SUSTAINABLE FARMING

THE NEXT **GREEN REVOLUTION**

Spotlight Series

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SUSTAINABLE FARMING

FEEDING MANKIND AND HEALING THE PLANET REQUIRES A NEW GREEN REVOLUTION

In the Green Revolution of the 1960s and '70s, high-yield crops and agro-tech dramatically increased land productivity and food output. This time it's different: To feed a growing population and to cope with harsh environmental constraints, agriculture must increase resource productivity and sustainability. This requires a New Green Revolution.

A GLOBAL CHALLENGE

THE BIG SUCCESS OF AGRICULTURE: On average, each hectare of land produces ten times as much food energy (usable calories) than a century ago.[1] An ever-growing population can be fed sufficiently and healthily. Famines are rare – and in many parts of the world, obesity is a bigger problem than malnutrition. But that success has some heavy side effects. The contemporary way of food production is not sustainable. For the first time in human history we now spend more energy on farming then we get out of the food we harvest[1] – mainly from fossil fuels, and mostly for machinery and fertilizer production. Today, food is responsible for 26 percent of global greenhouse gas emissions. And this is just one of the ecological problems linked to conventional farming.

WATER DEPLETION

The agricultural sector consumes about 69 percent of the planet's fresh water. Without creative conservation measures in place, agricultural production consumes excessive water, degrades water quality and leads to depletion of freshwater resources. Today, 1.2 billion people live in agricultural areas with very high water shortages or scarcity.[3] Some two-thirds of global water supplies used for irrigation are drawn from underground aquifers. In many places, these reserves are becoming depleted, as current extraction rates exceed the rate of recharge.[4]

SOIL DEGRADATION

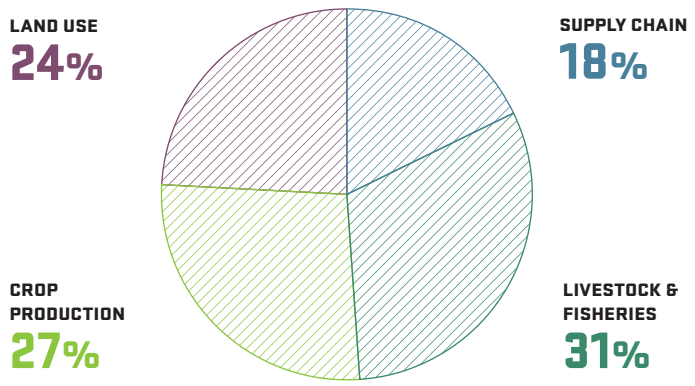
Agricultural expansion is a major driver of deforestation and other kinds of ecological destruction, decimating habitats and biodiversity. Oil palm displaces lowland forests in Indonesia, soy production damages the forests of Brazil and Paraguay. One result is extreme erosion. During the past 150 years, half of all agricultural topsoil has been lost.[5]

WASTE

The burning of agricultural residues – such as leftover vegetation from harvested crops →

Global greenhouse gas emissions from food production

Of all the greenhouse gases emitted by food production, core farming activities (livestock and crops) produce 58%. The rest results from land use (e.g. deforestation) and the supply chain (e.g. transport).



SOURCES: POORE & NEMECEK (2018)[8]. RITCHIE (2019)[2].

– releases carbon dioxide, nitrous oxide and methane. It's a traditional practice of millions of farmers around the world to burn crop residues after harvest to prepare the land for resowing the next season. This crop burning is responsible for a whopping 3.5 percent of all man-made greenhouse gas emissions – about as much as aviation and shipping combined.[6] And there's even more avoidable loss. The food wasted in all steps of production, transport, retail and consumption amounts to 25 to 30 percent of total production – another 6 percent of our GHG emissions.[7]

LOW-TECH FARMING SOLUTIONS

TO SPREAD SUSTAINABLE FARMING globally, a highly diverse solution portfolio is needed, catering for the needs of as many farmers and business models as possible. The economic range in agriculture is impressive: More than 500 million farmers work the Earth's soil, with farm sizes from 0.5 to 3,000 hectares, and business models from capital intensive agro-factories to labor-intensive subsistence production.[8] This requires solutions including everything from no-tech to ultra-hightech approaches.

FARM CONSULTANTS

Most rural areas around the world suffer a brain drain to cities and megacities. To bring innovations to the field, practical advice from farm consultants can be an efficient tool. A pioneer case was made in the United States more than a century ago. Julius Rosenwald, co-owner of mail-order company Sears Roebuck, sent farm agents around the country to teach and spread scientific farming knowledge and skills. Rosenwald saw the need to develop the competence, productivity and income (and, in the end, purchasing power) of American farmers. After almost a decade of private sector consulting, the US government took over.[9]

CROP ROTATION/POLYCULTURE

Growing a single crop at a time allows farmers increased efficiency in planting and harvesting but also increases the risk of plant diseases or soil degradation. Crop diversification and/or crop rotation techniques reduce these risks and also the amount of pesticides and chemical fertilizers required. A favorite species for crop diversification are legumes, as they fix atmospheric nitrogen into the soil that can be used by other plants, thus reducing or eliminating the need for industrial nitrogen fertilizers.

