Main drivers in agricultural research and education to secure food supply and assure sustainability

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Context

Drivers for change in production systems
Changes to production systems
Higher education (structure, capacities)
Requirements of the educational system
General principles for the design of agricultural education
(examples)

For discussion
Context

• Population increase will occur mainly Africa, Asia and LA
• Markets play a fundamental role in food security
• Climate change and variability; GHG emissions (CSA)

• Given the limited new land for cropping, increase in agricultural production can only be achieved by higher yields and more intensive use of land
• This must be done with respect of the environment and hence the increasing use of the terms “ecological / sustainable intensification”
• Advances in sensors, electronics and ICT are allowing more efficient and timely management by mechanized interventions in agricultural productions
• Agricultural enterprises and agribusinesses require all manner of workers ranging from unskilled labour through to highly-qualified and experienced academic researchers

• We focus here on higher education nevertheless:
  - we depend on previous school curriculum
  - we need to teach some agriculture (examples) in other degrees (geography, history, maths, physics and chemistry, science incl. environmental sciences)
**Drivers for change in production systems**

**Driver 1:** The main driver for change results from the opportunity offered to entrepreneurs among current and new farmers to supply the needed increase in agricultural production of 70%.
**Driver 2:** Most population growth will occur in Africa and Asia but the major increases in productivity to 2050 will be led by current major exporting countries such as USA, Brazil, Argentina and Australia (what about Europe?).

- FAO estimates that small-scale farmers produce over 70% of the world's food needs; currently 70% of people living below extreme poverty (<1$ / day) are in rural areas. Their problems will not be solved by agriculture only.
Drivers for change in production systems

**Driver 3:** Large increases in productivity require more efficient production (and lower GHG emissions) that in turn may require large-scale production units that seek more efficient use of inputs, produce safe products that also meet quality requirements by applying farming methods that are ecologically sensitive.
Driver 4: Substantial investment is required to develop these production units and is achieved by amalgamation of, or cooperation among, existing smaller production units and major investment in infrastructure.
Driver 5. Food chain value. The connection between agriculture and subsequent processing for consumption will be increasingly vertically integrated (diminishing waste). Much processing will be done on farm (or close by) so that enterprises obtain benefit from selling value-added products.
Change to production systems

1: Production - mainly staple foods - will be dominated by large, often integrated, agricultural enterprises covering large areas of field crops, orchards or pastures for grazing animals.

Animal production will be increasingly intensive (poultry, pigs, dairy) conducted in closed environments with fodder from adjacent large areas, or more widely by contract growers.
2: There will also be many smaller farms that will meet local needs and/or provide specialist products (e.g.: organic); premiums for local authentification.

3. For all food products, society will demand safety and environmental sensitivity of production methods. Given that, consumers will select products on the basis of price and quality.
Change to production systems

4: To meet these requirements and consumer preferences, agricultural enterprises will need to be efficient (economically and environmentally- “Climate Smart Agriculture”), apply modern technologies, establish close integration between production activities for efficiency and reduce waste, especially evident in joint crop-animal operations.

The key feature of agricultural production will be increasing application of science and technology, management by measurement, recording, and analysis of activities and inputs, and consequent traceability of all products by production steps to points of origin.
5: Risk management. Agricultural insurance and farm safety nets as tools for sustainability.

6. Small-scale farming: specific support from social-economic and extension services to evolve is crucial.
A consequence of this change is the need for more highly skilled staff to design and implement these new agricultural enterprises.

Grain and livestock enterprises of hundreds of thousands of hectares, possibly spread across climate zones to reduce variability of production.
Higher education: structure

BSc: 3 years
+ MSc: 2 years
+ PhD: 4 years

Graduate: 4 years
+ Master: 1 to 1.5 years
+ PhD: 4 years

Other courses on demand by Agribusinesses and Public Administration

International Conference on Agricultural Higher Education
CIHEAM-IAMZ Zaragoza, 15-16 June 2015
Capacities of graduate and postgraduate studies:

- Technicians
- Engineers
- Scientists
Higher education: requirements

Technicians (3 years)

To maintain and monitor production and processing systems.

This demands an understanding of the basic crop and animal production systems, including health and sanitary issues.

Principles of operation of measuring equipment, and the nature and significance of the parameters that are measured.
Higher education: requirements

Engineers ("Ingénieur") (5 years)

To design and manage (large) agricultural operations with complex infrastructure, including internal measurement systems, developed for individual enterprises.

Wide range of specialization but with common understanding of the soil-plant-environment –socioeconomic interactions involved in both design and management, and environmental issues consequent to production.
Higher education: requirements

Engineers (Ingénieur) (5 years)

The need for strong basic scientific and socioeconomic education both before and together with applied disciplines makes these courses longer than those for technicians.

A common solution is to include a post graduate master’s programme for specialisation
Scientists:
To resolve immediate problems, improve current processes and design new ways to achieve current objectives, improve crop cultivars and animal strains for higher productivity and resistance to stress and disease production, discover ways to provide new products, and resolve off-farm (and factory) environmental issues.

The linkages in the complete food change from “farm to fork” will more closely integrate primary production and food science.

The current system of formation of research scientists is likely to continue but with new specializations determined by changing scientific capabilities.
Higher education: requirements

Scientists:

Even so, training should produce researchers who can apply their training more broadly than in the inevitably specialized research project in which they obtain their qualification (doctorate)
General principles for design of agricultural education

- The unifying factor in courses to educate for these three levels must be the presentation in early years of the courses of appropriate levels of biology, mathematics, chemistry, and socioeconomics

so that students have a sound basis for the specializations they choose and a level of basic knowledge that allows them to adapt to changing technology through their career and gives them a flexibility to change specialization as required
General principles for design of agricultural education

For graduates at all levels there is the need for continuing education that educational institutions and professional societies can share and that professional societies can regulate.

There is also the question of flexibility for movement of current students or graduates between the three levels described above.

The major issue is probably for students studying technical courses, or graduates, to move to engineer level. The proportion of such students or graduates may be small but course structures should cater for transfers.
General principles for design of agricultural education (examples)

a) Designing vine trellis for avoiding high air and soil T during veraison and post-veraison; b) Designing high density olive plantations

- Production costs; jobs; marketing
- Radiation balance and energy balance
- Vine cultivar; roots stock, hybrids
- Water relations and irrigation needs; deficit irrigation
- Assimilate partitioning: pruning
- Soil management
- Mechanisation
- Pest and disease control: integrated or organic management
- Continuous monitoring
- Drones; robots
General principles for design of agricultural education (examples)

22/06/2010  11/05/2011  24/05/2012

Satellite images for drought risk monitoring and indexed insurances in pastures

- Maths and physics: data mining and analysis, remote sensing
- Grazing systems: ecology and plant physiology
- Extensive animal production

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CEIGRAM’s research and innovation flows for risk management

Crop/pasture monitorization

- Remote sensing
- Drones
- Low cost sensors

Sensors

Comunications

- Networks
- Big data

Support models

- Crop/pasture
- Meteo indices
- Vegetative indices

Historical data

Expert system

- Neural networks
- Data Science

Indexed insurance, yield insurance, income/revenue insurance, environmental insurances
For discussion

• Science, technologies, and social sciences
• Critical thinking and analytical capacities for graduates
• Links between Technicians and Engineers/Ingénieurs
• Duration of degrees
• Post graduate or post-doctoral: Continuous training
¡¡ GRACIAS !!