CGIAR Research Programs- Present & Future

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Chief Science Officer, CGIAR
31st May 2016

Defining & tackling global challenges: different ways of working & step changes

~9 Billion People / 1 Planet

Daunting challenges - impressive opportunities:

- The ***life science revolution*** is changing our understanding of the fundamental biology of plants, animals and people. It is transforming agriculture.
- ***Information revolution*** approaches are critically transforming the retail end of food value chains- ***radical transparency***.
- ***Investment opportunities-*** private and financial sectors aware of need to mitigate risk and build resilience into food systems.
- ***A new global development agenda***, with national commitments & indicators/targets
- Renewed policy focus on the central role of the ***Bio-economy*** in the broader sense


Science
11 April 2014 | $10
Killing Fields
Medical mystery in Central America
AAAS


A suicide spurs a bioethicist's crusade p. 793
Coral responses to climate change pp. 798 & 806
Simulation of a black hole evaporating pp. 806 & 883
Science
$10
23 MAY 2014
AAAS
Haves and have-nots
The science of inequality p. 818


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India
Science for All
AAAS


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DISEASE PREVENTION
AAAS


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How Rice Farming Has Shaped Psychology
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Horse hunters of ancient Germany
Tracing the impact that made the Moon
Ruminating on the sheep genome
Science
AAAS
Rethinking the global supply chain
Smarter, cheaper, greener ways to deliver the world's goods p. 1100


Science
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What is CGIAR?

CGIAR is the only worldwide research partnership addressing agricultural research for development, whose work contributes to the global efforts to tackle poverty, food and nutrition insecurity, and environmental degradation.

CGIAR Research Centers

CGIAR research is carried out by the 15 Centers, members of the CGIAR Consortium, in close collaboration with hundreds of partners, including national and regional research institutes, civil society organizations, academia, development organizations and the private sector.

CENTERS

1. AfricaRice
2. Bioversity International
3. Center for International Forestry Research (CIFOR)
4. International Center for Agricultural Research in the Dry Areas (ICARDA)
5. International Center for Tropical Agriculture (CIAT)
6. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
7. International Food Policy Research Institute (IFPRI)
8. International Institute of Tropical Agriculture (IITA)
9. International Livestock Research Institute (ILRI)
10. International Maize and Wheat Improvement Center (CIMMYT)
11. International Potato Center (CIP)
12. International Rice Research Institute (IRRI)
13. International Water Management Institute (IWMI)
14. World Agroforestry Centre (ICRAF)
15. WorldFish

CGIAR Research Programs (1st round of CRPs, 2011-2016)

Aquatic Agricultural Systems (AAS)

Agriculture for Nutrition and Health (A4NH)

Climate Change, Agriculture and Food Security (CCAFS)

Dryland Cereals

Dryland Systems

Forests, Trees and Agroforestry (FTA)

The Global Rice Science Partnership (GRiSP)

Grain Legumes

Integrated Systems for the Humid Tropics (Humidtropics)

Livestock and Fish

Managing and Sustaining Crop Collections (Genebanks)

Maize

Policies, Institutions and Markets (PIM)

Roots, Tubers and Bananas (RTB)

Water, Land and Ecosystems (WLE)

Wheat

New CGIAR technologies & public goods already in the field:

- ***Scuba rice***, which can survive under water for two weeks, is protecting the harvests, incomes, and food security more than 5 million farmers in Asia.

- New high-yielding, and more nutritious – ***biofortified - varieties*** of foods such as maize, cassava, beans, pearl millet, rice, beans and orange sweet potato are targeted to reach 50 million consumers by 2018.

- ***AFLASAFE*** reduces aflatoxin contamination in African farmers fields by up to 90% - a product that has 4 atoxigenic strains of the fungus developed by CGIAR with USDA.

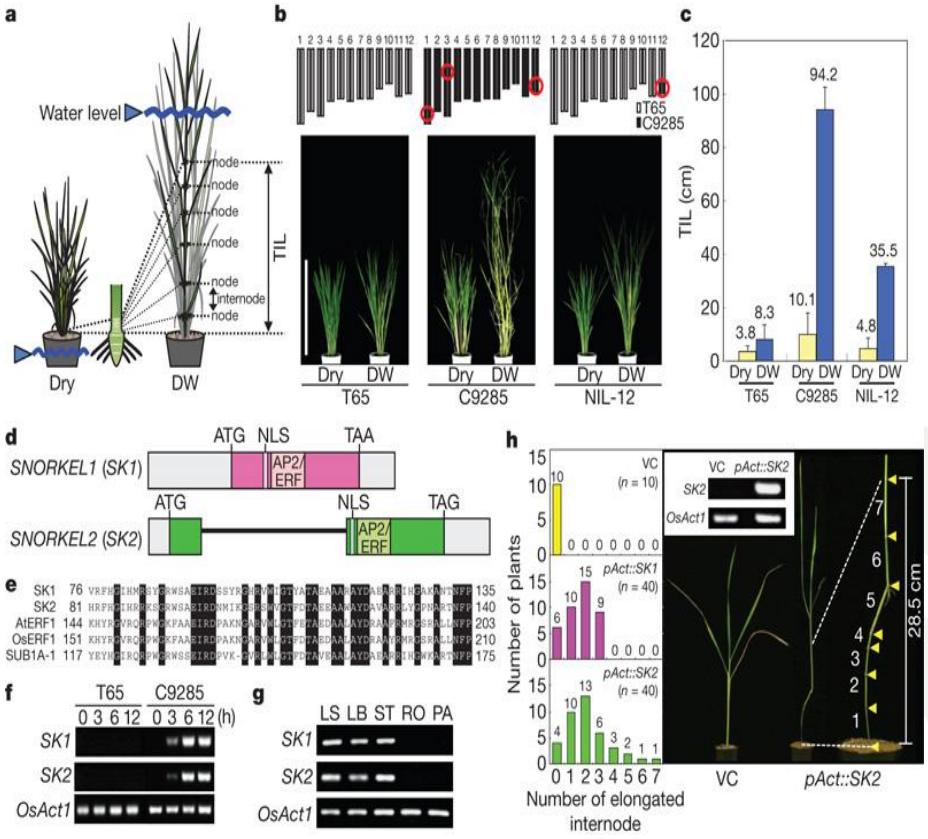
- Index-based crop and livestock ***drought insurance*** and seasonal weather forecasts now benefit millions of poor rural households in Africa and Asia.

