Market-Based Value Chains and Farming Technologies

Session 4: Agriculture and 2030 Agenda (the future of farming)

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Mia Marchini and Roberto Ranieri, Open Fields srl
Summary

- Conventional vs sustainable agriculture
- Blue economy
- Not waste but resources
- How plastics are damaging the world and the future of plastics
- Plant breeding towards new plant ideotypes
- Hydroponics
- Big Data in smart farming and precision agriculture mapping
- Food to stay healthy
- Example of innovation already in the future: robotization and automatization from farm to factory
The Conventional Agriculture scenario

Through a careful genetic breeding on **High Yielding Varieties**, supported by:

- Monocropping;
- Syntetic fertilizers;
- Exorbitant water consumption;
- Pesticides, chemicals, plant protection products;
- Ever-increasing mechanization;
- Use of pulluting energy sources;

Conventional Agriculture **has tripled** the production yield of many crops from the Green Revolution until today;

The goal of Conventional Agriculture is to **maximize the potential yield of crops and profits**.

Conventional Agriculture needs more in the way of resources than the earth can replenish.

Source: www.fao.org
Populations are at the centre of sustainable development and will be influential in the realization of the 2030 Agenda for Sustainable Development.

The world’s population is projected to increase by slightly more than one billion people over the next 13 years, reaching 8.6 billion in 2030, and to increase further to 9.8 billion in 2050 and 11.2 billion by 2100.

Tasks for a sustainable future

- A global perspective is needed;
- The (moral) recognition that food is a basic right and the (practical) one that sustainability is a high priority;
- To reduce and repair the environmental damage;
- To cut back on the production and consumption of resource-intensive food;
- To increase efficiency and do something about waste;
- A sensible and nutritious diet for everyone is essential; many people will eat better, and others may eat fewer animal products, which is also a eating better.

Feeding the Future

How sustainable and organic farming can help feed the world

✓ Sustain of the health of soils, ecosystems and people;
✓ Adoption of ecological processes, biodiversity and cycles adapted to local conditions;
✓ Combination of tradition, innovation and science to benefit the shared environment;
✓ Promotion of plant health and crop performance;
✓ Promotion of biodiversity and removal of pests and pathogens;
✓ Assurance of profits for farmers, economies, and food banks while existing symbiotically with the landscape;

Sustainable agriculture focuses on producing high yields without compromising the integrity of the environment.

Source: https://you.stonybrook.edu/environment/sustainable-vs-conventional-agriculture/
Principles of Organic Farming and Biodiversity could lead to a Sustainable Agriculture

5 reasons why organic farming is sustainable:
1. It promotes the health of the environment;
2. Organic farmers conserve resources;
3. Organic farmers produce more, (better-quality products) and achieve higher incomes;
4. Organic products provide market access and create added value;
5. It increases self-confidence and mobilizes new partnerships.

5 reasons why biodiversity is sustainable:
1. It is an essential component in the sustainable delivery of a more secure food supply;
2. It can maintain and increase soil fertility and mitigate the impact of pests and diseases.
3. It will be essential to cope with the predicted impacts of climate change;
4. It can increase the productivity of farming systems in a range of growing conditions;
5. It can be a tool for the production of plant-based products for the natural and sustainable crop protection.

When the Food Industry meet the Blue Economy core

The Blue Economy is now recognized as one of the best models to develop a sustainable economy, to undertake in harmony with our environment, to ensure a better and healthier live and to propose a positive future to youth.

- Agriculture is no longer just an activity that guarantees food security and stability;
  - Agriculture plays an essential role in creating jobs and prosperity in marginal and rural areas, preserving the soil, benefiting the climate and the environment and favoring the ideal balance of the whole ecosystem.
Not waste but resources

When the Food Industry meets the Blue Economy core

Biogas from sugar beet press pulp as substitute of fossil fuel

Aim of the project: to treat SBP (sugar beet pulp) to save in energy consumption and to produce biogas using anaerobic digestion. (Brooks et al., 2008)

Production of beet sugar

Sugar beet pulp is a by-product of the production of sugar from sugar beet. The beet is sliced up into small strips (pulp) and then mashed by heating with water to a T°=70°C to dissolve the sugar from the pulp. The sugar water and the pulp are separated in an extraction tower. The SBP (sugar beet pulp) is highly sought by the animal feed and animal husbandry.

