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# Automatic systems to identify semen straws: why and how?

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The purpose of this paper is to introduce the presentations at the 2<sup>nd</sup> session on AI technologies of the special session programme of ICAR, Nigara Falls 19 June 2008, on the topic of automatic identification of bovine semen straws. It presents the general problematic and challenges to be overcome to achieve this goal: why and how to invest in those technologies, what benefits are expected, what is the consequence on the organisation of the AI industry?

*Key words:* Identification, Semen straws, Automatic reading.

The idea of implementation automatic system to identify semen straws is not a new one. Before implementation, IA industry should a first equipped AI technician with computers and organise it self to support this project. Looking back the history of AI it's relative new and the systematic use of computers is becoming common just during the last years. Automatic reading is then a new step in the industry.

Automatic identification means that straws are read with automatic readers, whatever the identification system, or the reading devices, without hand recording. By "hand recording" it means paper forms, laptops or PDA. Straws are supposed to be deep-frozen to discuss the problematic in this paper, but general concepts apply also to fresh semen units.

Identification of semen straws means any information printed on straws. Identification data are defined either by the Authorities or by professional agreement. ICAR has adopted an international recommendation for identification of semen straws and edited in its guidelines.

Important items commonly recorded are:

- Semen collection or processing centre code.
- Breed.
- Identification of the bull (id or hb number, name).
- Collection code: date where the semen batch was collected.

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## Summary

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## Introduction

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## General definitions

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Formats, order of data are usually defined at national level but not at international level, where general recommendations are given, such as maximum length of codes, the possible formats etc.

By semen batch it means the set of semen units obtained after processing from one or several ejaculate(s) on collected from a particular bull on a particular day. Batches may be split in sub-batches of part of ejaculate having undergone the same process. Very often the terms “ejaculate” or “semen batch” do have the same signification in the context of our problematic.

## Goals for automatic straw identification

Hand recording of data identification on semen straws is daily done. Nevertheless many technician managers of AI centres wish to improve this process because:

- It's subject to recording mistakes (even when using electronic devices).
- It's time consuming, on farm when using papers and provides administrative constraints.
- A limited number of data on identification is collected.

The idea to implement automatic reading is to overcome these difficulties. The expected goals are:

- *To insure accurate identification of any semen unit* produced in Semen Collecting Centres from bulls to AI. Then accuracy of AI records will improve, allowing a better accuracy of parentage recording and then a better accuracy of genetic evaluation for any trait but especially for male fertility.
- *To take into account the information of semen batches.* Identification of semen refers on batches and for this reason date of collection is recorded: on a specific day there is a unique batch of semen produced for a specific bull. In add, a code allows to identify a specific treatment of this particular batch (or a part of it), (semen processing, extenders, semen sexing ...).
  - It's then a useful tool to have a better management of semen production because results of processing may be assessed by a limited number of AI bull by bull (example progeny testing) and then extended to the all bull's semen production.
  - It has been proven that the fertility of bulls varies from ejaculate to ejaculate. Taking into account batch semen information, it will improve male fertility.
- *To trace any semen doses all along the movement* chain from bull to semen use (AI) or destruction. The new sanitary requirements in Europe render responsible any operators (Collection or distribution centre) of the dissemination of diseases transmitted by bull semen if it's proven that there has been a failure in the quality system. If collecting centres are in a forbidden or restricted area due to disease outbreak, any distributed semen must be collected. Need for traceability is becoming crucial.

The summary of the questionnaire sent to world wide AI organisations to prepare this session made evident that those goals are shared by most of the AI organisations having or not a project of equipment for automatic reading.

In order to get accurate straw identification, it's necessary that there is continuous identification from the bull to straws ready to be stored in a nitrogen container. The way is optimal when bull's identification is automatically read from tag or chips and matched with identification tags prepared in advance on various devices used to collect , process semen and then filling straws. At the end of the process bull's identification and ejaculate references are printed on straws.

In many countries, regulation provisions impose that straws must enter a quarantine period and then distributed if analyses results prove that the bull is safe from legal diseases.