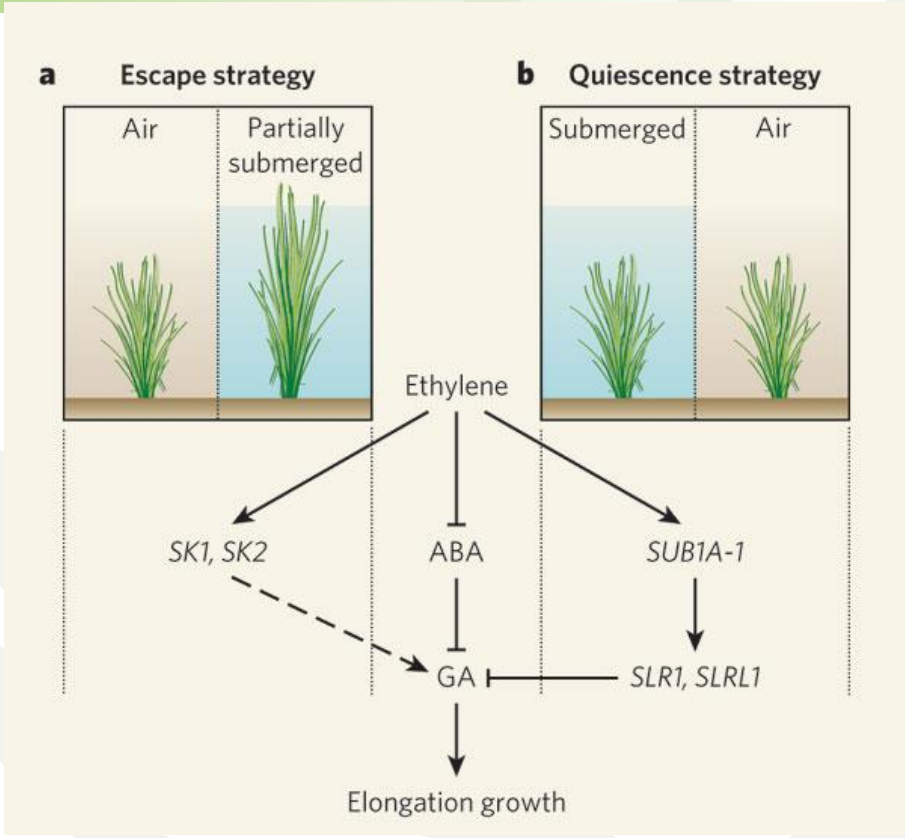
- ***Wheat stem rust -Ug99- resistant varieties*** have been made available, preventing disaster at a scale affecting many millions of people. ***Maize lethal necrosis resistant varieties*** have been developed through rapid cycling (4 years).

- ***Agroforestry:*** unfertilized maize yields under Faidherbia trees average **4.1** tonnes per hectare, compared to **1.3** tonnes; in Niger, more than 1.2 million households have regenerated 200 million fertilizer trees on their sorghum and millet fields across 5 million hectares.

- **Brachiaria forages** with Biological Nitrification Inhibition capacity have reduced greenhouse gas emissions and improved nitrogen efficiency on 500 thousand hectares.

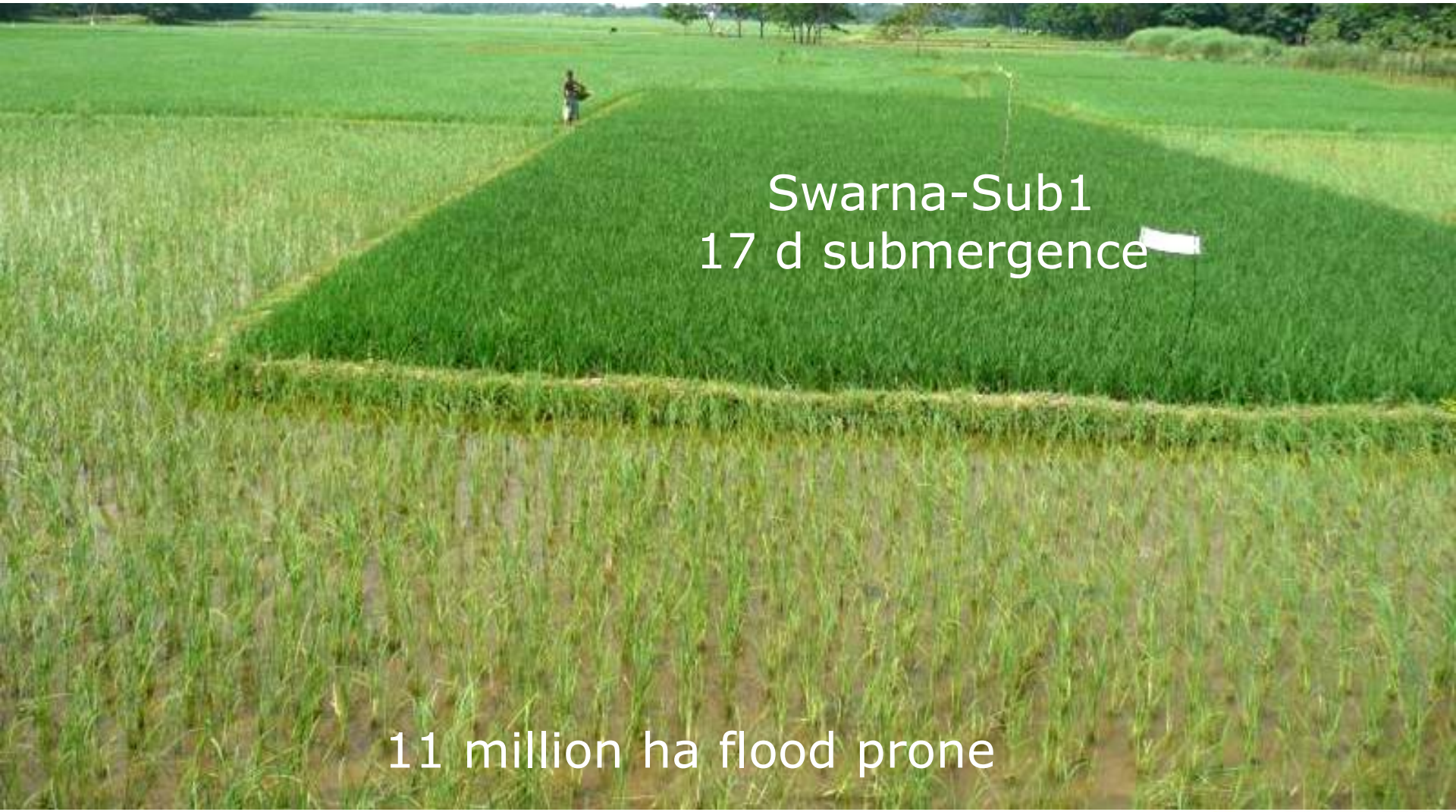
Identification of genes responsible for deepwater response in rice.





