table 2. Indicative size of the smallest mappable objects

	1:10 000 Scale		1:5 000 Scale	
	Area	**Linear object**	**Area**	**Linear object**
In the field	**0.10 ha**	**10 m width**	**0.03 ha**	**5 m width**
On the map	**≅ 3 x 3 mm**	**1 mm**	**≅ 3 x 4 mm**	**1 mm**

5 "Common specification for the production of Orthophotos and the creation of LPIS". See also "Guidelines for Quality Checking of Ortho Imagery". European Commission (1998). 26 pp.

6 Such as ASPRS (American Society of Photogrametry and Remote sensing) " Standards for large scale maps", in Photogrammetric Engineer and Remote Sensing , 1988, Vol LIV, pp 1038-1040

7 See Chapter 7, but also "Parcel Identification System, Creation and/or Updating - Parcel Block interpretation and numbering" Draft specifications, European Commission (19...).

4.3.3.3 **Digitisation tolerances** are a critical specification to reach the final accuracy of the LPIS.

The theoretical absolute accuracy of digitisation / paper maps is generally considered to be 1/10 mm, i.e. 50 cm for a 1: 5000 map[8]. However, in practical conditions, and for high volumes of data, this absolute accuracy RMSE will be more between 2/10 and 3/10 mm, i.e. 1m - 1,5 m (for a scale 1: 5 000) or 50 – 75 cm (for 1:2 500).

In case of digitisation on screen (on a digital orthophoto or on a scanned map), even if theoretically, clear features can be pointed at ½ pixel (50cm), in practise the digitisation will reache a similar absolute accuracy (RMSE between 1m -1.5 m for an orthophoto 1: 10 000).

These values can be considered generally

- as compatible to the IACS purpose, (and definition of the limits to be captured)
- but also rather consistent with the real accuracy of the cadastral maps in rural areas.

In case of existing maps (cadastre, O. Survey), the digitalisation is an important investment and the digital maps are likely to be used by many users. Digitisation tolerances should be clearly defined with modalities of quality checks (and possibly approved by the competent authority).

When using maps drawn by farmers, the main question to establish a digitisation tolerance is to clarify the value of these documents: Generally, these maps are only sketches, indicating the general position of a agricultural parcel in a block rather than its actual boundaries. In this case, digitisation should always be supported by recent orthophotos, with a very careful management of the non-visible limits indicated by a farmer.

4.3.4. Observation on "Homogeneous": Homogeneity should not be understood in a restrictive way, leading to homogenise a national coverage to the minimum quality or standard existing in a region.

If the minimum requirements are fulfilled, it should be considered as acceptable, depending on the available maps and/or to the regional characteristics of the agricultural parcels, to include locally in the LPIS more accurate graphical data.

4.4. **The recommended use of <u>ortho-imagery</u>**.

The Commission strongly recommends the National Administrations in charge of the IACS to <u>consider carefully</u>:

- The option of a combined use of ortho-imagery;
- **And, at least, to specify their GIS in such a way to allow the future combined use of ortho imagery [9]**.

Although the use of ortho-imagery is only recommended in the regulation 1593/ 00, the combined use of ortho-<u>imagery can be considered as one of the main advantages of a</u>

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8 this value does not prejudge on the intrinsic accuracy of the maps, as well as the possible deformation of the supports.

9 GIS software should manage both maps ("vector" type format) and images ("raster" format).

digital LPIS. This aspect has been clearly demonstrated by several Member States. More over, future trends in the development of ortho-imagery will, any way, make this type of information available all over Europe.

4.4.1. ***Source of the ortho-imagery:*** The regulation stipulates that the term "ortho-imagery" groups both ortho-imagery derived from aerial photographs as well as ortho-rectified images acquired by very-high resolution satellites.

This last type of data is available since one year but is still very expensive. Lower costs for the latter type of imagery is expected in the medium term, due to the technological development and the competition between several satellite systems.

At the same time, however, parallel technological evolution will occur in airborne data with the development of digital cameras and/or airborne scanners.

4.4.2. ***Type of data:*** Since 1993, the Commission has recommended the use of panchromatic (black and white) ortho-photos with a 1-meter resolution. An optimum cost efficiency ratio was obtained from high altitude flights (1:40,000 scale) using very-high-definition emulsions scanned at 20 micron[10].

