THE OHIO STATE UNIVERSITY

A perspective of science in the context of climate change emergency

A Perspective of Science in the Context of Climate Change

CFAES Rattan Lal Center for Carbon Management and Sequestration, OSU, Columbus, OH 43210 USA

IICA Chair in Soil Science, and Goodwill Ambassador for Sustainable Development Issues, San Jose, Costa Rica

G20 Meeting in Brazilia,Brazil,15th May 2024

FLOODS IN RIO GRADE:TWO SIDES OF THE SAME COIN

https://scroll.in/article/918797/more-than-40-of-india-is-reeling-under-drought-but-the-centre-may-not-even-acknowledge-it

https://www.indiatoday.in/india/story/over-2-100-dead-in-monsoon-rains-floods-across-india-1607709-2019-10-09

THE RESOURCES USED FOR AGRICULTURE

- 38% of the Earth's terrestrial surface (5 B ha) is used for agriculture,
- 75% of agricultural land (3.75 Bha) is allocated to raising animals,
- 70% of the global freshwater withdrawals (3,150 Km^3) are used for irrigation,
- 30-35% of global greenhouse gas emissions are contributed by agriculture,

And yet 1 in 8 persons is food-insecure and 2-3 in 8 are malnourished.

Transformation of Food Systems

Food systems and production agriculture must be solution to global warming and other environmental issues while advancing food and nutritional security and SDGs of the Agenda 2030 of the UN.

21ST CENTURY'S GREEN REVOLUTION

Rather than input-based (variety, fertilizers, irrigation), the GR of the 21st century must be:

(i) Soil-based : Soil resilience

(ii) Ecosystem-based : Eco-Efficiency

(iii) Knowledge-based : Science & Management-driven

SOIL HEALTH

Soil's capacity, as a dynamic and biologically active entity, to sustain multiple ecosystems services for human wellbeing and nature conservancy by eco-intensification.

Lal (2016)

MEETING FOOD DEMAND BY 2050

The world produces enough food to feed 10 billion peop… food and nutritional security must be achieved by:

- **Reducing** waste (30-50%),
- **Increasing** access to food by addre… wars and political instability,
- **Improving** distributio…
- **Increasing** u… ased diet,
- **Acc**… bility of not taking things for granted,

…nomic productivity from existing land, restoring …lands, enhancing BNF by legumes and converting some …ultural land for nature conservancy without any conversion of natural land to agro-ecosystems, through **Eco- intensification**

No additional appropriation of land and water to agriculture

ECO- INTENSIFICATION

The strategy is to produce more food:

Save Land, Water & NR for Nature

- from less land,
- per drop of water,
- per unit input of fertilizers and pesticides,
- per unit of energy, and
- per unit of C emission.

NO-TILL FARMING AS AN EMERGING GLOBAL TECHNOLOGY(IITA,1971)