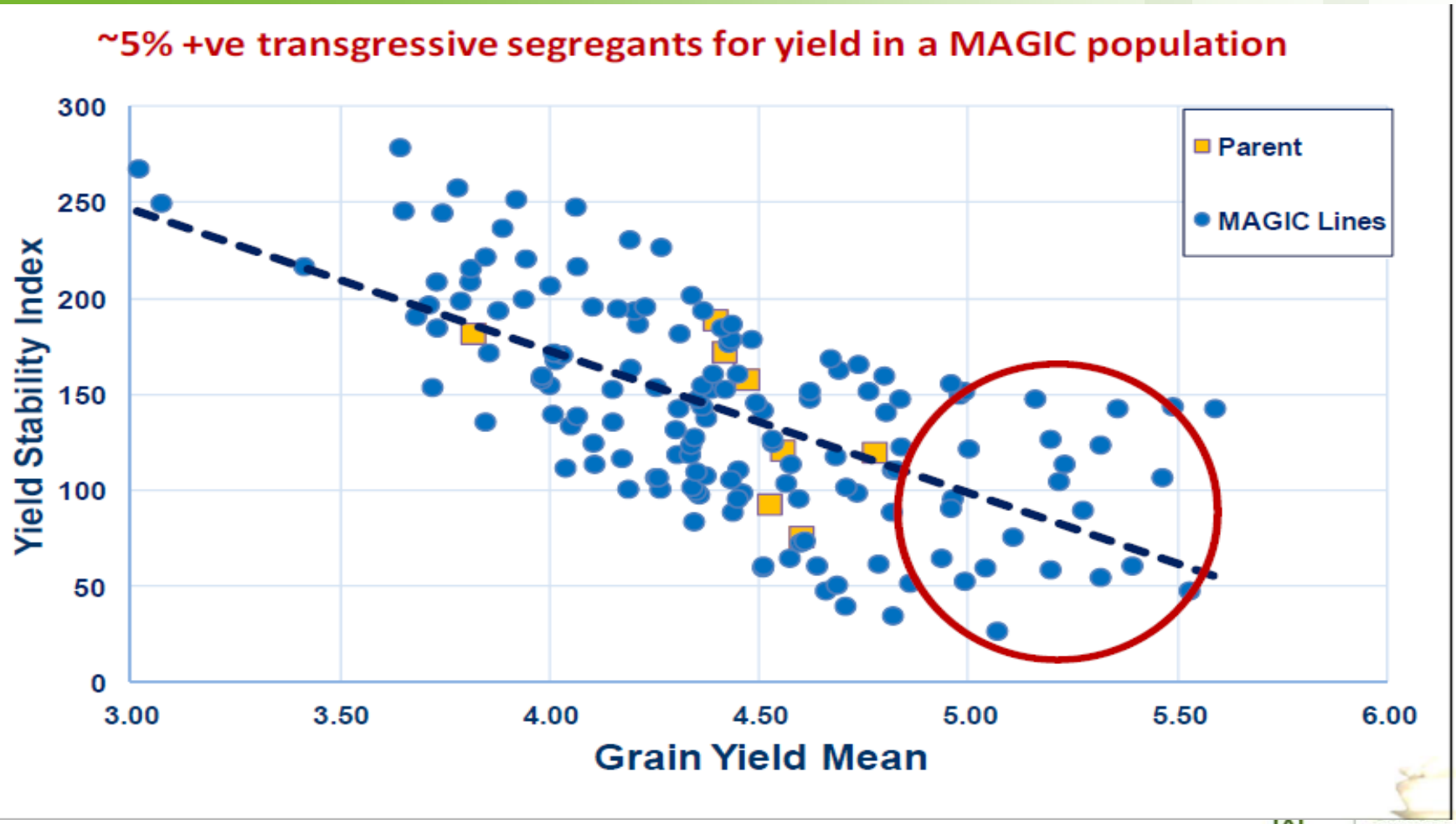
Y Hattori *et al.* *Nature* **460**, 1026-1030 (2009)
doi:10.1038/nature08258

Submergence-tolerant rice



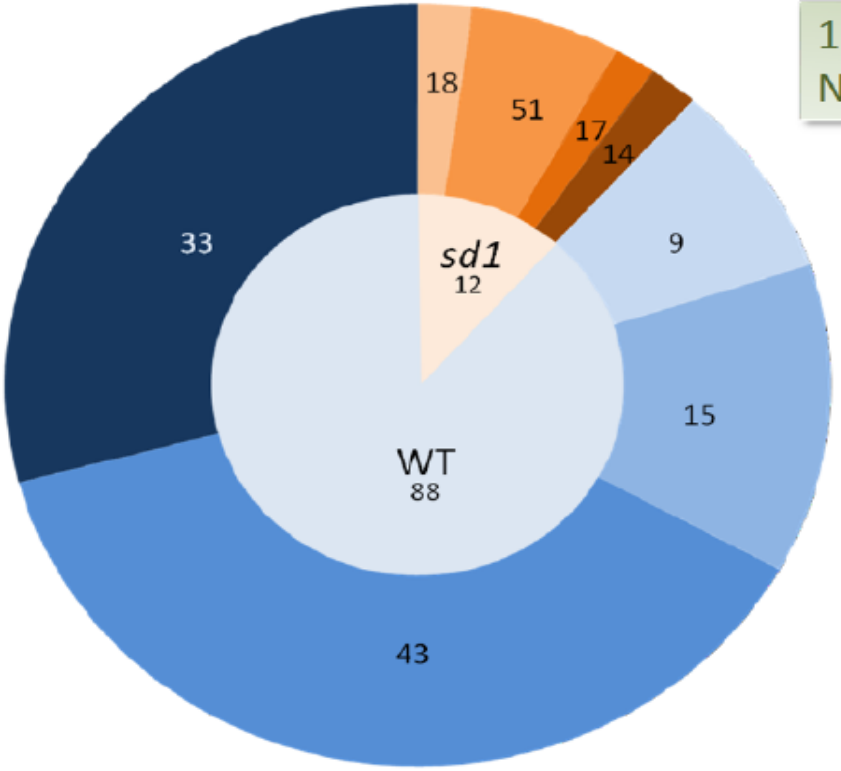
Technology-risk mitigation-social sciences

Rice MAGIC Populations and alleles determining transgressive segregation



Digital recombination

- **Breaking the linkage between semi-dwarf stature and susceptibility to drought**



1K genome analysis revealed
New genotypes: dwarf & tolerant due to;

- *sd1*/short/ QTL$^+$ — New alleles (18%)
- *sd1*/short/ QTL$^-$
- *sd1*/tall/ QTL$^+$
- *sd1*/tall/ QTL$^-$
- WT/short/ QTL$^+$ — New genes (9%)
- WT/short/ QTL$^-$
- WT/tall/ QTL$^+$
- WT/tall/ QTL$^-$

Source: Kohli

Beans staple diet for 0.5 billion people

http://www.bbc.com/news/science-environment-32039991

Vintage traits, Tempary bean & heat tolerance. (CIAT)

Global Stewardship of Plant Genetic Resources-Grand Societal Challenge

International Treaty on Plant Genetic Resources for Food and Agriculture

The CGIAR provides 94% of all germplasm distributed as part of the ITPGRA

The “second generation” CGIAR Strategy 2016–2030:

- Guides the development and implementation of an ambitious portfolio of “second-generation” CGIAR Research Programs (CRPs)
- Focuses on selected grand challenges, and is articulated in 3 strategic goals, or System Level Outcomes (SLOs), which by 2030 will contribute significantly to the achievement of key Sustainable Development Goals (SDGs)
- Highlights a return on investment evaluated at US$17 for every US$1 put into CGIAR over its lifetime

Nourishing the world's cities

Global food security will become primarily an urban challenge in the future. However, the current international food security agenda is mostly rural-oriented and still focuses more on food availability than on food access and nutrition.