Detailed recommendations were defined to optimise the aerial coverage, the scanning and the processing chain in order to ensure the quality of the product (see references, footnotes 5, 6 and 9).

Following the technological progress in photogrammetric processing, the use of colour ortho-imagery becomes a general trend.

The choice for colour ortho-imagery may be linked to multi-purpose and multiple user requirements. Technical constraints, such as the increase in storage requirements, do not outweigh the advantage of the additional comfort and information.

Both natural colour and infrared "false" colour films have been used successfully for the land parcel identification in Europe.

Also, the use of higher ground resolution (50 cm or less) has been demonstrated in several countries. [11]

4.4.3. ***Specific functionality of ortho-imagery:*** Ortho-imagery can be easily integrated in the GIS as a background layer to the LPIS graphical information. It will thus contribute to all the functionality described in § 4.2. Moreover, it can play a key role in:

a) The **quality of declaration filing**, by supporting it with a visual information of the terrain;

b) The **administrative checks**;

c) **On the spot checks**, in which ortho-imagery, even if from recent archive, will efficiently support inspectors. LPIS Ortho-imagery shall also be used for the controls with remote-sensing.

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10 Recent experiences demonstrated that scanning at 10-15 microns may provide extra information.

11 The MARS project intends to prepare a review of the state of the art and update its recommendation as a consequence.

d) **Eligibility checks**: As mentioned previously, the compulsory and systematic use of the ortho-imagery is not foreseen to check the eligibility on all the agricultural parcels on a yearly basis. See also § 4.2.1

It is more considered as a procedure of improvement and updating of the LPIS. Computer assisted photo-interpretation allows updating reference parcels (eliminating non-agricultural parts or assessing their corresponding area).

These information, as well as a general code of land use category, will be recorded into the alphanumeric database of the LPIS, used to perform yearly administrative checks of the declared parcels.

Several national Administrations have made this important investment (Italy), which should logically be updated at each new coverage of ortho-images.

Such an information could be very useful when creating brand new LPIS in Candidate Countries, in providing a clear picture of the reference.

4.4.4. Integration of ortho-imagery: According to the formulation of article 4 ("including"), the use of ortho-imagery covers two possible situations:

- Cases where the LPIS is created from the ortho-imagery;
- Cases where existing LPIS (for instance land register or Ordnance-Survey maps) are combined with ortho-imagery coverage.

Both situations present advantages and disadvantages, each which varying practical and economic constraints. Before changing completely a system, Member States should carefully assess these constraints and advantages in the context of their actual situation: suitability of the existing maps, quality and updating strategy of the existing LPIS.

Combining a present LPIS with ortho-imagery can thus constitute an intermediate step, allowing the progressive creation of a new LPIS without a major discontinuity in its use, and gradually integrating resolved anomalies.

4.4.5. Use of archive imagery and updating: The prime interest of the ortho-imagery is to provide a rather recent overview of the general land use with details on the terrain, which are generally not mapped in the LPIS: isolated trees, small hedges, ditches or tracks.

Old imagery will always contain a number of out-dated features, with the risk of introducing more confusion than providing a real support. Experience shows that ortho-imagery of up to 3-5 years is still useful, even as a support to controls and field inspection.

The general recommendation of the Commission is thus to update the ortho-imagery coverage every 5 years. This results in two possible strategies:

- a regular replacement of around 20% of the area each year;
- an overall replacement of the ortho-images after a five-years period.

Each option has its specific consequences for maintenance of the LPIS. In the first case, special attention is required to ensure consistent overlap with the existing set, and possibly involves image-processing techniques that result in a seamless integration of the partial coverages. The second option is likely to be more demanding in terms of production and integration efforts.

5. General recommendations

5.1. Creation of LPIS from ortho-imagery:

In the context of the IACS, agricultural parcels shall be always clearly identified in the **alphanumerical** database, but they can be identified **graphically**

- ***Directly***, as **agricultural parcels** located on a very recent orthoimage or surveyed on the ground;
- Or ***indirectly***, using intermediate references parcels, such as:
    - **Îlots** (or farmer block), grouping together a number of neighbouring agricultural parcels cultivated by the same farmer;
    - **Blocks** (or physical block), grouping together a number of neighbouring agricultural parcels cultivated by one or several farmers and delineated by the most stable boundaries. (cf. Fig 3, here-under).

