# Advanced Course

# USE OF SENSORS IN PRECISION AGRICULTURE

**Zaragoza (Spain), 3-8 February 2020**

## 1. Objective of the course

Food production must increase by 70% in order to feed a world population that is expected to reach 9.6 billion by 2050. This challenge is even greater when we take into account the low increase rate of available land, the effects of climate change on agricultural production and the societal demand for decreasing the impact of agriculture on the environment. To achieve a more rational, competitive and environmentally friendly production of food and biomass, a change in farm management is required and precision agriculture is part of the solution.

Precision agriculture (PA) is the management of spatial and temporal variability to improve economic returns and reduce environmental impact. PA technology makes it possible to log data of soil and crop properties at even centimetre level across an entire field.

Although most people can see the benefits of using a more precise approach to manage crops with additional information, the tools provided by PA and other information technologies have not yet moved into mainstream agricultural management. The complexity and the investment in new equipment inhibit easy adoption. Training in the use of tools and technologies and a deeper analysis of successful implementation can enhance adoption.

Sensors play a crucial role in PA. They are the key for collecting data in a more efficient way in order to make the most appropriate management decisions. The objective of the course is to deliver knowledge about different aspects of sensors, how to use them and how to integrate their data into the decision making process. The focus will be on the specificities of the Mediterranean agriculture.

At the end of the course participants will have gained:

- An overview of the role played by sensors in PA.
- Knowledge of the large range of different sensors and their possibilities and limitations.
- Better understanding of sensor common principles and technical implement requirements.
- Criteria to choose the appropriate technology and strategy for monitoring the required parameters under different conditions.
- Experience on current sensor system technology successfully implemented for different purposes and situations.
- Hands-on experience in sensor operation and in-field data acquisition.
- Skills for sensor data processing and integration of the derived information into the farm management information system.
- Awareness of the economic issues involved in the implementation of PA.
- An overview of emerging sensor technologies and future developments.

## 2. Organization

The course is jointly organized by the **International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM)**, through the **Mediterranean Agronomic Institute of Zaragoza (IAMZ)**, and the **International Center for Agricultural Research in the Dry Areas (ICARDA)**. The course will take place at the Mediterranean Agronomic Institute of Zaragoza and will be given by well qualified lecturers from international organizations and from research centres, universities and companies in different countries.

The course will be held over a period of 1 week, from 3 to 8 February 2020, in morning and afternoon sessions.

## 3. Admission

The course is designed for 25 participants with a university degree and is especially oriented towards public and private decision makers and managers, producers, technical advisors and R&D professionals of the crop production sector. The course is also open to ICT experts interested in applications for sustainable crop production.

Given the diverse nationalities of the lecturers, knowledge of English, French or Spanish will be valued in the selection of candidates, since they will be the working languages of the course. The Organization will provide simultaneous interpretation of the lectures in these three languages.

## 4. Registration

Candidates must apply online at the following address:
http://www.admission.iamz.ciheam.org/en/

Applications must include the curriculum vitae and copy of the supporting documents most related to the subject of the course.

The deadline for the submission of applications is **12 November 2019**. The deadline may be extended for candidates not requiring a visa and not applying for a grant if there are free places available.

Applications from those candidates requiring authorization to attend the course, may be accepted provisionally.

Registration fees for the course amount to 500 euro. This sum covers tuition fees only.

## 5. Scholarships

Candidates from CIHEAM member countries (Albania, Algeria, Egypt, France, Greece, Italy, Lebanon, Malta, Morocco, Portugal, Spain, Tunisia and Turkey) and from ICARDA Middle East and North Africa

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See updated information at
**www.iamz.ciheam.org**

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(MENA) partners may apply for scholarships covering registration fees, and for scholarships covering the cost of travel and full board accommodation.

Candidates from other countries who require financial support should apply directly to other national or international institutions.

## 6. Insurance

It is compulsory for participants to have medical insurance valid for Spain. Proof of insurance cover must be given at the beginning of the course. Those who so wish may participate in a collective insurance policy taken out by the Organization, upon payment of the stipulated sum.

## 7. Teaching organization

The course requires personal work and interaction among participants and with lecturers. The international characteristics of the course favour the exchange of experiences and points of view.

The programme has an applied approach. Lectures are complemented by examples, practical work, technical visits and a round table discussion. Technical visits will show working sensor systems in commercial farms. Practical work will allow participants to gain hands-on experience in sensor use and data collection as well as on data analysis and mapping.