30 year maize trial at CIMMYT in Texcoco, Mexico

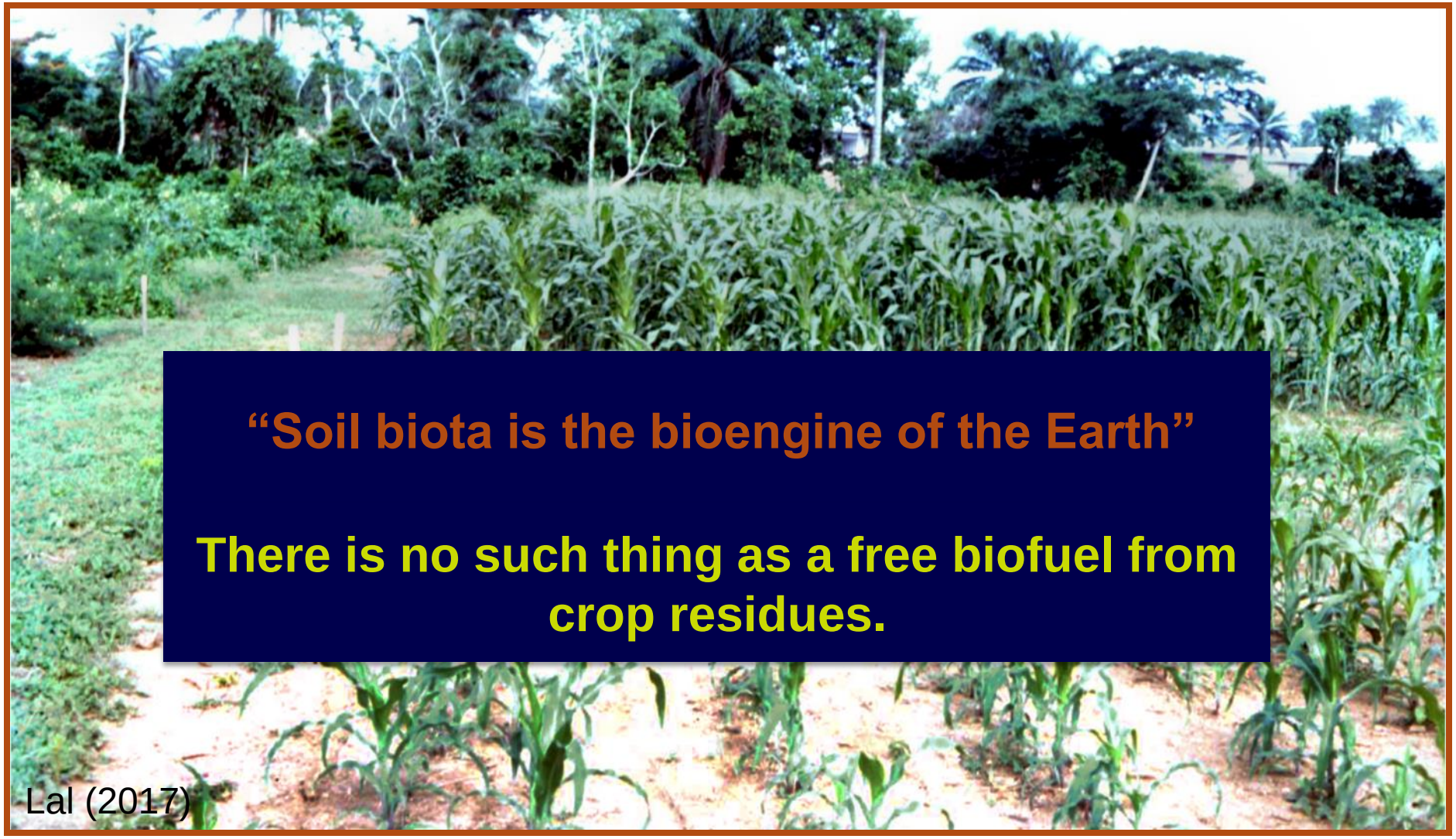
Explanation: crop residues + increased soil organic matter increased soil water infiltration & storage (both were fertilized).

DROUGHT OF 2012

Corn with no residue.