Compared to the use of existing reference maps, LPIS based on îlots are implicitly involving an additional phase in the declaration by the farmer.

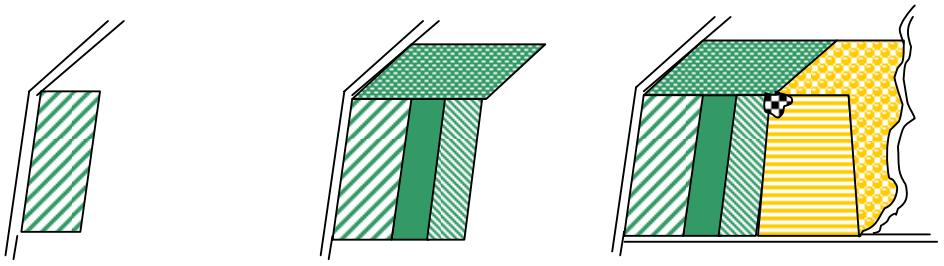
LPIS based on blocks can be created without any input or involvement of the farmers. Block limits and numbers, however, have to be made available as a new map reference to the farmer for the identification of the agricultural parcels.

The main experience in Europe is with the creation of the "block LPIS". Computer-assisted photo interpretation (CAPI) is used for the on-screen digitising of the more permanent field boundaries and is summarised in an Annex of the present document.

However an initial block system can evolve, if maps are collected from the farmer and integrated by the Administration,

- to a îlot system;
- to a parcel system;
- or to a ***mixed system***: a number of agricultural parcels are graphically identified in the blocks, which are still used as a reference but with the remaining area (cf. Po).

Fig. 3: The 3 geographic entities



Agricultural parcel (declared) ≤ **(Farmer) Ilot** (often declared) ≤ **(Physical) Block** (predefined / Admin.)

1 Piece of land cultivated by one farmer with a single crop

1 Piece of land cultivated by one farmer with one or several crops

1 Piece of land with permanent boundaries, may contain several crops and farmers

5.2. Combining ortho-imagery with existing LPIS

5.2.1. ***Geographic co-referencing:*** According to the geometric quality of the two types of documents the integration of the digital ortho-images with the LPIS will be achieved by geo-referencing of the two data sets. A simple overlay allows displaying the ortho-imagery as a background to the LPIS maps.

In general, different projection systems, or even local projection systems for the old maps, will require geometric correction in order to match the two data sets.

5.2.2. Management of the discrepancies: Whatever the quality of the LPIS maps and the geometric corrections, discrepancies will remain because of different dates and specifications of the maps (content or purpose).

Such discrepancies are pointing to the importance of the combined use with ortho-imagery: the ortho-imagery provides an ancillary information improving the understanding and the use of the LPIS boundaries.

However clear definitions should be established in order that the discrepancies do not increase confusion, for instance, at the farmer level. It is thus important to clarify:

- what is the main information to be considered as a reference to declare the real agricultural parcels?
- how to deal with small fringes of agricultural parcels outside the reference boundary from the LPIS ? [12].

In practice thresholds and tolerances have to be defined in order to avoid:

- an artificial fragmentation of the agricultural parcels
- and/or an increase of the references parcels to be declared and managed.

Similar but less accurate problem will have to be managed at each updating of the ortho-imagery.

5.3. General case of the cadastres:

5.3.1. Suitability of the cadastre for the identification of agricultural parcels

a) With respect to their main functions, historical and regional considerations, the content and the geometric quality of the cadastre systems are quite variable in Europe.

Their suitability to reference efficiently agricultural parcels varies accordingly and to a great extent, on a regional or even very local scale.

[12] This problem may be rather accurate in the specific case of cadastre.

b) Cadastre systems generally presented the following **advantages**:

- they are available and familiar to the farmers;
- they are very detailed (scale 1:2,000 – 1:5,000) and accurate (if modern);
- they provide reference parcels with a unique reference number;
- they provide readily available gross area and sometimes official land use, almost always in digital format, allowing efficient administrative cross checks;
- they allow possible cross-checks with ownership information: This point is not required by the Regulation, but was used by some Member State at the implementation phase of the IACS.

c) But they present also the following **drawbacks**:

- they may have variable geometric accuracy, use local and/or various projection systems;
- they may suffer from heterogeneous quality and date of updating;
- they may not constitute a regular map-sheets coverage (format, irregular shape, scales, north orientation);
- they are generally not available as digital maps in rural areas;
- And, more fundamentally, due to the fact that the cadastre is most often concerned with property rights, cadastral parcels may not correspond directly to the agricultural parcels, which are the one required by the IACS regulations.