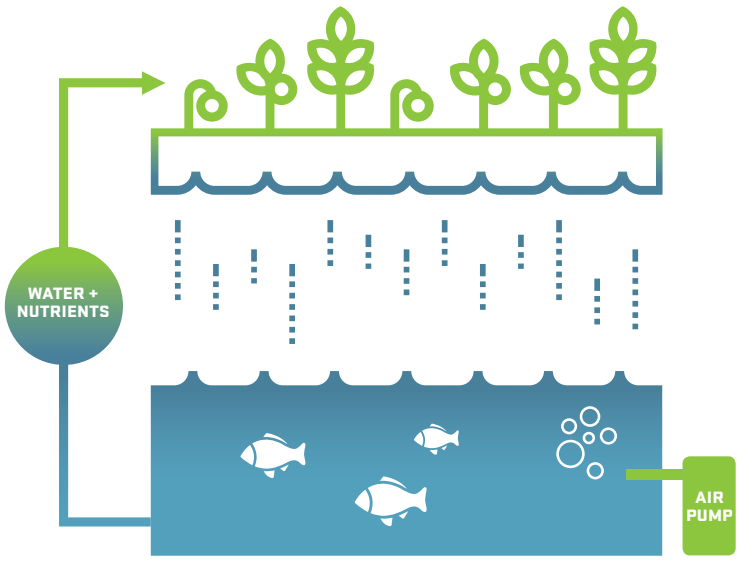
WASTE REDUCTION/RECYCLING

There are always better ways to use biomass than burning it. Crop residues can be used to produce manure or to power a biogas plant. Farm-scale or even mobile biogas plants are already available,[10] and could lead to reduced use of fossil fuels and less pollution. The reduction of food waste, however, is an issue that needs to be tackled mainly along other parts of the value chain. More than half of all wasted food gets lost or thrown away by retailers and households.[11]

AQUAPONICS

Aquaponics is a system that combines hydroponics, soilless agriculture and aquaculture within a closed system. The farmer combines the recirculating aquaculture with hydroponic vegetables – the fish water is used as fertilizer for the plants, and the plants clean the water for the fish. The result is resource-efficient, value-added local production of both fish and vegetables together, using the same water.[12]

The biological components in the aquaponic process: fish, plants and bacteria



SOURCE: WWW.FAO.ORG/BLOGS/BLUE-GROWTH-BLOG/ADVANCING-AQUAPONICS-IN-THE-CARIBBEAN/EN/

HIGH-TECH FARMING SOLUTIONS

VERTICAL FARMING

While land goes low, plants can go high. Growing crops in vertically stacked layers can optimize plant growth and reduce agricultural land use. Vertical farms can be installed in buildings, shipping containers or even underground – for example, in abandoned mine shafts. The main problems so far are high upfront investment for the building and high energy consumption for light and air conditioning. So vertical farming remains a very small niche in agriculture. The biggest producer in the UAE, Uns Farm, operates just 4,500 square meters of vertical farmland. But progress in LED technology and solar power generation will improve the competitiveness and sustainability of vertical farms.[13]

SOLAR-POWERED DESALINATION

Desalination of sea water is practiced in more than 180 countries and processes about 80 million cubic meters of water per day.[14] This is highly beneficial given the depletion of fresh water reserves and allows farming on previously non-arable land. The downside is that desalination needs at least ten times more energy than fresh water processing. This disadvantage can be avoided if the heat and power needed is generated from renewable sources. The most advanced technology to date is represented by solar-powered reverse osmosis desalination plants.[15]

NUCLEAR TECHNOLOGY FOR AGRICULTURE

The International Atomic Energy Agency (IAEA) is not usually the first institution people think of in matters of sustainable farming. But nuclear and isotopic technology (NIT) has great potential to enhance both crop and resource productivity.[18] With the help of nuclear techniques, scientists can measure the amount of fertilizer that plants take up and provide farmers with the optimal amount. A coordinated research project that the IAEA has been running since 2014 in cooperation with the Food and Agriculture Organization of the United Nations showed emission reductions of over 50 percent through implementing nuclear technology.[19] In Burundi, NIT helped triple the yield of cassava, a root vegetable that is the third-largest source of carbohydrates worldwide.[20] ←

"There is no silver bullet to address the problem of sustainability in agriculture. We need to combine all of the best practices."[18]

Novel food: Eating more sustainably

PLANT-BASED MEAT

Veggie burgers and the like reduce cattle breeding and greenhouse gas emissions. Their production requires far less energy per each calorie consumed.