Agricultural Use of Biogas Digestate as a Replacement Fertilizers

Aim of the project: to test digestate obtained from an agricultural biogas plant for the content of macroelements and heavy metals. The content of macroelements in the soil was also examined before and after digestate application. Digestate was used in alfalfa cultivation. The analysis showed an increase in macroelements content in alfalfa leaves. It was found that digestate can be used as a fertilizer. (Koszel et al., 2015)
Agropyrogas. Towards a bio-energy production chain from pyrogasification.

Aim of the project: to develop an energy supply chain including: retrieval of waste biomass from agriculture; its implementation in the pyrogasification process; the use of biochar (byproduct of the pyrogasification process) as agricultural fertilizer.

In agriculture, biochar can represent a valid option for the management of waste agricultural residues to produce renewable energy.

www.openfields.it/portfolio/agropyrogas/

Coffee in the field!
Toward the Zero Waste Strategy

Aim of the project: To use coffee grounds as fertilizers and draw citizens' attention to the potential of the circular economy, based on systems where the waste can become a resource.

www.caffeincampo.it

CartaCrusca case history

CartaCrusca contains 20% of bran residues that can no longer be used for human consumption, replacing cellulose and filler materials to produce high-quality paper. Favini proved to be an ideal partner for Barilla, which has been looking for ways to make better use of its residues

www.favini.com

CELUS-BI, ingredients for the cosmetics made from renewable raw materials

- CELUS-BI Esters, suitable for specific applications in the health and body care;
- CELUS-BI Microbeads, inherent biodegradable microspheres suitable as exfoliating agents for personal care and cosmetic products.

www.novamont.com

Not waste but resources

Fabrics from natural fibers

✓ Orange Fiber

The world’s first brand to produce a patented material from citrus juice by-products, repurposing them to create materials that reshape the sartorial experience.

www.orangefiber.it

✓ Vegeatextile

The valorization of a 100% vegetal feedstock comprising the skins, the seeds and the stalks of the wine grape bunch. From the seeds a bio-oil is extracted, and it is polymerized using an innovative patented process. The skins and the stalks are employed for the production of a textile with advanced technical properties.

www.vegeacompany.com
How Plastics are damaging the world

- **Plastics problem**
  - **Production problems**
    - Plastic from petroleum, natural gas;
    - Contribute to oil dependency.

  - **Landfill disposal**
    - Plastic winds up in Landfills;
    - Cannot break into pieces.

  - **Marine pollution**
    - Appears like food in the oceans;
    - Threats to marine animals.

  - **Contamination**
    - Polluting environment and drinking water.

  - **Plastic recycling**
    - Very few plastic being recycled;
    - Most common recycle plastic is polyethylene.

  - **Incineration**
    - Expensive;
    - Air pollution.
Case Study for Sustainability
The Future of Plastics

PlantBottle™ packaging

The first-ever fully recyclable beverage bottle partially made out of plastic derived from sugar. Looks and functions just like traditional PET plastic, but has a lighter footprint on the planet and its scarce resources. PlantBottle packaging is reducing our dependence on fossil fuels and increasing our use of renewable materials. * www.coca-colacompany.com

PHAs produced by BIO-ON.
Bio-on turns off pollution

Using MINERV PHs (Polyhydroxyalkanoates developed using beets) Bio-on has identified the possibility of producing a new family of naturally biodegradable polyesters derived from sugar beets. PHAs is a linear polyester chain produced in nature by bacterial fermentation of sugar. The MINERV PHA increases its biodegradability factor in bacteriologically impure water: In just 10 days in normal river water, MINERV-PHA turns into river water or sea water. It is the first biopolymer obtained from sugar co-products to achieve this important result. www.bio-on.it

Cardoon
a “weed” promoting a strategy of profit and productivity.

• Cardoon flower: there is a white substance that contains an enzymatic bacterium used to make goat’s cheese.
• Cardoon stem: made of cellulose, it contains sugars that can be transformed into alcohol.
• Cardoon roots: rich in ingredients for the treatment of wrinkles.
• The biomass is used as animal feed and energy source.