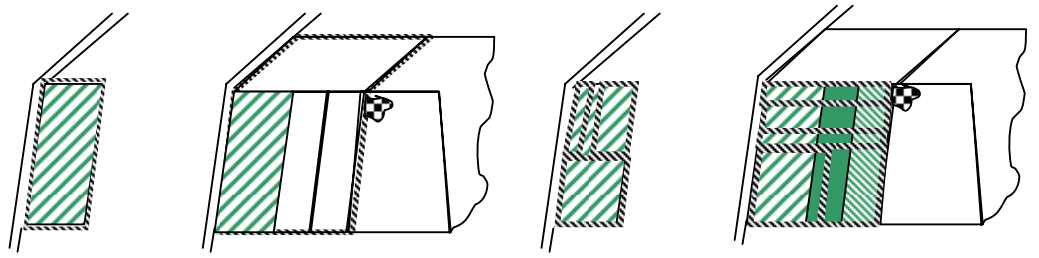
As a consequence, a cadastre parcel:

- may include non agricultural and non-eligible features13
- may include one or several agricultural parcels (e.g. "îlot" case)
- may be in use by more than one farmer ("Block" case)14.
- could be a combination of some of the three cases above .

These 4 situations may result in a number of generic problems, which are also encountered in block or ilot systems:

- difference between gross (reference) and net (declared, agricultural) areas;
- multiple agricultural parcels located in one reference parcel;
- Resulting in decreasing efficiency of the administrative cross-checks.

Fig 4: Possible relationships between Agricultural and reference parcels



Unique 1-1
1 A. Parcel = 1 reference (ilot, block, Cadastre)

Subdivision n- 1
The reference contain several Agric. Parcels (Ilot, Block, Cadastre)

Regroupement 1 - m
1 Agric. Parcel is the sum of severc references (Cadastre)

Complex n- m
Several Agric Parcels have to be merged to correspond to several references (Cadastre)

d) But, in some situations, the cadastre system also contains **cadastral parcels that are smaller than agricultural parcels[15]**, a situation which does not occur in îlot or block systems.

The appropriate graphical identification of a single agricultural parcel requires thus the declaration of several reference parcels, and this may be an extra source of errors.

13 In some case, these features are not mapped, but are describe in the alphanumerical database.

14 Case of a landowner renting parts of his parcel to 2 other farmers.

15 Cadastre systems have a trend to the fragmentation of the parcels by heritage, but also because no procedure obliges a land owner to merge adjacent parcels.

In **complex cases,** the cadastral boundaries, locally, do not correspond at all to actual alignment of the agricultural parcels: Several cadastre parcels have to be regrouped, then subdivided differently to define to agricultural parcels.

These cases are complex to manage both for farmer and the IACS, and even when their occurrences are low (10%), they risk to jeopardise the whole system.

Complex cases have lead some Member States (e.g. France, Germany) to utilise a **declarative "îlot" system**, where the farmers have the possibility:

- to declare adjacent cadastral parcels to define farmer–îlots,
- and then to declare their agricultural parcels with reference to these îlots.

5.3.2. ***Official cadastral area.*** The cadastre (as well as the Ordnance Surveys) generally provides for each parcel an official reference area. This value, which is recorded in the alphanumerical database, is considered as a legal basis.

However, significant differences may exist between this official area (in the database) and the area of the parcel on the map. This paradoxical situation results from the fact the initial measurements from the land survey were used in two different processes in order:

- to compute the area, parcel per parcel (and with the best possible accuracy);
- to generate the map (i.e. a general representation of all the parcels) with a number of approximations and rules.

These discrepancies are generalised and rather important in the "old" cadastre documents, for which paper maps were drawn manually. This problem tends to be much reduced with modern cadastres and will only completely disappear in the rather rare case of unique photogrammetric processing where the area and map are derived simultaneously.

It should be noted that the digitisation of paper maps does not fundamentally improve the content of the cadastre, but only modernises the support. This step merely conserves and reveals the discrepancies between the actually measured areas and their graphical representation.