Corn with 100% residue

ECONOMICS OF RESIDUE REMOVAL FOR BIOFUEL

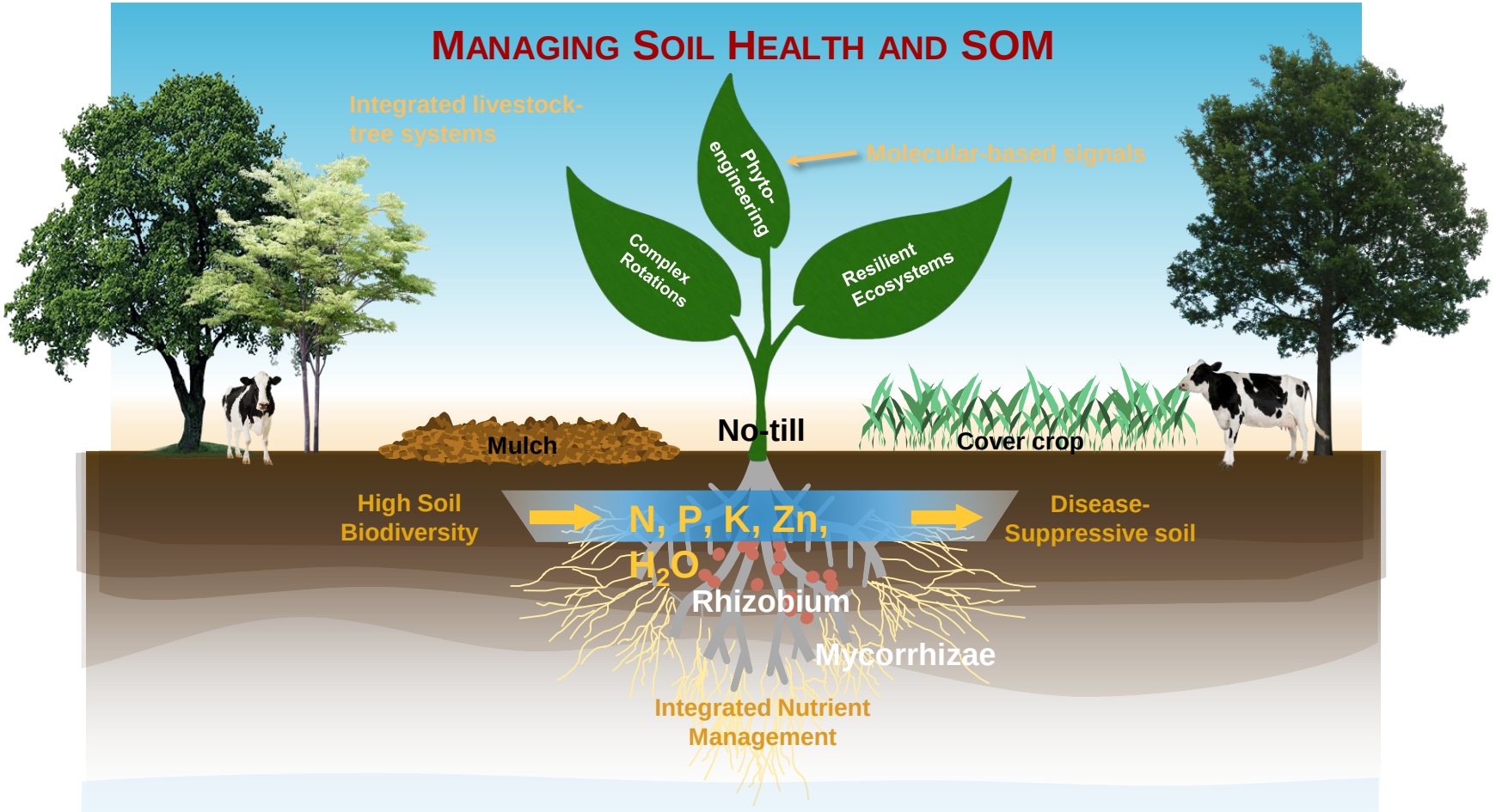


CARBON-BASED FERTILIZATION

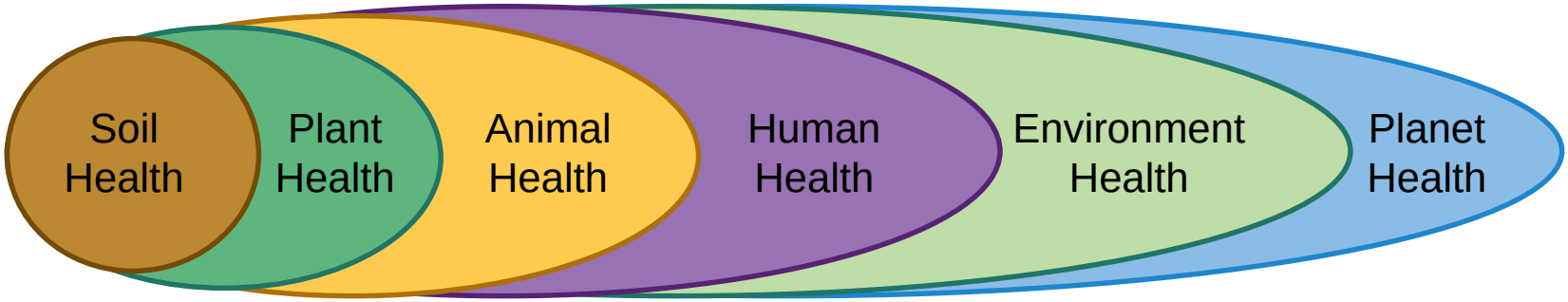
CNPK

rather than

NPK


MANAGING SOIL HEALTH AND SOM
Integrated livestock-tree systems
Phyto-engineering
Molecular-based signals
Complex Rotations
Resilient Ecosystems
Mulch
No-till
Cover crop
High Soil Biodiversity
N, P, K, Zn,
H2O
Disease-Suppressive soil
Rhizobium
Mycorrhizae
Integrated Nutrient Management

Soil, Human, Planet-Health Nexus



"When we try to pick out anything by itself, we find it hitched to everything else in the Universe." (John Muir).