Mater-Bi by NOVAMONT

MATER-BI is an innovative family of biodegradable and compostable bioplastics certified in accordance with the main European and international standards. Materials made of MATER-BI use starches, cellulose, vegetable oils and their combinations. It is biodegradability and compostability properties and its high content of renewable raw materials allows optimal organic waste management, reduce the environmental impact and contribute to the development of virtuous systems.

• Biodegradable in soil and compostable MATER-BI agricultural products: mulch film, bindings [thread], pheromone dispensers (pest control clips). These innovative products biodegrade into the soil without harmful residue. Other products such as flower pots, are compostable at the end of their use. www.novamont.com

«Short agro-industrial chains for bioproducts: Novamont and Coldiretti sign strategic agreement on raw cardoon and plant waste utilization for the production on low environmental impact chemical products, employing innovative low-impact processes and creating a strong synergy with the Matrica biorefinery in Porto Torres (Sardinia)»

Banana Plastic,
from Fruit that Rivals Kevlar

Now a group of scientists from Sao Paulo State University have developed a way to use the fibers from bananas, pineapples, and other fruits to create incredibly strong, lightweight plastics. The nanocellulose fibers make a plastic that’s up to 4 times stronger and 30% lighter than petroleum-based plastics and is biodegradable. To create the plastic, the leaves and stems are cooked in a device similar to a pressure cooker, creating a talcum powder-like substance. www.inhabitat.com/banana-plastic-researchers-create-incredibly-strong-plastic-from-fruits/

*Solutions for a sustainable future

*Source: https://www.sciencehistory.org/case-study-for-sustainability-the-future-of-plastics
Gene Editing will allow plant breeding towards new plant ideotypes

Biofortification

Biofortification is the process by which the nutritional quality of food crops is improved through increasing the content of an essential micronutrient, i.e. vitamins and minerals in a food, so as to improve the nutritional quality of the food supply and provide a public health benefit with minimal risk.

Optimization of farming production

- Varieties requiring less inputs;
- Varieties with a greater ability to recover nutrients from the soil, greater absorption capacity and greater use of water (developed root system, symbiosis with fungi, etc);
- Varieties with high adaptability to extreme climate conditions;
- Varieties with re-usable and valorizable by-products;

Source: www.who.int
Plant breeding towards new plant ideotypes

NEWCOTIANA
Breeding new tobacco varieties for health

EU H2020 Project, it aims to modify the composition and therefore the use we make of tobacco plants, replacing smoking nicotine by added value substances used in medicine and cosmetics, using Precision Gene Editing and other New Plant Breeding Techniques (NPBTs).
www.newcotiana.wordpress.com

TRITORDEUM
The best of durum wheat and barley in a new natural cereal

The first newly-created cereal suitable for human consumption and developed by traditional breeding techniques.
• Alternative crop with high resistance to drought and heat stress. It is a sustainable crop since it needs little water and few fertilizers;  
• Nutritional properties that cannot be found in other cereals and that make it a healthy alternative;  
• Pleasant aroma, sweet and natural flavor, attractive golden-yellow color. www.tritordeum.com

HYVIDO™ technology.
A new era in high yielding hybrid feed barley

HYVIDO™ barley was created for cattle feed, straw and biogas production. A barley performing consistency better year after year, thriving in all soils and season; stronger plants with hybrid vigour; flag leaves up to 3 times bigger than conventional; roots up to 70% longer; nutrient scavenging, tolerance to stress, access to moisture. www.syngenta.it/hyvido
Hydroponics can be defined as growing plants under soilless conditions with nutrients, water and an inert medium, i.e. gravel, sand, perlite and other substrates.

Benefits:
- Traditional farming practices are not required and recirculation of water is allowed;
- Higher yield per area because of the optimum growing conditions and controlled environment;
- Economic benefits: Growers can produce multiple crops in one year.