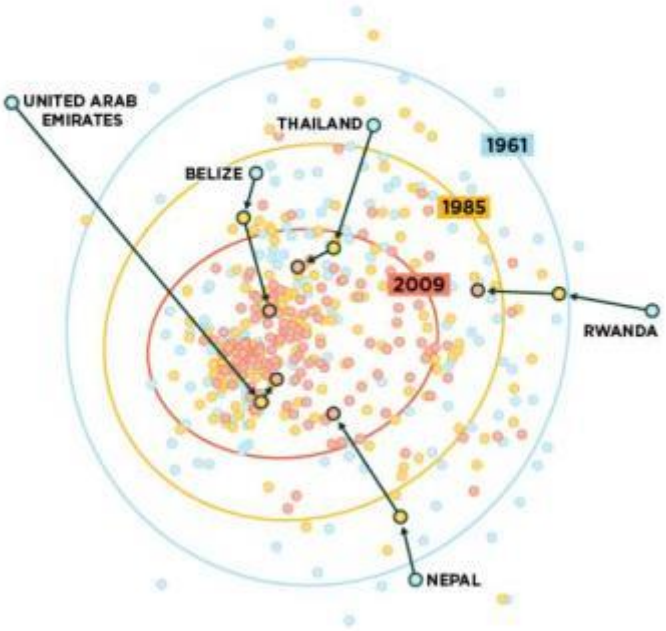
- Food deserts
- *Urban* food security indicators
- Informal economy
- Rural-urban linkages

Convergence of global diets & a need for diet diversity

A study of the world's countries finds that over the last 50 years, diets have become ever more similar.

Each country's food supply composition in contribution to calories in:

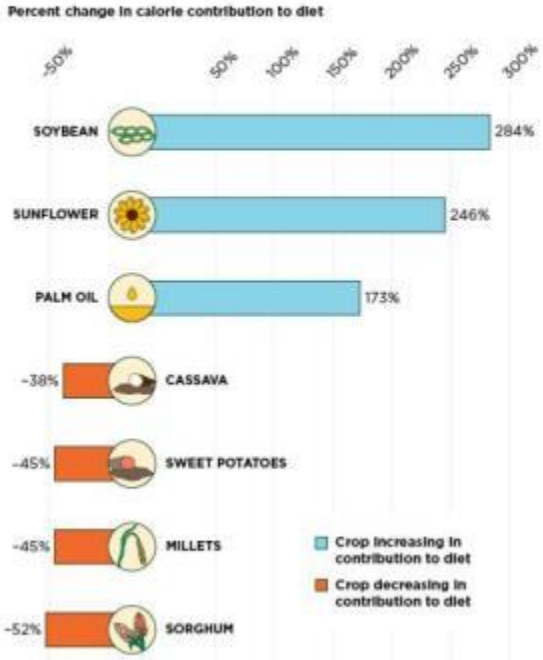
1961 1985 2009



Source: Khoury et al. 2014. Proc. Natl. Acad. Sci. USA.

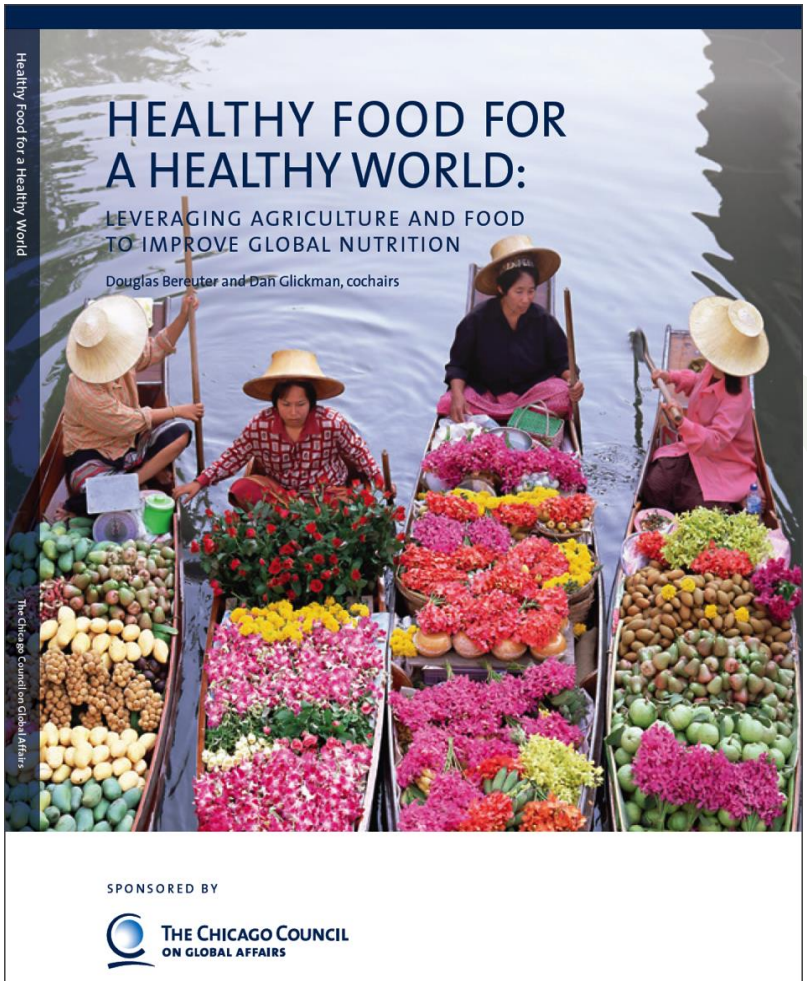
Over the last 50 years, the global diet has shifted dramatically, including greater amounts of major oil crops and lesser quantities of regionally important staples.

Average change in the calories from crops in national diets worldwide, 1961–2009



Source: Khoury et al. 2014. Proc. Natl. Acad. Sci. USA.