(Lal 2020)

LIMITING GLOBAL WARMING TO 2^0C

A. Using No-C energy,
B. C capture and sequestration
C. Re-Carbonizing the Land
D. Revisiting the Life-Style
E. Managing Land Natural Resources
F. Dryland Agriculture and SIC Sequ.
G. Return Some Land to Nature
H. Urban Agriculture
I. Carbon Farming

TECHNICAL POTENTIAL OF C SEQUESTRATION

I. Soils ..... 1.45 – 3.44 Pg C/yr (2.45 Pg C/yr)

Lal (2018)

II. Terrestrial Biosphere by 2100

- Soils ..... 178 Pg
- Vegetation ..... 155 Pg

Total 333 Pg (157 ppm

Future Policies for Global Agriculture

Actions to be Taken by 2030:

- Reduction in pesticide use,
- Reduction in fertilizer use,
- Increase in water use efficiency,
- Return some marginal land to nature

CARBON FARMING

Growing soil carbon as a farm commodity that can create an other income stream for farmers @US$50/credit

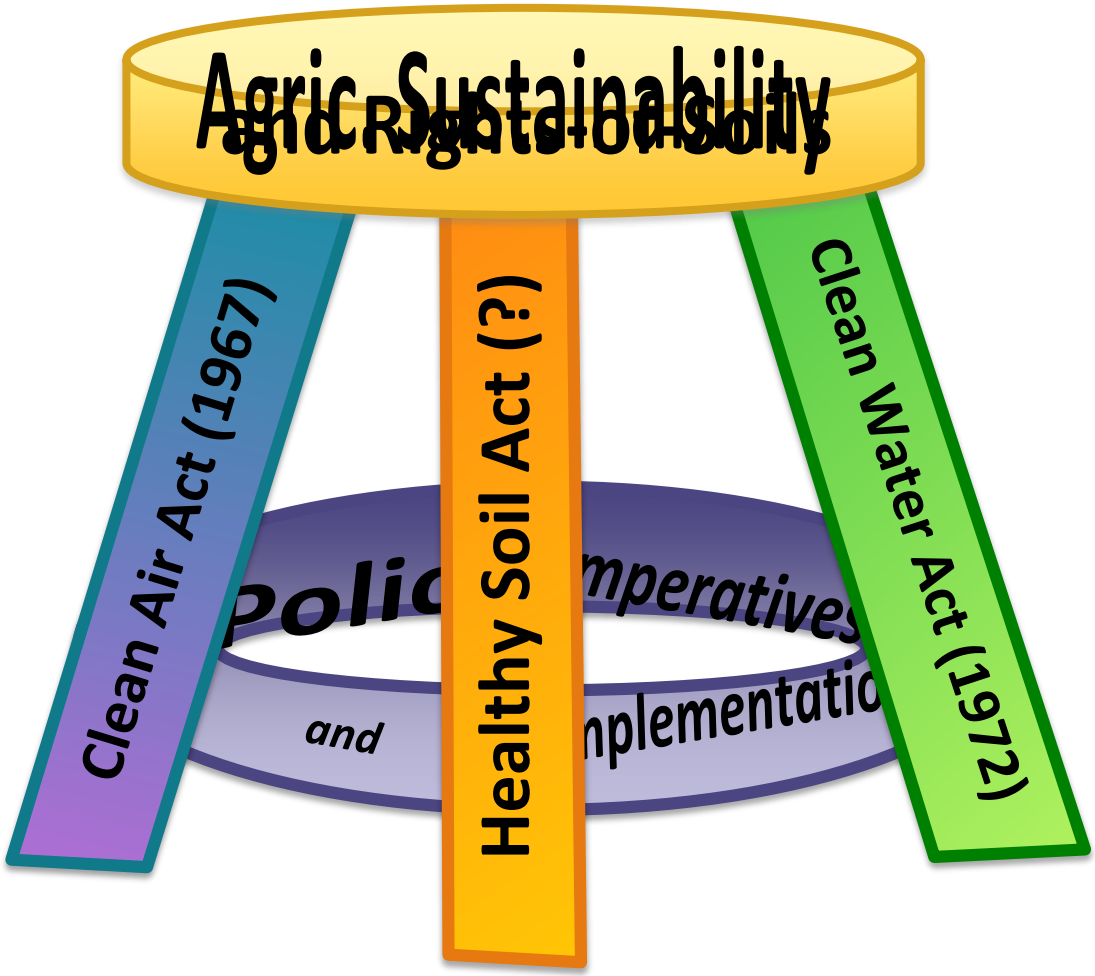
Funds Required To Make Agriculture a Solution