Limitations
- Dependence on electricity use;
- Starting overheads being much greater compared to traditional farming;
- Knowledge of the system and the principles of hydroponics are required;
- Microbiological contamination can still occur indoors and pure water quality is important to ensure that harmful elements do not accumulate in the plant.
- Quality and nutritional implications

Mission. “We believe that controlled-environment agriculture (CEA) is the future to achieve true food security in arid climates. Our high-tech greenhouses provide precise climate & environmental controls, enabling increased productivity and reduced waste (including water, energy & time). We use technology to take-on the challenges of the region’s harsh climate so that your food doesn’t have to.”

http://pureharvest.ae/#
Solutions for a sustainable future

Big Data in Smart Farming

Big Data are massive volumes of data with a wide variety that can be captured, analysed and used for decision-making.

The role of BIG DATA in Smart farming
Provide predictive insights in farming operations;
Drive real-time operational decisions;
Redesign business processes for game-changing business models.

Push and Pull factors that drive the development of Big Data and Smart Farming

<table>
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<tr>
<th>Push factors</th>
<th>Pull factors</th>
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<td>General technological developments</td>
<td>Business drivers</td>
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<tr>
<td>Internet of Things and data-driven technologies</td>
<td>- Efficiency increase by lower cost price or better market price</td>
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<td>Precision Agriculture</td>
<td>- Improved management control and decision-making</td>
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<td>Rise of ag-tech companies</td>
<td>- Better local-specific management support</td>
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<td>Sophisticated technology</td>
<td>- Better cope with legislation and paperwork</td>
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<td>- Global Navigation Satellite Systems</td>
<td>- Deal with volatility in weather conditions</td>
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<td>- Satellite imaging</td>
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<td>- Advanced (remote) sensing</td>
<td>- Public drivers</td>
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<td>- Robots</td>
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<td>- Unmanned Aerial Vehicles (UAVs)</td>
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<tr>
<td>Data generation and storage</td>
<td>- Sustainability</td>
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<td>- Process-, machine- and human-generated</td>
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<td>- Interpretation of unstructured data</td>
<td>- General need for more and better information</td>
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<td>- Advanced data analytics</td>
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<td>Digital connectivity</td>
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<td>- Increased availability to ag practitioners</td>
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<td>- Computational power increase</td>
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<tr>
<td>Innovation possibilities</td>
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<tr>
<td>- Open farm management systems with specific apps</td>
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<tr>
<td>- Remote/computer-aided advice and decisions</td>
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<tr>
<td>- Regionally pooled data for scientific research and advise</td>
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<td>- On-line farmer shops</td>
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Examples of Big Data applications/aspects in different Smart Farming processes

Precision Agriculture Mapping

**Satellite imaging corporation. Precision Agriculture Mapping**

Geographic Information Systems (GIS) tools and online web resources can help farmers to conduct crop forecasting and manage their agriculture production by utilizing multispectral imagery collected by Satellites, fix wing Aircraft or Unmanned Aerial Vehicles (UAV’s) and processed to provide NDVI and other vegetation/soil indices, to identify crop stress. This data is used in regional GIS or CAD management systems and web portals. The ability of GIS to analyze and visualize agricultural environments and workflows has proven to be very beneficial to those involved in the farming industry.

When agriculture management software is not in place, vegetation and soil index imagery can be reviewed in Google Earth Pro™ for regional farmers to identify areas in the fields, requiring a closer analysis, to decide if additional irrigation or fertilization of the crop is required.

https://www.satimagingcorp.com/applications/natural-resources/agriculture/

**The Institute of Biometeorology of the National Research Council of Florence and Foggia (Bibmet-Cnr, Bioagroalimentare-Disba Department) in collaboration with Barilla S.p.a. has created ‘Agrosat’: an online and free service, able to support the management of fertilization through precision farming techniques. For those who do not have the latest equipment, Agrosat allows you to browse the prescription maps so as to enable real-time rationalization of fertilization: a smartphone or tablet will be sufficient to monitor its position on the map and determine the release of fertilizer according to what is prescribed. Map processing is possible thanks to the satellite data of the Esa Sentinel-2A and 2B platforms of the European Copernicus Earth Observation Program.**

https://www.agrosat.it/it

**Sentinel - 2**

The Sentinels are a fleet of satellites designed specifically to deliver the wealth of data and imagery that are central to the European Commission’s Copernicus programme. Sentinel-2 carries an innovative wide swath high-resolution multispectral imager with 13 spectral bands for a new perspective of our land and vegetation. The combination of high resolution, novel spectral capabilities, a swath width of 290 km and frequent revisit times provides unprecedented views of Earth. The mission is based on a constellation of two identical satellites in the same orbit, 180° apart for optimal coverage and data delivery.