Healthy diets from sustainable food systems



CrossMark

Production diversity and dietary diversity in smallholder farm households

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Edited by B. L. Turner, Arizona State University, Tempe, AZ, and approved July 15, 2015 (received for review June 4, 2015)

Undernutrition and micronutrient malnutrition remain problems of significant magnitude in large parts of the developing world. Improved nutrition requires not only better access to food for poor population segments, but also higher dietary quality and diversity. Because many of the poor and undernourished people are smallholder farmers, diversifying production on these smallholder farms is widely perceived as a useful approach to improve dietary diversity. However, empirical evidence on the link between production and consumption diversity is scarce. Here, this issue is addressed with household-level data from Indonesia, Kenya, Ethiopia, and Malawi. Regression models show that on-farm production diversity is positively associated with dietary diversity in some situations, but not in all. When production diversity is already high, the association is not significant or even turns negative, because of foregone income benefits from specialization. Analysis of other factors reveals that market access has positive effects on dietary diversity, which are larger than those of increased production diversity. Market transactions also tend to reduce the role of farm diversity for household nutrition. These results suggest that increasing on-farm diversity is not always the most effective way to improve dietary diversity in smallholder households and should not be considered a goal in itself. Additional research is needed to better understand how agriculture and food systems can be made more nutrition-sensitive in particular situations.

nutrition-sensitive food systems | small-scale farmers | food security | Africa | Asia

Hunger and malnutrition are complex global problems. Despite improvements in food and nutrition security over the last few decades, the prevalence of undernutrition remains high, especially in Africa and Asia (1–3). Close to 800 million people are still classified as chronically hungry, meaning that they do not have sufficient access to calories (4). An estimated 2 billion people suffer from micronutrient malnutrition, mostly due to low intakes of vitamins and minerals such as iron and zinc (3). Nutritional deficiencies are responsible for a large health burden in terms of lost productivity, impaired physical and mental human development, susceptibility to various diseases, and premature deaths (5). Nutritional deficiencies are not only the result of low food quantities consumed, but also of poor dietary quality and diversity. In fact, the level of dietary diversity was shown to be a good indicator of people's broader nutritional status in many situations (6–12). More diverse diets tend to be associated also with lower rates of overweight and obesity—other nutritional problems of rising magnitude in many parts of the world (13). Increasing dietary diversity is therefore an important strategy to improve nutrition and health. This implies that agricultural production also needs to be diversified, so that a wide range of different types of foods are available and accessible also to poor population segments (14). Over the last 50 y, agricultural modernization has contributed to narrowing global production patterns with a focus on a limited number of major crop plants (15).

In Africa and Asia, the majority of the undernourished people live in rural areas. Many of them are smallholder farmers (16). Against this background, further diversifying production on these smallholder farms is often perceived as a useful approach to improve dietary diversity and nutrition (17–20). Several recent development initiatives have promoted smallholder diversification through introducing additional crop and livestock species with the intention to improve household nutrition (21, 22). Because farm diversity can help to increase agrobiodiversity too, this approach is also welcome from environmental perspectives (21, 23, 24). But is there really such a clear link between production diversity on the farm and consumption diversity in the farm household? What are other factors that influence this relationship and dietary diversity in smallholder farm households more generally? These are under-researched questions of relevance for improving agriculture and nutrition in the small-farm sector (25, 26). Here, we address these questions empirically with data from several developing countries.

A positive relationship between farm production diversity and dietary diversity is plausible, because much of what smallholder farmers produce is consumed at home (27). However, assuming that all smallholders are pure subsistence farmers and do not sell and buy any food is too simplistic. Taking into account market transactions, the relationship between production diversity and dietary diversity becomes more complex. Instead of producing everything at home, households can buy food diversity in the market when they generate sufficient income (17). Farm diversification may contribute to income growth and stability up to a certain point, but beyond that point further diversification may reduce household income due to foregone benefits from specialization (28). Because lower household incomes tend to be associated with lower dietary quality, the relationship between production and consumption diversity may even turn negative in some situations. Beyond farming, the majority of smallholder households in developing countries also have off-farm income sources (29), further adding to the complexity. When relying on markets, nutrition effects in farm households will also depend on how well the markets function and

Significance

Given that hunger and malnutrition are still widespread problems in many developing countries, the question of how to make agriculture and food systems more nutrition-sensitive is of high relevance for research and policy. Many of the undernourished people in Africa and Asia are smallholder subsistence farmers. Diversifying production on these farms is often perceived as a promising strategy to improve dietary quality and diversity. This hypothesis is tested with data from smallholder farm households in Indonesia, Kenya, Ethiopia, and Malawi. Higher farm production diversity significantly contributes to dietary diversity in some situations, but not in all. Improving small farmers' access to markets seems to be a more effective strategy to improve nutrition than promoting production diversity on subsistence farms.

Author contributions: K.T.S., V.V.K., and M.Q. designed research; K.T.S. analyzed data; and K.T.S., V.V.K., and M.Q. wrote the paper.