5.3.3. ***Accuracy of cadastral boundaries.*** Although cadastral maps may be at a large scale and recorded at a high precision, their information is related to land ownership and not to the real agricultural parcels to manage in IACS.

More over, the maps give only an "indicative" information, especially in most rural areas where the limits of cadastral parcels may not be materialised in the field by boundary stones.

For instance, the sole use of a cadastral map may not be sufficient to decide whether an unmapped small farm track (or hedge, ditch, etc.) is shared between two parcels or fully included in one.

In practise, this means that before splitting a property or modifying a road, the land-surveyor first has to transpose the cadastral boundaries in the fields, possibly with a number of small adaptations to be agreed by the respective owners.

So, when the digital cadastre and an ortho-image are accurately geo-referenced, the resulting superimposition will always present a number of discrepancies and uncertainties

- because these small adaptations are not possible;
- But also, in some cases, because an actual agricultural parcel may have been extended - intentionally or not - into a neighbouring property!

It is not the purpose or the mandate of the IACS to solve these cases, or to update the present cadastre.

As a comparison, in the case of a traditional IACS field control, the inspector will use the cadastre only to locate the parcel and check whether it is appropriately referenced. But he will always measure - preferably with the most accurate equipment - only the real agricultural parcel, and will never try to position the cadastre accurately in the fields, nor to identify the discrepancies or graphical errors.

At the level of a LPIS combining cadastre with ortho image, the discrepancies will be clearly visible and, as mentioned before (§ 5.2.2), provision should be taken to avoid increasing without reason the complexity of the system.

- Tolerances should be defined and tested to allow to declare inside a cadastral parcel, the external fringes of an agricultural parcel when the width in discrepancy is smaller than a given value (for instance 10 m);
- Clear recommendations should accompany the provision of maps to farmers (in this case ortho-imagery + cadastre) to avoid misunderstanding by clarifying what is the priority and what is the ancillary information.

It is also possible, to reduce these confusions:

- To keep during a first phase (e.g. 2 years) the ortho-images for an internal use in Administration, for the purpose of checking / consolidating the graphical reference and the declarative data (cf. also § 5.4.2 on the îlots);
- Or to decide to carry out a complete and detailed readjustment of the cadastral boundaries with the ortho-images.

But, in this last case, the final boundaries and parcels may loose any cadastral signification, especially because it will be very difficult to define a logical limit to the elasticity of the graphical boundaries…

The result will be thus a new LPIS, clearly based on the ortho-photos, but build with the help of cadastral parcels, ensuring an efficient migration from the old LPIS and a smoother transition and link with the old declarative system…

5.4. Digital information to be recorded in the GIS / LPIS

5.4.1. Main considerations.

The IACS has to manage two types of parcels:

- The agricultural parcels, declared by the farmers, which may change every year;
- The reference parcels, used by the farmer to identify and locate their agricultural parcels, and by the administration to cross-check the declarations, and which boundaries are expected to be relatively stable.

In principle, the LPIS should contain in a graphical digital form, at least **all the reference parcels**, i.e., according to the choice of the Member States:

- Agricultural parcels;
- Farmer's îlots;
- Physical blocks;
- cadastral parcels,
- or a combination of this entities.

In order to be fully recognised by the GIS, and to allow appropriate GIS functionality (spatial queries, distance and area measurement, regrouping or subdividing parcels, etc.), the **reference parcels have to be "vectorised"**, which means the digitisation of the parcel boundaries in vector format plus definition of an appropriate topology.

Additionally, ancillary data may be recorded in "raster" format. This is naturally the case for ortho-images, but it may also apply to the use of the cadastre, in case it is only used for the creation of blocks or Ilots (see § 5.4.2).

In line with the considerations presented in § 4.3.3, it will not be compulsory to digitise and record all the small linear features, such as ditches, hedges and stone walls. However it may be of prime interest to have these elements visible in a background image (e.g. ortho-imagery) of the LPIS.

5.4.2. Digitisation of cadastre maps.

When the cadastral maps are not available in digital form, digitisation of the maps may represent a bottleneck in the implementation of the LPIS, with respect to:

- the volume of parcels to digitise and map sheets to manage;
- the requirement to geo-reference, in a unique reference system, all the map sheets which may have variable local projection and quality.