After a quarantine period, batches of semen are distributed and introduced in semen storage centres of the distribution centres. The same batch may be distributed to several distribution centres and there are movements of semen between storage centres, nationally or internationally. Commonly, national or international health regulation requires that bull identification and semen batch identification must accompany the movement from the semen collection centre to storage centres by paper forms or electronic files. There are usually physical controls when doses arrive to destination to a storage centre, but when units are distributed to another storage centres or to technicians or to farmers depots the track of batches are lost because the transmitted information refers just to bull identification and number of units. To get full traceability of semen doses it should be necessary to have tools able to record automatically straws movements. Otherwise the unique solution is to organise physical controls of any container where semen doses of one particular bull subject to veterinarian problems have been stored. This is not always possible.

Figure 1, below, presents semen flow with authorized and forbidden movements in the French situation. Similar diagrams should be sketch for other countries, especially in Europe.

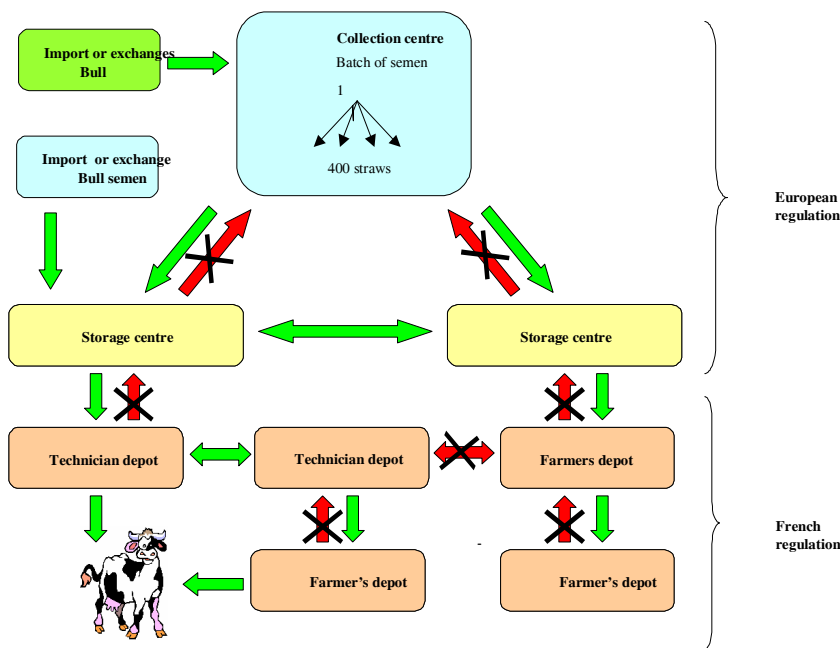


Figure 1. Semen flow from production to AI.

## Semen production and distribution

### Semen production: collecting centres

### Semen flow: distribution centres and storage centres

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**Artificial insemination**

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After insemination, technicians of companies providing AI services fill in systematically paper forms or record AI on their laptop or PDA. This is not systematically done by farmers. AI recorded data refer *inter alia* to technical information such as bull and semen batch (not always done), cow identification, herd, date and technician code. If semen identification is automatically read from straw before service and recorded in the technician computer, then the accuracy of bull identification recording is tremendously improved. It's also possible to record at the same time other information according to the capacity and the sophistication of the automatic reading system. Until now only semen batch reference are recorded by this way. It could be mentioned that automatic reading of cow identification is not practiced in AI context.

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**Constraints**

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Systems implemented to read automatically semen straw must match a set of constraints

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**Characteristics of semen straws**

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Semen straws are little cylindrical containers (0.5 ml) with few space to print readable information and deep-stored in nitrogen (-196°C). The tag or automatic system used for automatic reading must be printed or imbedded in / on each straw and must resist to storage conditions. When deep-frozen straws are removed from containers, it appears condensation that makes difficult reading. Straw must then be cleaned but damages to the frozen cells may occur, which is an inconvenience if straws must be transferred again into the container.

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**Practicability**

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Systems must be practicable at laboratory level of the collecting centre where straws are produced and at technician level where there are read in other words simple and affordable in order to not increase too much production costs.

- Codes must be easily allocated within the process of production.
- Technicians in charge of semen movements in laboratory or in storage centres may use easily the system.
- Automatic reading by technician devices is used to record bull's identification for AI recording; the code read must automatically refer to the AI bulls registered in the technician computer data base.
- Reading at farm level must be quick, accurate- with few failures in reading-and not compulsory because a percent of straws will never be coded or read.