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AGRICULTURAL SCIENCES

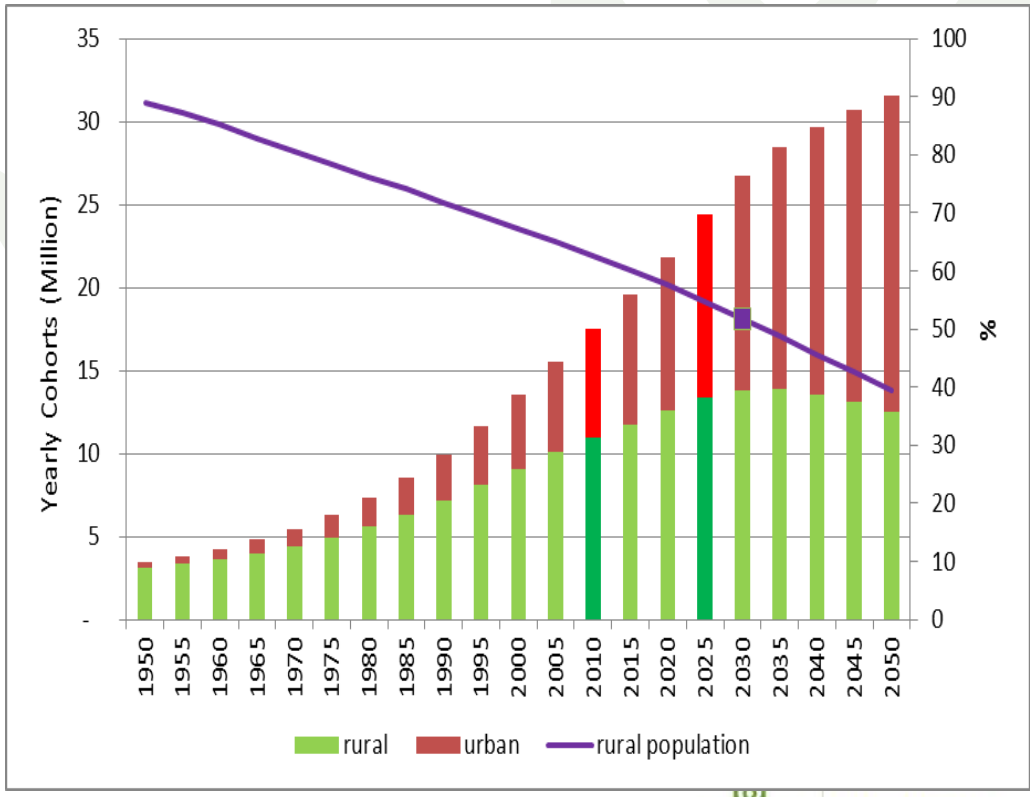
SUSTAINABILITY SCIENCE

Youth & Gender in the context of Research

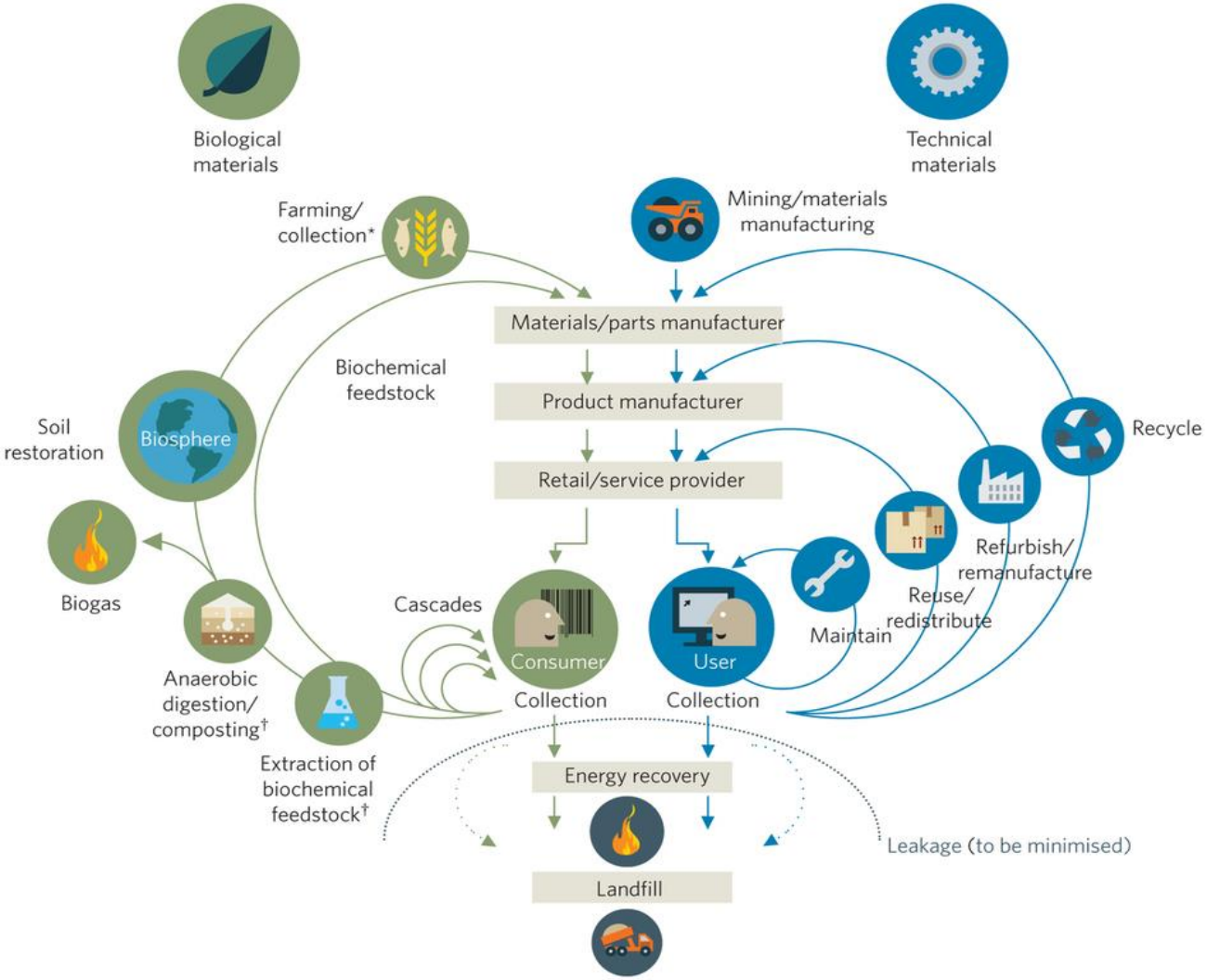
Youth and agriculture:

KEY CHALLENGES AND CONCRETE SOLUTIONS

Youth employment in agriculture especially relevant in Africa south of the Sahara