An optimisation of the volumes will be obtained by the *a priori* exclusion of large build-up areas and homogeneous non-agricultural area (e.g. forest, nature reserves, water bodies, high mountains).[16]

Ortho-imagery will provide the best ground control points to reference the map-sheets.

In the case of an **îlot system based on the regrouping of cadastral parcels**, the îlots are indeed the real reference parcel, in which the farmer locates its agricultural parcels. As a consequence, a recommended strategy is:

- to scan the cadastral map sheets to obtain raster images.
- to geo-reference all rasterised maps into a unique reference system
- to digitise a point inside each cadastral parcel ("centroid"), and link it with the number of the parcel. This system will allow locating any parcel declared on the images.
- in a second step, **îlots declared will be digitised**, e.g. outlining the external boundaries of the grouped cadastral parcels and clearly identified, as any reference system, by a **unique identification number** establishing the link with the alphanumerical databases.

During this stage, the GIS processing is expected to allow a **validation / consolidation of the ilots declared by the farmers**. The on-screen digitisation of the ilots will identify a number of anomalies, which were not identifiable and solvable by the alphanumerical crosschecks: In practise, some ilots will have to be split, some other will have to be merged, this changes being notified to the farmers.

5.4.3. *Other graphical information.*

The GIS should contain also all the geographic information of interest for the IACS purpose, and especially:

- The administrative boundaries;
- The limits of the yield zones;
- The limits of the eligible area (e.g. for relevant agri-environmental measures).

5.5. Provision of the maps to the farmer and declaration procedures

Various methods and procedures have been implemented since 1993 by a number of Member States:

a) *Sending individual maps every year to all the farmers* (with ortho-imagery);

b) *Sending individual maps only on request*;

[16] Development of agri-environmental measures reduces the interest and impact of these exclusions.

c) *Maps are sent in one or two copies* (one has to be returned with the declaration).

d) *Providing maps coverage to local organisation supporting the farmer's declarations*. Maps are made available to local administrations or farmer associations, on paper or in digital form. In this last case the declaration is made on screen, and generally combined with a data entry of the declaration.

The maps provided to the farmers

e) are indicating *all the reference parcels of the area;*

f) *or only the reference parcels of the farmer* (e.g. based on the declaration of the preceding year);

g) *Are mentioning or not the gross area of the reference parcels.*

The farmers are always using the maps to fill the pre-printed forms (alphanumerical part of the declaration). After this, the existing procedures are quite variable as far as the exchange of graphical information is concerned.

The farmers may have to send back a copy of the maps:

h) with a sketch of all the agricultural parcels;

i) only for the parcels with specific requirements (e.g. strip set-aside);

j) Only for the new reference parcels or the new agricultural parcels;

k) Only to notify permanent changes of the reference parcels (blocks, îlots).

After having received the declaration, the Administration

l) generally updates the reference parcels and the LPIS with the permanent changes notified;

m) may digitise all or some of the agricultural parcels;

n) may use the maps without digitisation for visual administrative checks;

o) Use the map and digitise the parcels in the case of on-the-spot checks;

p) may store the maps in a paper archive;

q) may scan the maps and store them in a digital archive, etc.

Most of the Member States presently using GIS and digital LPIS, have continuously introduced improvement and changes in their IACS workflow and procedures.

6. General Strategy of implementation

The general implementation of the regulation 1593/00 will regroup two main tasks, which may have distinct implications:

- The **creation of the LPIS**, i.e. the information layers of digital maps and possibly ortho-imagery.
- The **implementation of the GIS**, i.e. of the system, tools and procedures to use the digital information from the LPIS.

6.1. **he creation of the LPIS** is rather technical. Whereas the Administration in charge of IACS has to make the technical choices in terms of type of systems (cadastre, îlot, ortho-imagery, etc.), the creation of the LPIS and of the ortho-imagery coverage can be fully carried out externally by contractors or by the most appropriate institutional organisations.

In this context, the IACS Administration can decide:

- either to be owner of the data and leader of a national project possibly involving mapping agencies, national cadastre offices, private companies; the Administration will thus have to co-ordinate the various actors and negotiate their tasks and responsibility, then ensure the technical, administrative and budgetary follow-up.

- or to benefit from any existing project, or buy existing data sets. For instance, the Danish Ministry of Agriculture funds only 50% of the costs of the ortho-imagery, which is created and updated by a private company. The latter retains the rights to market the data to other users.