The mission mainly provides information for agricultural and forestry practices and for helping manage food security. Satellite images can be used to determine various plant indices such as leaf area chlorophyll and water content indexes. This is particularly important for effective yield prediction and applications related to Earth’s vegetation.

http://m.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Sentinel-2/Introducing_Sentinel-2
The Agri-food sector for a safe, healthy and sustainable nutrition

Governments should incorporate into their polices:

- Sustainability considerations and promotion;
- Consumer education programmes and recommendations that promote specific food practices and choices:
  - Having a mostly plant-based diet;
  - Focus on seasonal and local foods;
  - Reduction of food waste;
  - Consumption of fish from sustainable stocks only;
  - Reduction of red and processed meat, highly-processed foods and sugar-sweetened beverages.

Personalized nutrition creates a window of opportunities

✅ Opportunities with a huge innovation potential and with benefits for citizens' health and wellbeing as well as for future-proofing our food systems so that they become more sustainable, resilient, responsible, diverse, competitive, and inclusive.

Whereas a one-size-fits-all approach may fail, personalized nutrition can empower consumers to adhere to a long-lasting, healthy, pleasurable, nutritional and sustainable diet when tailored to individual parameters such as: the physical and psychological characteristics (health status, phenotype, genotype, microbiome configuration), the needs and preferences, behaviour, lifestyle, and budget; alongside to general economic factors and socio-cultural aspects.

A compilation of putative business actors for smart personalized nutrition offerings

Source: Smart personalized nutrition: quo vadis. Reflection paper on the discussions of the Smart Personalized Nutrition workshop. 16 June 2016, Brussels, EU commission

The future of Tartary buckwheat and it's role in personalized nutrition

http://www.goodmills.com
Sustainable Livestock Husbandry - The pasture-based system

- Eating nutritious grasses and other plants that their bodies are adapted to digest
- Improving the welfare of farm animals
- Helping the reduction of environmental damage
- Yielding tastier and more nutritious meat, eggs, and dairy products
- "Food as disease-prevention tool" concept
- Optimizing natural and human resources
Examples of innovation already in the future

Robotization and automatization from farm to factory
WEEDING ROBOT

The first ever completely autonomous machine for the ecological and economical weeding of row crops, meadows and intercropping cultures.

Pros

- Conserves the organic life of the soil
- Improved yield: no or less herbicide
- Up to 30% less expensive than std treatments
- 20X less herbicide per application or none

Cons

- Workforce reduction
- Substantial investment for small-medium enterprises
- Waste management: batteries, solar panels, electronics

Solutions for a sustainable future

www.ecorobotix.com
BoniRob KILLER ROBOT

A new robot from Bosch can travel through crop fields, learn what weeds look like, and crush them. Using machine learning it applies its knowledge to what it sees when it’s in the field, stamping down only on the weeds it’s been asked to kill.

BoniRob could potentially rid farms of the need to use herbicides or other weed killers on crops, which have been seen as potentially harmful to humans.

TriQ – process capacity grain quality sorting

The BoMill TriQ machine enables to take advantage of the natural variability in grain and get maximum value out of the harvest.

Source: www.bomill.com
Consumers, UN, countries and big companies will lead more respect for the planet and the food production;

Demonstrating that the product that is sold respects the planet will become a fundamental background for food companies in the future;

Blue economy will reduce the waste; the energy will be used in a more efficient way and it will originate not only from oil;

Plant breeding towards new plant ideotypes tanks the contribution of the genome editing;

The future of plastics is green;

Personalized nutrition, personalized crop in each flat, hydroponic growth in highly technologized microenvironments as tool for a sustainable future;

Further robotization, automatization and the management of Big Date from farm to factory (“precision value chain”) are key words for the food industry of the future.

But, what will be the cost of all of this?
Thank you for the attention