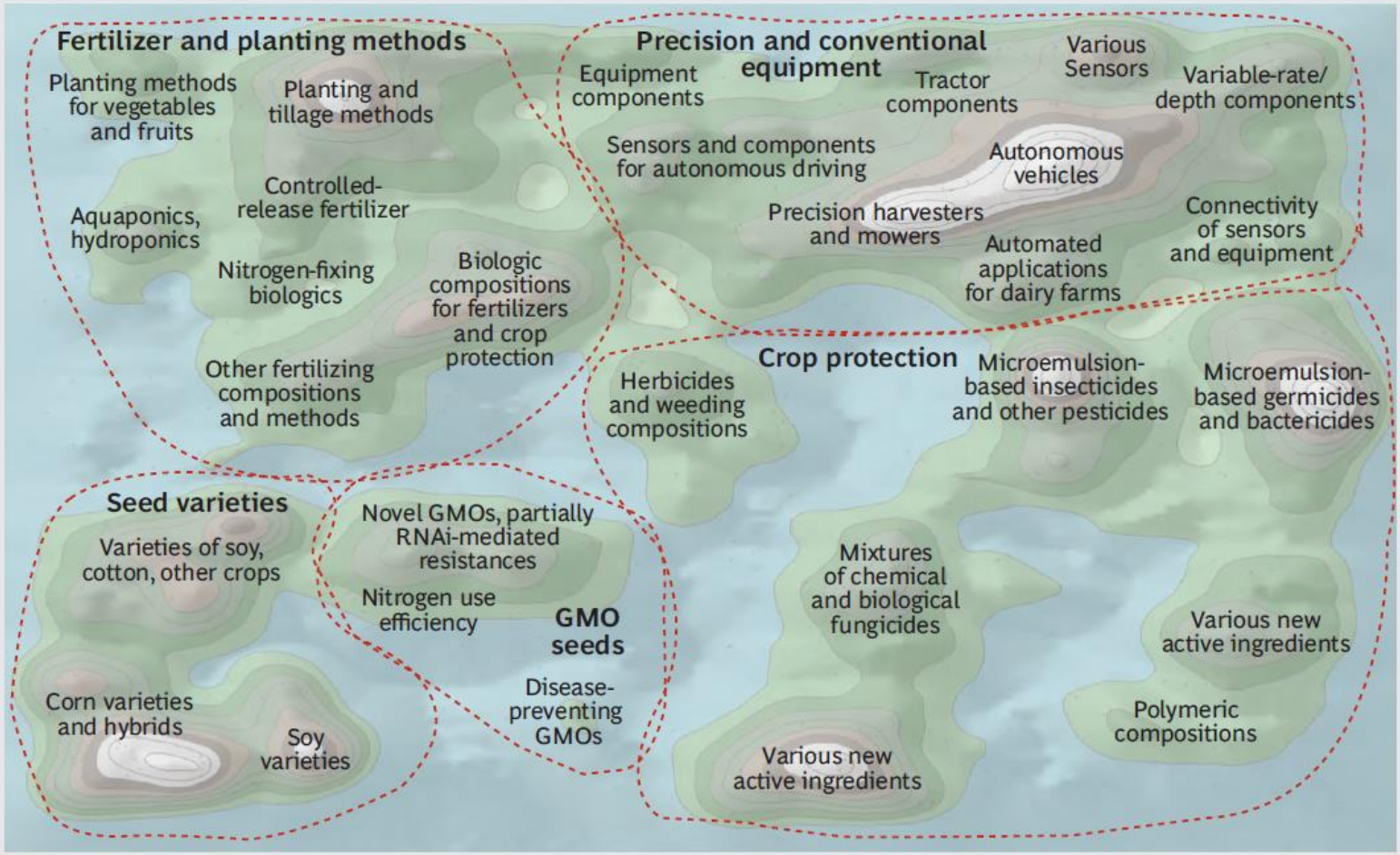


Boosting the Circular Bio-economy



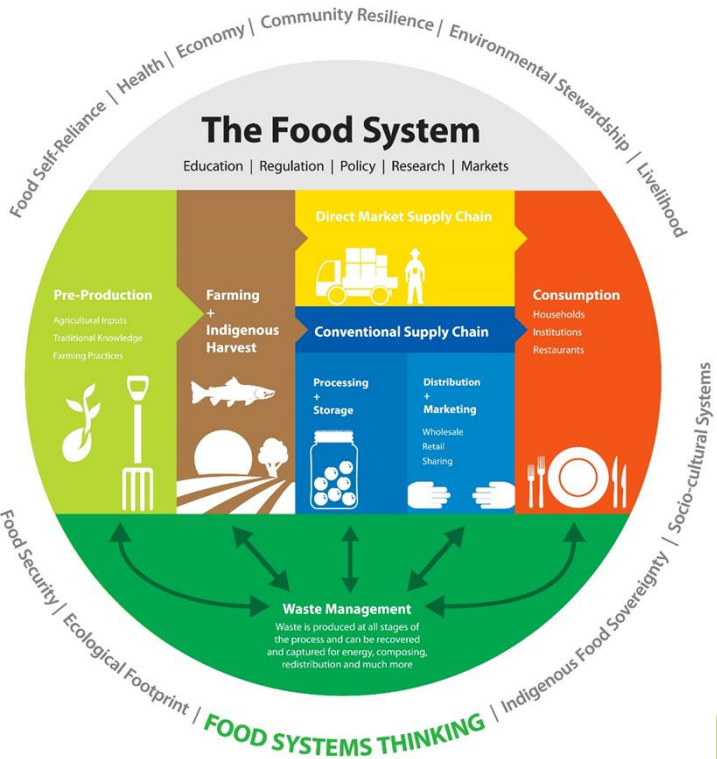
Private sector engagement

EXHIBIT 4 | Agriculture Patents Registered Worldwide from 2010 Through 2014



Sources: Thomson Innovation; BCG analysis.
Note: Analysis based on approximately 16,000 Derwent World Patents Index patent families registered from 2010 through 2014.

The CGIAR Portfolio 2017+



8 Agri-Food System programs

- Dryland Cereals and Legumes systems
- Fish agri-food systems
- Forests and Agroforestry landscapes
- Livestock agri-food systems
- Maize agri-food systems
- Rice agri-food systems
- Roots, tubers and bananas agri-food systems
- Wheat agri-food systems