- US$100B/Yr.
- US$ 70B /Yr. for Small farms
- US$30B/Yr. for other farms

SOURCE OF FUNDS

- Fossil Fuel Exporting Countries,
- Agro- Industries,
- Private Sector,and
- Consumers

SOIL HEALTH ACT



LiSAM for Making Soils and Agriculture a Carbon Sink

- Soils of managed ecosystems(crops, pastures , forests and urban) have a large C sink capacity, and it must be harnessed for adaptation and mitigation of ACC.

- Soils of these ecosystems can be sink for atmospheric CO_2 by judicious management and adopting the science-based and TEK options.

OBJECTIVES OF LiSAF

- Assess SOC Stock and Flux for Key Ecosystems
- Relate SOC Stock and Flux to Agronomic Productivity
- Evaluate Savings in Input (Fertilizer, Irrigation, Energy) Per Unit Increase in SOC Stock
- Validate Models with Ground Truthing Data
- Develop Scaling Protocols
- Provide Training Opportunities
- Identify Policy Issues, and
- Promote soil health act at national & Africa level

Small Landhold Farms (SLF) in Africa

- Small landholder farmers (SLF) are 33M in Africa who cultivate <1 ha
- SLF provide 70-80% of Africa's food
- These farms are less productive and labor-intensive

Small Farms in the World

Worldwide, about 570M small farms cultivate < 2ha and comprise over 2B people operating with traditional and informal tenure.

(Roop et al., 2023)

Bringing Green Revolution to Africa?

- Africa has the natural resources needed to be the Next Bread Basket of the World
- The strategy is to translate the proven agronomic/soil management science into action by using strong political willpower

ACTIONS NEEDED BY "THE LISAF" INITIATIVE BETWEEN 2024 AND 2030

- Increasing fertilizer use and its efficiency
- Improving soil health and agronomic productivity
- Increasing land area under irrigation
- Removing CO_2 from the atmosphere by sequestering carbon in terrestrial ecosystems
- Including soil restoration as an integral component of the National/Regional Programs
- Protecting C in soils, forests, and wetlands

A Multi-Institutional Consortium

- Coordinate by IICA
- Internl. Develop. Organizations
- Land Grant Univ. & other Academies
- NGOs, and philanthropic Institutions
- Private Sector,
- Policy Makers in Africa

VISION FOR ADAPTED CROPS AND SOILS (VAC

Catalyze a movement to boost agricultural productivity, nutrition, and farmer livelihoods through diverse, climate-adapted crops grown in healthy soils.

