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FARM OF THE FUTURE

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Challenges

Child and maternal nutrition
Source: FAO

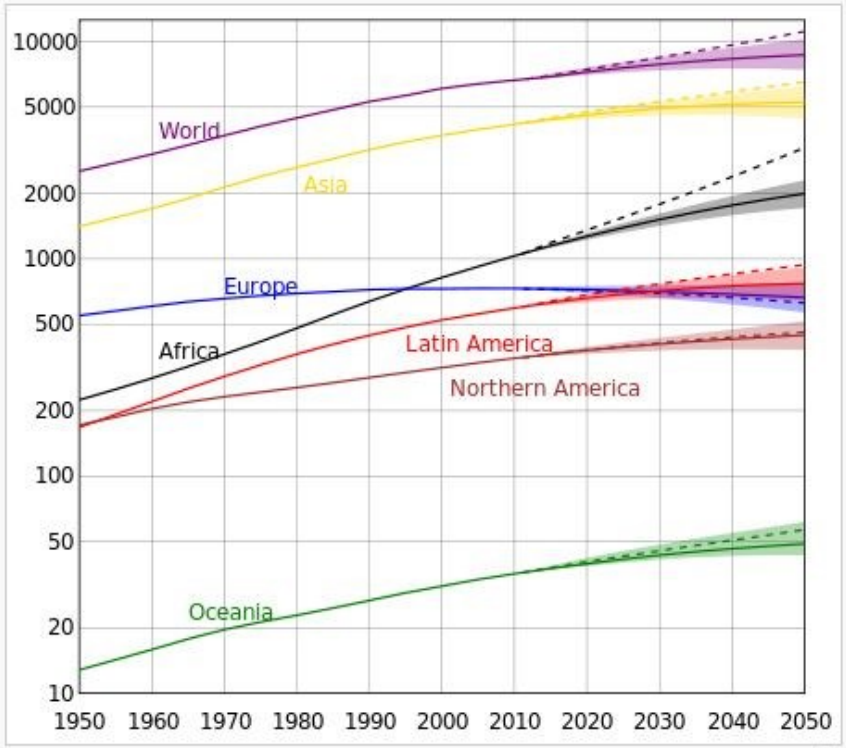
The world today is facing extraordinary challenges; amongst the major ones, we surely have to include :

- the need to feed all the world inhabitants, up to 9 billion people foreseen in 2050
- and the need to preserve the environment and the life on the planet.

Agriculture is the key tool, the main enabler for feeding the planet and re-balancing the use and regeneration of resources.

The world population is just over 7 billion today, and it's expected to grow up to around 9 billion in 2050. It's more than 28% increase in 35 years.

Average global life expectancy is increasing, while fertility rates show a limited decrease, mainly in high-fertility countries.



Estimates of population levels in different continents between 1950 and 2050, according to the United Nations. The vertical axis is logarithmic and is in millions of people.

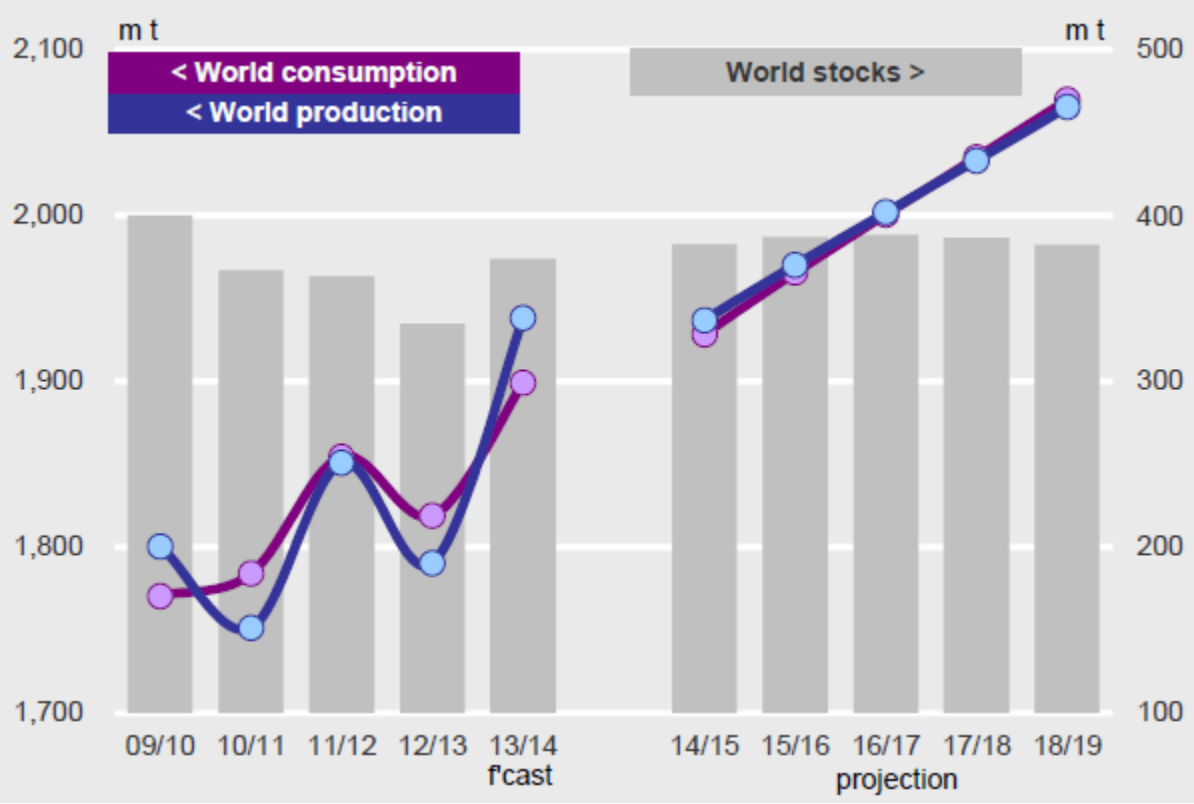
World population trends.
Source: UN, World population prospects.
The 2012 Revision, 2013