Nutrition and Health

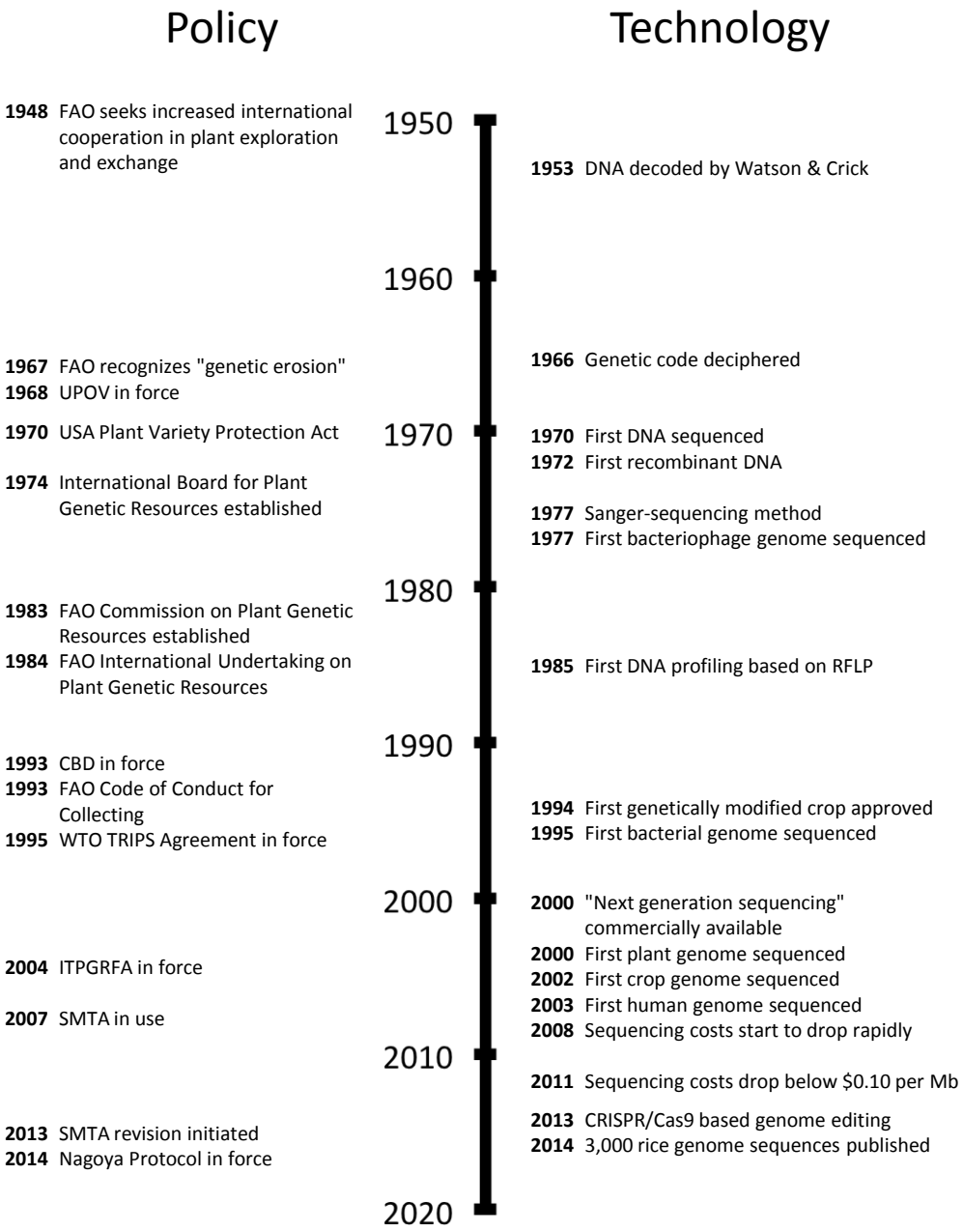
Policy, Institutions and Markets

Water, Land and Ecosystems

Climate Change

3 Platforms

Genebanks	Genetic Gains	Big data & ICT



Disconnect between Policy Genetic Resources and Technology Development

Disruptive technologies: Genome editing

GE is the process of precise editing genome

Nucleotides can be

- added
- deleted
- replaced

Pigs edited to protect them against African Swine Fever- Roslin Edinburgh

New tools allow us to look in new places for sources of variation – including wildlife

"traditional" linkage mapping requires crosses – so initial discovery is limited to variants within a species

```
Cow NDama   KFITRRPSLKTLQEKGLIKDQIFGSPLHTLCEREKSTVPRFVKQCIEAVEK
Cow Boran   KFITRRPSLKTLQEKGLIKDQIFGSHLHTLCEREKSTVPRFVKQCIEAVEK
Human       KFISRRPSLKTLQEKGLIKDQIFGSHLHTVCEREHSTVPWFVKQCIEAVEK
Pig         KFITRRPSLKTLQEKGLIKDQIFGSHLHTVCERENSTVPRFVKQCIEAVEK
Chicken     KFISRRPSLKTLQEKGLIKDQIFGSHLHLVCEHENSTVPQFVRQCIKAVER
Salmon      KFISRRPSMKTLQEKGIIKDRVFGCHLLALCEREGTTVPKFVRQCVEAVEK
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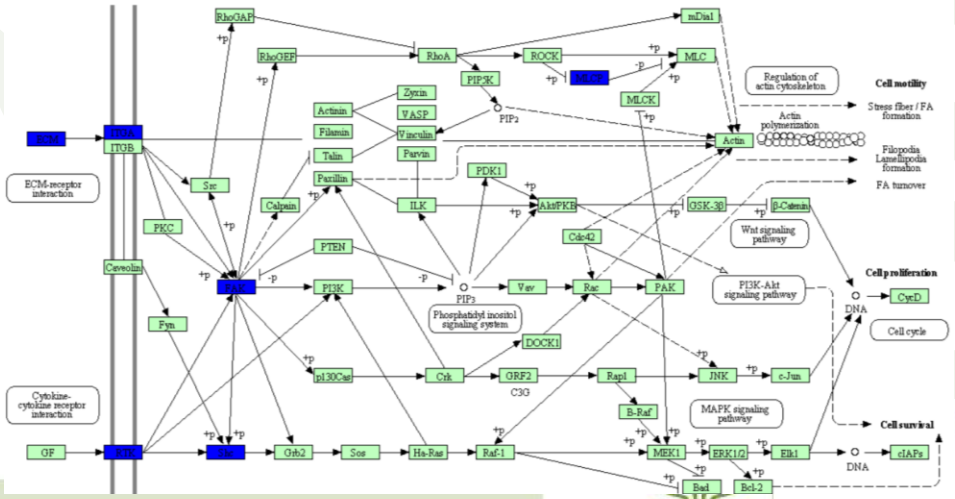
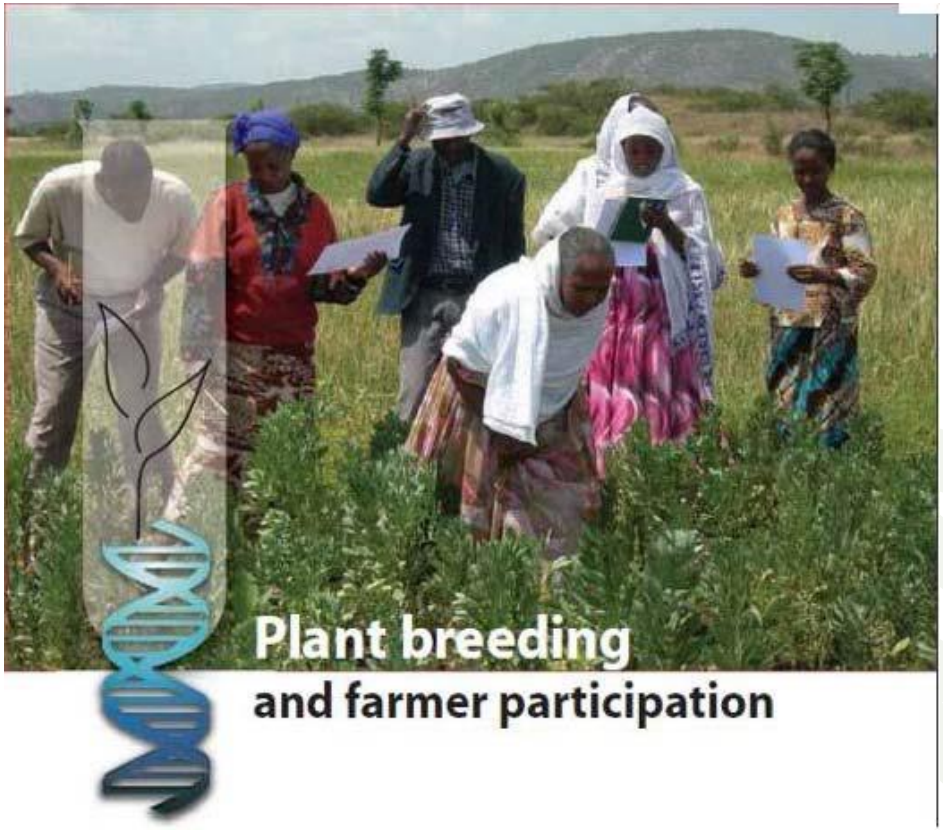
Comparative gene network and sequence analysis allows to ask new kinds of questions about genomes – eg *"what is different about this (group of) species compared to all other mammals"*



Genomic selection, editing & new population development

- 

Integration of modern Genetics, Data and NRM/Agronomy & Participatory approaches.
Compatible with mixed farming systems

Our Donors/Investors

Thanks to our donors, CGIAR research has **transformed the lives of hundreds of millions of people** through tangible research outcomes.

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Turkey
United Kingdom
United States of America
World Bank

Thank you

CGIAR is a global research partnership for a food-secure future

For more information about the CGIAR Strategy and Results Framework, visit **www.cgiar.org/our-strategy**

www.cgiar.org

SRUC

Our Vision

Leading innovation and sustainable development in agriculture, land and the rural sector.