3D FOOD PRINTING

Synthesizing food via a 3D printer can customize a diet for individual needs and reduces food waste on the consumer level to almost zero.

MICROBIAL PROTEIN

Some bacteria are fast and highly efficient producers of protein that can be used as a resource-saving ingredient for animal feed or human food products.

INSECT MEAT

Already commonly used in parts of Africa and Asia, insects such as crickets or mealworms are highly nutritious. Insect farming needs much less land, water and energy than traditional meat production.

WHAT CAN YOU DO?

THE TWIN PROBLEM of food insecurity and mitigating the negative impacts of climate change on our natural resources and on human health and nutrition could be addressed if we develop and adopt climate smart agricultural (CSA) practices. These include both management strategies and specific technologies that enhance crop productivity, environmental sustainability and conservation in agroecosystems.[18] ←

What can be done by decision-makers on the global, national and local level?

Focus on rural development
Farming takes place in the countryside. Most farmers live in sparsely populated areas, in small villages or isolated farmsteads. That's not where the action is, not where the elites, the creative classes and the governments are – that's not where development plans focus. But that is where the Next Green Revolution will happen: in the backwaters. To make it happen, rural areas will need a minimum of social services (like healthcare and education) and information about and access to farming innovation and technologies.

Global technologies, local adaptation
The Green Revolution of the 20th century was all about one-size-fits-all solutions. Some newly developed cultivars of maize, wheat and rice were deployed all over the world. The adaptation to the specific local situation was reached by varying the amount of fertilizers and pesticides used. The Green Revolution of the 21st century, in contrast, will show much more diversity. Sure, there will (and should) be scientific breakthroughs that can improve farming conditions everywhere. But at the same time there will (and should) be countless local adaptations: Optimizing teff for Ethiopia and cassava for Burundi, developing AI-assisted harvesting for the United States, customizing seeds for local soils and microclimates, and many others.

Combination of best practices
Sustainable agricultural development would require the combined use of soil, nutrient and water management strategies that enhance crop productivity and at the same time promote environmental sustainability. There is no single silver bullet to reach that target. Instead, we need to combine all the best practices for soil, nutrients and water, along with the selection of improved crop varieties.[18]

Close cooperation of key stakeholders
Climate smart agricultural practices promise a multiple-win situation: enhancing soil fertility, sequestering more carbon, increasing the resilience of soil against land degradation processes and climate change, conserving more nutrients and water, increasing crop productivity, and improving the livelihood of farmers.[18] The success of this approach, however, relies on close cooperation and coordination among researchers, NGOs, members of civil society, decision-makers and farmers. This requires partnerships among key stakeholders, including national, regional and international institutions.

Prospects and targets

15 GIGATONS/YEAR
Likely greenhouse gas emissions by the global agricultural sector in 2050, as predicted by the baseline scenario of the World Resources Institute.[17]
+20% of today's level

4 GIGATONS/YEAR
What greenhouse gas emissions by the agricultural sector should be by 2050 to be in line with the global warming target of 2°C.
-70% of today's level

0 GIGATONS/YEAR
What greenhouse gas emissions by the agricultural sector should be by 2050 to be in line with the global warming target of 1.5°C.
-100% of today's level

"Governments may want to consider policies that combine food and energy security to meet sustainable development objectives."[4]

ABOUT FII INSTITUTE

THE FUTUREINVESTMENTINITIATIVE (FII) INSTITUTE is a new global nonprofit foundation with an investment arm and one agenda: Impact on Humanity. Global, inclusive and committed to Environmental, Social and Governance (ESG) principles, we foster great minds from around the world and turn ideas into real-world solutions in five critical areas: Artificial Intelligence (AI) and Robotics, Education, Healthcare and Sustainability. We are in the right place at the right time: when decision makers, investors and an engaged generation of youth come together in aspiration, energized and ready for change. We harness that energy into three pillars: THINK, XCHANGE, ACT. Our THINK pillar empowers the world's brightest minds to identify technological solutions to the most pressing issues facing humanity. Our XCHANGE pillar builds inclusive platforms for international dialogue, knowledge sharing and partnership. Our ACT pillar curates and invest directly in the technologies of the future to secure sustainable real-world solutions. Join us to own, co-create and actualize a brighter, more sustainable future for humanity.

This paper is part of our Sustainability Series, where the Institute's approach to addressing issues within this field emanates from our focus on SDG 13, SDG 14 and SDG 15. To drive results, the FII Institute's attention will initially focus on ecosystem preservation in both land and sea capacities, before moving onto sustainable marine and land exploitation and carbon-capture solutions in 2022. We will tackle this in a sequential manner, in which inhibitors to progress are identified, potential solutions are mapped out, and organizations and individuals to partner with are approached.

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