As far as the cadastral data are concerned, the IACS administration should preferably try to reach common agreements in order to reduce the costs of the use of the data. For instance, the Italian Administration has obtained from the Cadastre a free delivery of all the cadastral maps (paper or digital when available) in exchange for a copy of the ortho-imagery coverage.

In other situations, digitisation may have to be carried out in order to respect the work program and the specifications of the Cadastre. In all cases, a number of issues related to copyrights, confidentiality, restrictions and conditions of use of the data need to be addressed.

6.2. **The implementation of the GIS** is, on the other hand, a key issue, as it is closely linked to the IACS. The Administration should be directly in charge and closely involved in the design, implementation and testing phases.

As a general rule, the GIS functionality to be implemented can be regarded as an additional module on top of the present IACS systems. The implementation of this extra module should be carefully considered within the present IACS, in terms of integration with the alphanumerical databases, hardware, and software.

However, after almost 10 years of a first generation IACS, and given the tremendous progress in information technology in this period, Regulation 1593/00 may provide some Member States the opportunity to re-define their present system. A change of the type of reference parcels (e.g. migration from a cadastre system to a block or ilot-based system) will have indirectly the same consequences.

In such a case, and given the agreed time frame of a 5 years available for the implementation of the regulation, we recommend to IACS National Administrations:

- to assess carefully their present LPIS and the different options;

- to take advantage of the possible regional experiments or pilot project and of the experience with systems already in place in other Member States;

- to consider approaches enabling a progressive changes, thus reducing the risks of discontinuity, increase of anomalies and difficulties;

- to seek advice on the technological advances in GIS (including image handling), data base management, and software and hardware choices, including important trends in the next 5 years (e.g. network technology, Web based systems, etc.);

- to probe the potential of the LPIS, or derived information products, for other uses linked to IACS (e.g. spatial statistics, risk analysis, agri-environment), to rural area management (e.g. rural development, forestry, nature protection schemes) or to tracebility and certification (GMOs, appellation of origine, food quality).

6.3. **Technological choices**

It is not the mandate of the Commission to recommend the use of any particular software solution. Most of the commercial GIS and data base software packages are offering similar general functionality. The general trend points to increasing compatibility and use of standard formats.

The preferred choice should, as a rule, integrate aspects of support and maintenance, possibility to scale and migrate, risk of exclusivity, etc., that are common to system procurement at this level.

Strategic choices on the intended end-use of the GIS-enabled IACS and LPIS should play an important role in the choice of hardware and software. Issues to be considered in this context could be:

- The use of IACS/LPIS in a centralised or decentralised set-up. If all application handling (e.g. forwarding to farmers, reception and filing) and administrative control tasks are carried out at a single central location, a system centred on a server architecture with propriety software systems could be considered. If these tasks are distributed over, for instance, a number of regional offices, client-server architecture may be more appropriate.

- Since map production for farmers and filing of declarations are the most critical elements in the GIS processing of the IACS, electronic support for these tasks is expected to have a major impact. The use of networked distributed systems (internet, intranet) should be considered in this context. Special attention should, in that case, be given to aspects of reliability of service, scalability, security and privacy protection. Internet access to the either the alphanumerical or graphical parts system by farmers could be considered in this context, but also intermediate solutions, e.g. on-line access at regional or communal services.

- Current trends in portable devices, and their integration with communication capabilities, is expected to have a major impact in the collection of agricultural information (e.g. for certification, knowledge systems, precision farming). Functionality to interface with relevant electronic data holdings could be part of the IACS system. For control tasks, inspection with GPS-supported devices would obviously benefit from direct link with the IACS and digital LPIS.

- Extensibility of the IACS system, for instance, to include future support schemes (e.g. cross-compliance, agri-environment, national schemes). Most of these schemes require additional attributes to be recorded, with a different management and updating calendar. Furthermore, they may set additional requirements to cross-checking functionality, e.g. for multi-annual support measures (e.g. long term set-aside, biodiversity measures) or impose additional control measures (e.g. measure for grassland protection). The system architecture should allow such “thematic” extensions in a straightforward manner.

7. Annexe: General procedure for the creation of a Block system

7.1. Block delineation

Blocks should have stable limits that do not change from year to year. They should be easily recognisable both on the cartographic support documents that are used in the application process, as well as in the terrain.