All these people will be there tomorrow, and they will all need to eat.

The first issue to solve is food availability to everyone: today over 800 million people are chronically undernourished, one in nine of the world's population.
This number is slowly decreasing over the years, but we must go to zero undernourishment at a much higher speed.
In 2012 FAO stated: "*Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition*"

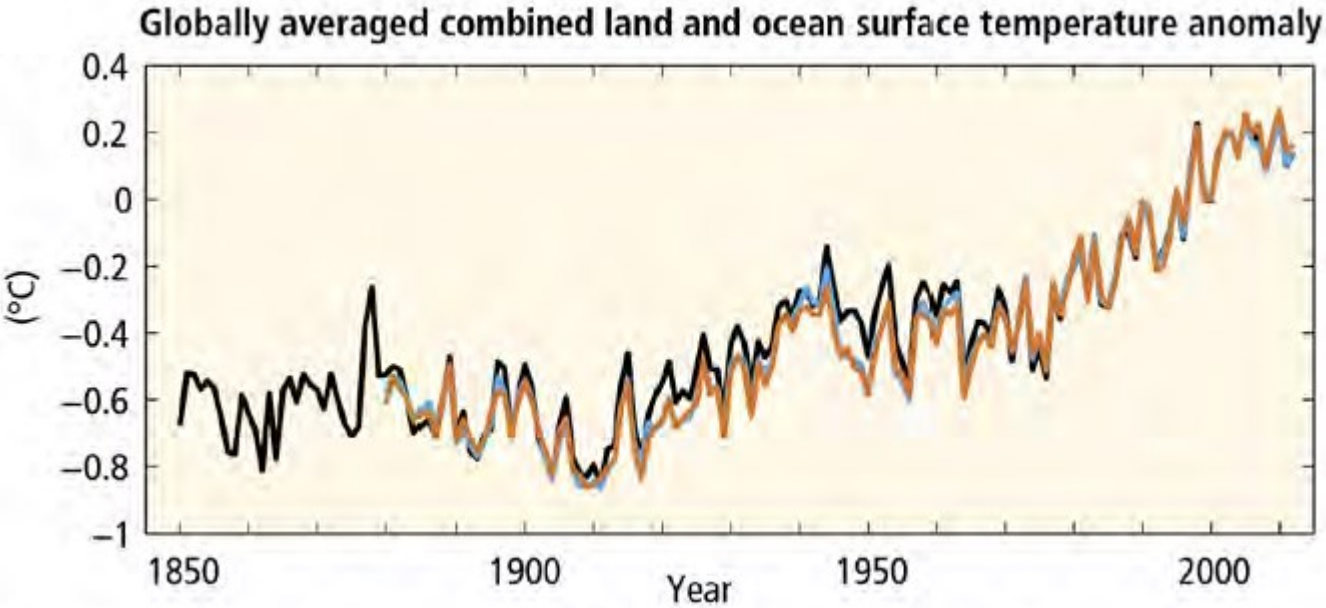
The second significant trend is the increase of the amount of available protein per person, and of the share of livestock products in protein supply, due to an increase of the per capita income. Then a proportionally higher increase of vegetal products needed to grow animal proteins (7 to 10 times).

All that means agriculture has to find ways to overcome economic constraints and to dramatically increase productivity and efficiency.
World agricultural production would need to expand by some 60 percent from now to 2050.