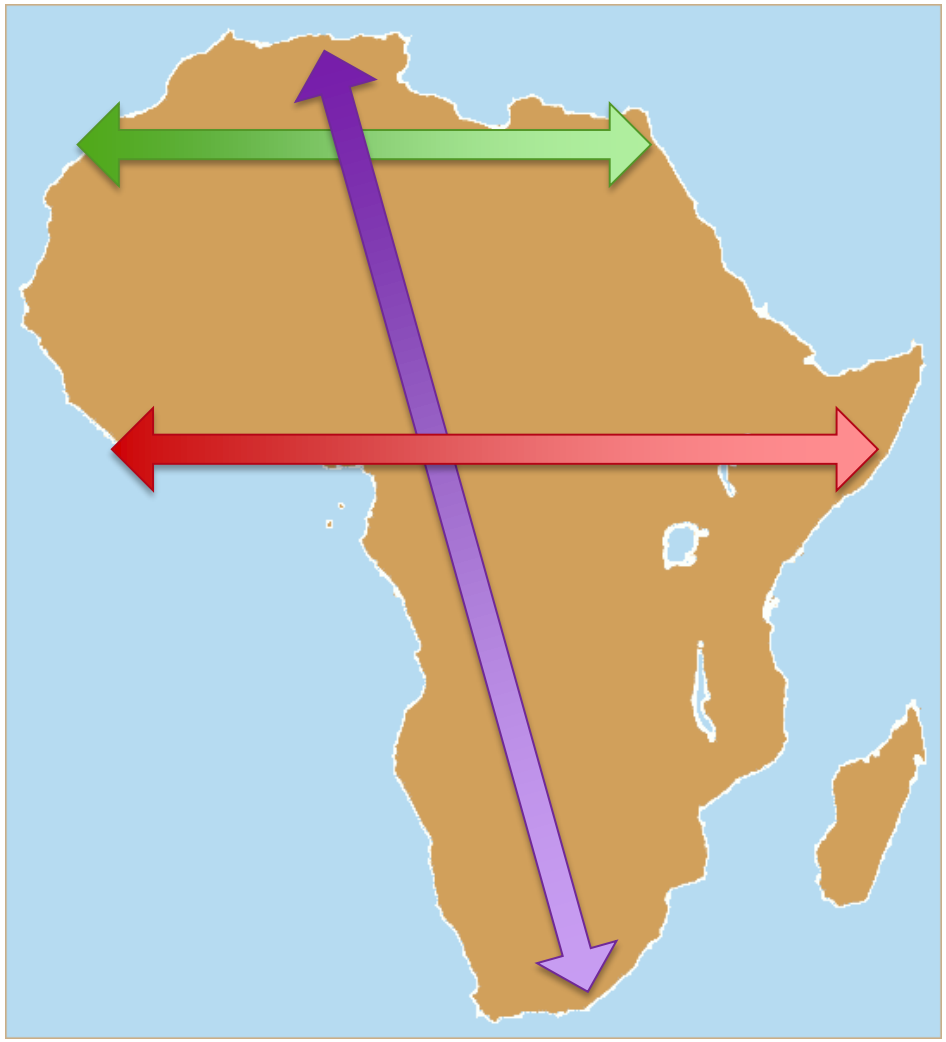
Build Supply and Demand for a Diverse Range of Crops

- More **farmers** have access to improved nutritious opportunity crop varieties.
- **Institutions** and **consumers** increasingly demand opportunity crop products.
- New **value chains** exist for opportunity crops that substantially increase the volume of opportunity crops sold and consumed.
- National and international **research centers**, working together, produce improved varieties of an expanded list of opportunity crops.
- **National and international networks** to catalyse change exist with strong farmer and private sector participation.

Promote Sustainable Land Use with Opportunity Crops

- **Farmers** and **governments** are empowered with the options and information necessary to maximize the sustainable value of the land and enable the long-term sustainable production of nutritious foods.
- **Development partners** integrate comprehensive and evidence-based soil management practices into all agricultural programming.
- **Public and private sectors** work together to promote sustainable land use.

SELF-RELIANCE IN AFRICA BY MASHA, LISAF, VACS, AAA



A ROAD MAP FOR AFRICA

Technological Options	2020	2025	2030
Fertilizer Use (kg/ha)	17	30	60
Irrigated Cropland (%)	6	10	20
Conservation Agriculture (M ha)	1.5	10	50
Agroforestry (% of tree cover on agric. land)	10	15	20

Cropland Area = 242 Mha

AF = Zomer et al. (2009)
CA = Kasam et al. (2008)

Bridging the Gap

Famines and wars are man-made tragedies.

We must make famine and mass-starvation politically intolerable, morally toxic, ethically unthinkable, and humanely unacceptable.

Restoring Soil Health Globally must be a part of the solution.

(Lal 2020)

Global Peace and Soil Science

1. Global peace is also a scientific issue.
2. A war involves 3 parties : two countries/ communities and the soil to grab which they are fighting.
3. In addition to people , soil is also suffering but silently: being polluted, contaminated ,cratered ,compacted and its biodiversity destroyed & recovery will take generations
4. No one has right to destroy soil
5. Moratorium must be declared on crime against nature,& top priority to restore soil health.