The type of limits foreseen to be used in block definition, are (in order of hierarchical importance):

- Infrastructure (roads, railways, water channels, etc.)
- Farm tracks and other limits between land cover types that are considered mostly permanent (streams, vineyard, orchard / olive grove limits, woodland borders, etc.)
- Limits between parcels of the same cover type that can be considered permanent (fence-lines, hedge-rows, etc.).

7.2. Block characteristics

7.2.1 The size and structure of a block is expected to vary according to the structure of the agricultural landscape, and according to the predominant land cover types.

However, to allow an efficient cross check of the declarations:

a) An overall objective of an average size of 10 ha **and** less than 15 agricultural parcels can be indicative for productive agricultural areas (and arable blocks).

b) The internal, non-productive, areas larger than 0.5 ha should always be graphically excluded from the block area. This last threshold is indicative, as the minimum absolute area for non-eligible land is 0.1 ha (see also § 4.3.3).

c) Below this limit, the presence of non-agricultural features could be assessed and recorded in the LPIS database (e.g. as an attribute to the block definition) rather than be digitised.

7.2.2 – The maximum size of the blocks and the maximum number of parcels are critical specifications of the Block implementation. The values of 10 ha and 15 parcels mentioned in the point a) above are purely indicative and were proposed for a Mediterranean country with small parcels.

These values will not be applicable in an area where larger parcels occur, for instance 20 - 50 ha … Appropriate values have thus to be defined according to regional situations, i.e, to the size and distribution of the agricultural parcels.

In practice, the Block definition is a “descending” approach, in two steps:

- A splitting of the landscape in units fairly homogeneous in size (around the maximum size of the parcels);
- A subsequent subdividing of some of these Units, after a check of the number of parcels.

The resulting blocks are expected to content

- one or a few parcels in zones where parcels are rather large,
- more parcels in the locally more fragmented landscape with small parcel size, in order to avoid a strong increase of the blocks to be managed.

In consequence, **the two conditions have to be maintained and respected both**. The replacement of "**and**" by "**o**r" will allow only one condition to be fulfilled and may lead to inappropriate blocks, containing a high number of large parcels.

7.3. Block Land-use

The blocks will be characterised according to appropriate land- use categories, such as:

- Arable agriculture land,
- Pasture and grazing land,
- Orchards, tree plantations, olive groves, vineyards[17],
- Other permanent agriculture,
- Woodland, forest and shrub-land,
- Built-up zones and infrastructures…

In order to ensure efficient eligibility checks, special attention should be given to the two first categories. The blocks should be very homogeneous regarding land cover for these categories. They should, for instance, contain less than 10% of cover from the other classes.

Nevertheless, mixed blocks may be acceptable, in specific circumstances such as

- Borders of built-up areas, when no limits can be utilised as block limits;
- Blocks of less than 5 ha in size, or where the non-productive elements or the other land use categories within the block are smaller than the mapping threshold;
- Complex land-use with small parcel size;
- Importance of temporary grassland / arable lands.

Small non-agricultural features, will not be extracted from the block, for instance when linear and having less than 5 -10 m width: hedges, stone walls, ditches, etc. These elements will be included in the gross area of the block, or will split between 2 blocks if selected as a boundary.

As mentioned before (§ 7.1.2, c), the spatial importance of these elements, when they are particularly abundant, can be assessed and recorded as an attribute in the GIS.

7.4. Block numbering GIS implementation

7.4.1. A **unique number** can be automatically attributed to each block by the GIS software. This number could be derived, for instance, from the following components:

- The geographic coordinates of the block centroid (Easting and Northing, inside a kilometre grid square to the nearest 10 m), combined with
- Information concerning the kilometre grid references.

[17] Additional or stricter constraints could be added in case of olive groves and/or vineyards, in line with the respective regulations.

7.4.2. **Administrative boundaries** that are relevant in the definition of yield zones or eligible area should be integrated in the GIS, such that any block will correspond to one and only one category.

7.4.3. **Attribute data** may be recorded in the GIS database concerning the type of the boundaries (i.e. road, stream, woodland/agriculture limit, etc.) and the main land use of the block.

7.4.4. **Additional information** such as the main place names for villages and towns, road codes, river names should be recorded in appropriate GIS layers; they will facilitate the use of the documents by farmers and inspectors.

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