Total grains: world supply and demand.
Source: International Grains Council, Five year global supply and demand projections, 2013

The increase of population will drive 70% of the increase in the world agricultural production, while the remaining 30% will be caused by the per capita income growth (meat consumption and other shifts in diets)



Source: IPCC - Climate Change 2014 (Synthesis Report)

Climate changes will be a major challenge to the development of agriculture, forcing farmers to find robust and sustainable ways of increasing production and productivity of their land.

Not only they have to face increased weather-related risks, water scarcity and land degradation, but at the same time they must invest in crops and farming practices that minimize the impact on the environment, to prevent further issues and invest on long-term environmental benefits (fertile land, water, energy).

Sustainability

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Land degradation costs an estimated US$40 billion annually worldwide.

The consequences of land degradation are reduced land productivity, socio-economic problems, including uncertainty in food security, migration, limited development and damage to ecosystems. Degraded land is costly to reclaim and, if severely degraded, may no longer provide a range of ecosystem functions and services with a loss of the goods and many other potential environmental, social, economic and non-material benefits that are critical for society and development. [FAO, LADA Project, 2010]

If the agriculture output has to grow so much in the next decades, the only option is to make it fully sustainable, for the environment and for the economy.

The Multi-Factor Sustainable Farm

- World population increase
- Overcome undernourishment
- More proteins in the diet

Double food production
Dramatically expand agriculture output

Sustainable Farm

Land	Water	Energy	Technology
New land	Wisely use and preserve water	Save energy	Farm equipment
Defend fertile land	Desalinate seawater	Produce energy	Bio-technology
			Information & Communication

With the same land as today, there will be not “enough future”.

New land suitable for agricultural use theoretically available in the world can be estimated around 1 billion ha, of which about 90% is concentrated in Sub-Saharan Africa and Latin America.
There is virtually no spare land available for agricultural expansion in Southern Asia, the Western Asia and Northern Africa. [FAO, World Agriculture Toward 2030/2050, 2012].

A big portion of the theoretically available land will need strong efforts to be actually “put in service” and some of it will be good only for some crops.

Strong actions are required to find new land and to cultivate and preserve the fertile land already available today:

- Farm concentration and cultivation practices evolution will allow for more usable land, and the extension of irrigation systems will improve the usability of existing land for more varieties of crops.
- Conversely, soil degradation leads to the reduction of good available land, at least reducing the variety of crops that can be cultivated in the area or the crop yield. Therefore regeneration of soil fertility and maintenance of biodiversity must become common practices in future farms.
- Improving plant characteristics and increasing plant vigor will make double cropping or triple cropping possible, on the good production ground, equivalent to have more land.

Water

Only 0.003% of the planet's water, are what is called "fresh water resources", about 45 000 cubic km, water that theoretically can be used for drinking, hygiene, agriculture and industry. In fact, only about 10,000 cubic km are economically available for human use.

- Agriculture is by far the biggest user of water, accounting for almost 70 percent of all withdrawals, and up to 95 percent in developing countries.
- The water needed for crops amounts to 1 000-3 000 cubic meter per ton of cereal harvested. Put another way, it takes 1 - 3 tons of water to grown 1 kg of cereal [7].
- It appears very clear that new water management strategies are needed to guarantee future agricultural output increase.

Rain-fed land, currently about 80% of available arable land, will continue to be subject to weather variations, probably worsening with the effects of climate changes. Actions will be needed to facilitate drainage of excess water or compensate drought periods with supplemental irrigation.

Water

- ✓ For irrigated land (20% of arable land, constantly growing), freshwater availability is a very critical issue, as water used by activities other than agriculture and water pollution are increasing.
- ✓ Farms will have to use very wisely the water they have access to, limiting the water needed by specific cultivations, re-using water in closed loop systems, contributing to water purification, etc.
- ✓ The closed loop irrigation systems, with feedback from the plant health and soil conditions, will be imperative. It will help with the water usage along with plant breeding and selections for drought resistance.
- ✓ "*Farmers who switch from surface irrigation to localized irrigation can cut their water use by 30 to 60 percent*" [FAO, Water at a Glance, 2014].

Another possibility for some lands is irrigation with desalinated saltwater (saltwater is 97% of all planet's water). Desalinization requires a lot of energy, but in certain regions it may become the only alternative to regain usable land. And the energy can be derived from renewable sources at increasingly affordable costs.

"*Using and managing the world's water efficiently is everybody's business, from government officials to small-scale farmers*" [FAO, Water at a Glance, 2014].

Energy

- ✓ Energy saving has no alternative. The quantity of energy economically available to the farm will simply not be enough to support all the farm activities. And an inefficient use of energy would rapidly lead to limit the needed increase of productivity, to increase CO2 emissions, to push the demand of energy and its marginal cost.
- ✓ The search for efficiency must be continuous and smart, in all farming operations, with: energy efficient equipment, precise and very limited use of fertilizers and pesticides, accurate planting and seeding, limited tillage, very accurate field and crop mapping and monitoring. In most of the cases the use of closed-loop systems will be a must, with actions directly related to actual and specific plant conditions and needs.