## 8. Programme

1. **Introduction to precision agriculture (PA) (2 hours)**
   - 1.1. What is PA?
     - 1.1.1. Spatial and temporal variability
     - 1.1.2. Tryptic measure/decision/action
     - 1.1.3. Applications: vegetable crops, tree crops, arable crops, viticulture
   - 1.2. Needs and opportunities induced by PA
     - 1.2.1. Sampling strategies and data acquisition
     - 1.2.2. Data analysis and decision making
     - 1.2.3. Variable rate technology (VRT)
     - 1.2.4. Reporting, traceability and farmer feed-back
     - 1.2.5. Implementation of PA with low cost technology
2. **Introduction to sensors (2.5 hours)**
   - 2.1. Basics of metrology (accuracy, precision, resolution, error, etc.)
   - 2.2. Types of signals
     - 2.2.1. Analog and digital (binary, digitized, frequency)
     - 2.2.2. Multiplexing and bus communication (USB, ISOBUS, Ethernet, etc.)
   - 2.3. Data acquisition and communication
     - 2.3.1. Digitation
     - 2.3.2. Acquisition systems
     - 2.3.3. Calibration
     - 2.3.4. Wireless sensor networks
   - 2.4. Sensor system classification
     - 2.4.1. According to the measuring principle
     - 2.4.2. According to the variable measured
     - 2.4.3. According to the distance to the target (in contact, proximal, airborne, spaceborne)
     - 2.4.4. According to the object to be sensed
3. **Global navigation satellite systems (2 hours)**
   - 3.1. Working principle and errors
   - 3.2. Current systems (GPS, Galileo, Glonass, Beidou)
   - 3.3. Augmentation systems (satellite- and ground-based systems)
   - 3.4. Receivers and accuracy (characteristics and specifications)
   - 3.5. Applications in agriculture
4. **Sensors for PA (9.5 hours)**
   - 4.1. Crop sensing
     - 4.1.1. Canopy and biomass characterization
     - 4.1.2. Vigour sensing
     - 4.1.3. Flower and fruit monitoring
     - 4.1.4. Health sensing (pest and diseases monitoring)
     - 4.1.5. Weed detection and classification
     - 4.1.6. Water status
     - 4.1.7. Yield monitoring
   - 4.2. Soil sensing
     - 4.2.1. Soil moisture
     - 4.2.2. Salinity
     - 4.2.3. Soil texture
     - 4.2.4. Compaction
     - 4.2.5. Nutrients
     - 4.2.6. Organic matter
     - 4.2.7. pH
     - 4.2.8. Soil biological activity
   - 4.3. Other sensors
     - 4.3.1. Microclimate sensors (rainfall, temperature, humidity, leaf wetness, etc.)
     - 4.3.2. Machinery sensor (fuel consumption, draft forces, seeding condition, traceability, etc.)
5. **Sensor data processing: from sensor data to piece of information (3 hours)**
   - 5.1. Data post-processing and tools
     - 5.1.1. Data preparation (filtering)
     - 5.1.2. Mapping (interpolation, clustering)
     - 5.1.3. Correlation between maps/variables
     - 5.1.4. Decision making
     - 5.1.5. Delineation of management zones and application map creation
   - 5.2. Real-time data processing
6. **Integration of sensor information in the global farm management (2 hours)**
   - 6.1. Farm management information system
   - 6.2. Data interchange
   - 6.3. Variable rate machinery
     - 6.3.1. VRT systems
     - 6.3.2. ISOBUS
7. **Digital augmentation for sustainable agroecosystems (2 hours)**
   - 7.1. Agronomic uses of remote sensing/sensors in small farms
   - 7.2. Some case studies in dryland agroecosystems
8. **Adoption and economic issues (2 hours)**
   - 8.1. Cost-benefit analysis based on case studies
   - 8.2. Adoption strategies
9. **Practical work (8 hours)**
   - 9.1. Global navigation satellite systems
   - 9.2. Use of sensors
   - 9.3. Data processing
10. **Round table discussion: Precision agriculture adoption in Mediterranean countries for small and medium farms (2 hours)**
11. **Technical visit (Saturday)**

## GUEST LECTURERS

**J. ARNÓ**, Univ. Lleida (Spain)
**C. BIRADAR**, ICARDA, Cairo (Egypt)
**S. CILLA**, ESSP SAS, Madrid (Spain)
**A. ESCOLÀ**, Univ. Lleida (Spain)
**S. FOUNTAS**, Agricultural Univ. Athens (Greece)
**R. GEBBERS**, Leibniz Institute for Agricultural Engineering Potsdam-Bornim (Germany)
**G. GRENIER**, Bordeaux Sciences Agro, Gradignan (France)
**S.C. KEFAUVER**, Univ. Barcelona (Spain)
**J.M. MARTÍNEZ-CASASNOVAS**, Univ. Lleida (Spain)
**S. PEDERSEN**, Univ. Copenhagen (Denmark)
**B. TISSEYRE**, Montpellier SupAgro (France)

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