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**Organisation**

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- Equipments. Labs must be equipped with systems identifying semen straws. AI technicians, have to be compulsory equipped with computers, the reading system being complementary
- Implementation of automatic reading systems is more possible in the situations where AI companies are providing technician service to farmers and decide of the investment in those technologies.
- Coding of information

It must be decided the kind of information that must be coded for automatic reading, having in mind that the code will refer to a unique batch of semen. The wishes of AI managers is to put as much information as possible to be close to the regulatory requirements ( Bull ID, breed, date of collection, code number of the collecting centre).

Unfortunately the current systems do admit a limited number of digits. Then codes for automatic reading must be cross-referenced with other files. When there are discussions on this topic, mainly at national level, two decisions have to be made at first:

1. To define the length of the code.
2. To define the code structure and there are two ways: either it's a non significant number or it's a significant number.
  - Non-significant means that the code has to be cross referenced in the technician data base with the information of any batch of semen possible to be used.
  - Significant means that the structure of the code refers to the most important items: bull's code, date of collection.

Each system has advantages or disadvantages as mentioned in table 1.

The table shows that there is no ideal solution and that choices must be done by the AI industry itself in accordance with its organisation and independently of the manufacturers.

*Table 1. Advantages and disadvantages of non-significant-significant ode structure.*

System	Advantages	Disadvantages
Non significant code	<ul style="list-style-type: none"> <li>• No need to define code structure</li> <li>• Codes are practically unlimited and don't have to be changed over the time</li> <li>• Code may refer to a large number of items</li> </ul>	<ul style="list-style-type: none"> <li>• Management of cross reference files</li> <li>• Data base must be referenced with any batch of semen susceptible to be used.</li> <li>• Adapted to situations where collection centres and distribution centres are more or less integrated and where majority of semen is issued from few (one) AI companies.</li> </ul>
Significant code	<ul style="list-style-type: none"> <li>• No need to store references of any batch of semen in the data base</li> <li>• Fits well with AI industry practices: codes for bull are commonly used for many purposes, technician data bases contain this code</li> <li>• Date of collection is easy to define</li> <li>• Easy to implement when there are many semen movements between independent AI companies</li> </ul>	<ul style="list-style-type: none"> <li>• Code structure must be defined at least at national level</li> <li>• Code list of bulls may be accessible to any stake holder of the AI industry.</li> <li>• Codes of bulls or dates are not unlimited.</li> <li>• Well adapted to countries having a strong national organisation on AI.</li> </ul>

3. Current technological possibilities.

The number of technological possibilities is limited today: bare code systems are implemented on large scale in France and in the Netherlands, and many other organisations or countries are thinking about this. But technology offers new developments that may be of interest for the AI industry: RFID chips, magnet ink etc.

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**Discussion**

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**Costs/benefits**

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It's difficult to assess balance between costs and benefits for such equipment because benefits are indirectly connect with the investment. If the system avoids dissemination of diseases in farms the benefits are huge but impossible to calculate. There are certainly benefits in increasing accuracy of breeding values but again difficult to assess. Indirect benefits come from the better management and better organisation of AI companies (semen traceability, better knowledge of technician stocks etc) to implement systems.

Then the costs may be considered as insurance for the AI industry. A rough calculation for the French situation comes up with an extra expense of 0.1 % of the service costs (0.5% of the administrative costs).If should also be added the cost of data processing and organisation to support the project.

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**Exhaustively of recording**

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It will be impossible to record any AI with automatic systems because AI companies producing semen are interested in such system only if they also provide AI service or if their clients request labelling straws for automatic reading.

Farmers and free lance operators will not use automatic system to record straw identification: the challenge for those populations is to get any record of AI with good accuracy

Nevertheless it's interesting to develop this service because it improves quality of service and image besides the technical advantages mentioned above. Exhaustively is not requested to launch the projects.

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**International harmonisation**

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As the international trade increases from year to year it will be necessary to harmonise the coding system accordingly to the technologies in order to get full benefits of the automatic reading.

The AI working group of ICAR made some proposals in this respect. This is to be discuss by the AI industry before it becomes a standard after adoption by the general assembly.

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**Conclusion**

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Automatic reading of semen straws is already developed by some countries. It is no more a project and not yet a common way of working in the AI industry