The energy produced in the farm may have several positive characteristics:

- It normally comes from renewable sources (sun, wind, waste, biomass), with very low CO2 emissions
- Can be generated with limited investments (small scale plants and equipment)
- Does not require wide area distribution (local production and use)
- Can be accumulated using energy vectors (pressurized gas, biofuels)
- Energy in excess can be offered and sold to others (e.g. feeding the grid)
- Some process by-products can be used as fertilizers
- The energy production and cost is more controlled by the farm and can be balanced and optimized inside the overall farm economy
- Possible issues of energy availability from the grid are mitigated by a distributed production and sharing model.

- Not all farms can and need to produce energy; in a local area a group of farms can pool and share costs and benefits for a small-medium size energy plant.
- Energy production in the farms will require social investments on awareness, training, supporting regulations, financing tools, technology and service offering, etc.

Having seen the challenges and scale of the other factors (land, water, and energy), technology must provide a lot of "answers" to support the development of future farms.

And the technology, widely speaking, has already well demonstrated to be a key positive factor for the development of agriculture:

- ✓ Agricultural mechanization has been, and continues to be, a positive revolution in farming operations all over the world, allowing a major increase of farm productivity.

- ✓ Plant hybridization has always been a very powerful boost to farm productivity, providing continuously improved plant varieties with characteristics adapted to the demanding conditions of land, water, weather, diseases and weeds. Now genetic engineering is going beyond known limits, manipulating the DNA (genetic material) of plant cells to change hereditary traits and produce new biological products.
- ✓ Bio-chemical engineering helped developing very effective fertilizers, fungicides and pesticides, allowing for precise targeting and selective actions on land and crops.
- ✓ Biological engineering studies allow the application of improved farming techniques to optimize outputs and support higher yields.

- ✓ Information and communication technology is being driving another deep revolution in agriculture. The availability of a huge variety of data and information and the connectivity among equipment, farms and farm service providers, is unbelievably expanding farmer's ability to control their actions and processes with high precision and high automation.
- ✓ This is more than boosting again productivity, it's a big change in nature of the modern and future farms, where farm operations are totally integrated into a much wider system, including fleets of equipment, groups of farms, energy supply networks, logistic systems, info and service providers, seed and chemical suppliers, crop buyers, communities of users, finance and insurance sources, global market players.

The "**connected farm**" is becoming the new model, progressively applicable to all farms, small and big, because no future farm will have the possibility to work or even exist isolated. Also the small and family farms, including the ones in the developing countries, will find the "network" their new and necessary environment.

Path to the Future

The farm of the future will surely be new and different from today. It will be a continuous evolution, step by step, but at an increasing speed, touching all the countries and continents.

The drivers are so big and so strong that will inevitably cause a complete change in the agriculture scenario world-wide. All the necessary increase in production and productivity will not just come from better farming practices; an intimate revolutionary change will pervade agriculture and its main players, the farmers.

Of course there is not just one model, one path to the future, even if the target is clear.

Several think tanks are contributing to imagine and planning the journey.

Pathways and instruments for sustainable productivity growth in agriculture.
Source: FAO, The State of Food and Agriculture, 2014

Pathway	Types of instruments
Developing, adapting and applying new technologies and practices	• Farmer-led improvements in technologies and practices • Formal scientific research and development • Combining farmer-led improvements and formal scientific research and development
Accelerating and increasing adoption of existing technologies and practices	• Addressing economic constraints to adoption of technologies and practices • Extension and advisory services (public and private) • Promotion of innovation capacity • Individual (education, training) • Collective (including producer organizations and cooperatives) • Enabling environment for innovation (including linkages and networks)

10 Big Ideas to Boost Global Food Availability.

Source: Rabobank, The Rabobank Duisenberg Lecture, Washington, DC, 2014

A very clear recommendation to all the players, and in particular to the farmers, surfaces from these vision reports: don't wait for future issues to come, plan and act in advance, define 5-10 years plans and then execute the plans, deliver plan results and start new plans, leveraging on new awareness, new information and new technologies already available today.

Actions, to be effective, will have to be taken by farms in a united and coordinated way, not isolated.
Only collaboration, coordination, network operations will produce sensible and sustainable results.

A paradigm shift, a major change in thought-pattern will happen, with the need for the farm to re-think the use and the regeneration of its key factors: **land**, **water**, **energy**, with the help of new **technology**.

Sustainability will be necessary, not desirable.

It will be the new mission of agriculture:

feed the world, preserve the planet.