



THE OHIO STATE UNIVERSITY

Soil Health and Sustainability

Carbon Management and Sequestration Center

Dr. Rattan Lal

GIFS Conference, 14-16 June, Saskatoon



SOIL HEALTH

Soil health is a journey and not a destination.



THE DESTINATION OF SOIL HEALTH CHANGES WITH EVERY GENERATION

The bible depicts Moses stating around circa 1400 BC as they entered Canaan:

"See what the land is like and whether the people who live there are strong or weak, few or many. What kind of land do they live in? Is it good or bad?--- How is the soil? Is it fertile or poor? Are there trees on it or not? Do your best to bring back some fruit of the land" (Numbers 13:18-20)

Brevik and Sauer (2015)



SOIL HEALTH MANAGEMENT IN ANCIENT ASIA

- ***Chanakya/kautilya (4th BCE)***: 'Artha Sastra' explains manuring and other systems of soil fertility management and water conservation.
- ***Shi Jing(770-476 BC)***: *In the book of Oades* explains agricultural practices dating back from Zhou Dynasty. A compilation of 305 poems covering ancient life in China, it also describes landforms, animals, and plants.

- Lal(2014)



KITAB-AL-FELAHA

Ibn-Al-Awan, a Moorish Philosopher wrote in the
“Book on Agriculture” during the 12th century:

“The first step in the science of agriculture is the recognition of soils and of how to distinguish that which is of good quality and that which is of inferior quality. He who does not possess this knowledge lacks the first principles and deserves to be regarded as ignorant”.

(Vol. 1, p. 23)

“One must also take into consideration the depth of the soil, for it often happens that its surface layer may be black.”

(Vol. 1, p. 336)



SOIL HEALTH AND QUALITY GOALS

"The continued capacity of soil to function as a medium for plant growth, within ecosystem and land-use boundaries, to sustain biological productivity, conserve water, and enhance the quality of air and water environments, and to support plant, animal and human health."

The climate aspect is overlooked

Doran et al. (1996)



SOIL HEALTH AND NUTRITIONAL SECURITY

- Micronutrient deficiencies are an important cause of malnutrition and mortality.
- Children are especially vulnerable to micronutrient deficiencies.
- Fe deficiency causes anemia.
- Seventeen micronutrients essential to human health are: Fe, Zn, Cu, Mn, I, Se, Ni, As, Li, Sn, V, Co
- Ten macronutrients essential to human health are: Na, K, Ca, P, N, S, Mg, C, H, O
- All nutrients must be supplied through soil.

The health of soil, plants, animals, people and ecosystems is one and indivisible.



SOIL QUALITY VS SOIL HEALTH

- The term *soil quality/functionality* is not synonymous with *soil health*, and they should not be used interchangeably.
- Soil quality/functionality is related to soil functions or what it does, whereas soil health presents the soil as a finite and dynamic living resource. Soil health is directly related to plant health.



SOIL FUNCTIONALITY

Capacity of a soil to perform numerous functions:

These functions
are difficult to
measure directly
and are estimated
through SQI

- Production of biomass
- Moderation of climate
- Cycling of elements
- Decomposition of waste
- Renewal and purification of water
- Providing habitat for biodiversity
- Creating media for plant growth
- Being foundation of civil structure
- Source of archive of human and planetary history, and of paleoclimate



MOST IMPORTANT THINGS CANNOT BE MEASURED BUT MUST BE MANAGED (Edward Demmings)

**Therefore, question is not "What is there in
the soil that can be measured, but what it
does which must be quantified "?**

&

What it does is "soil quality/ functionality".



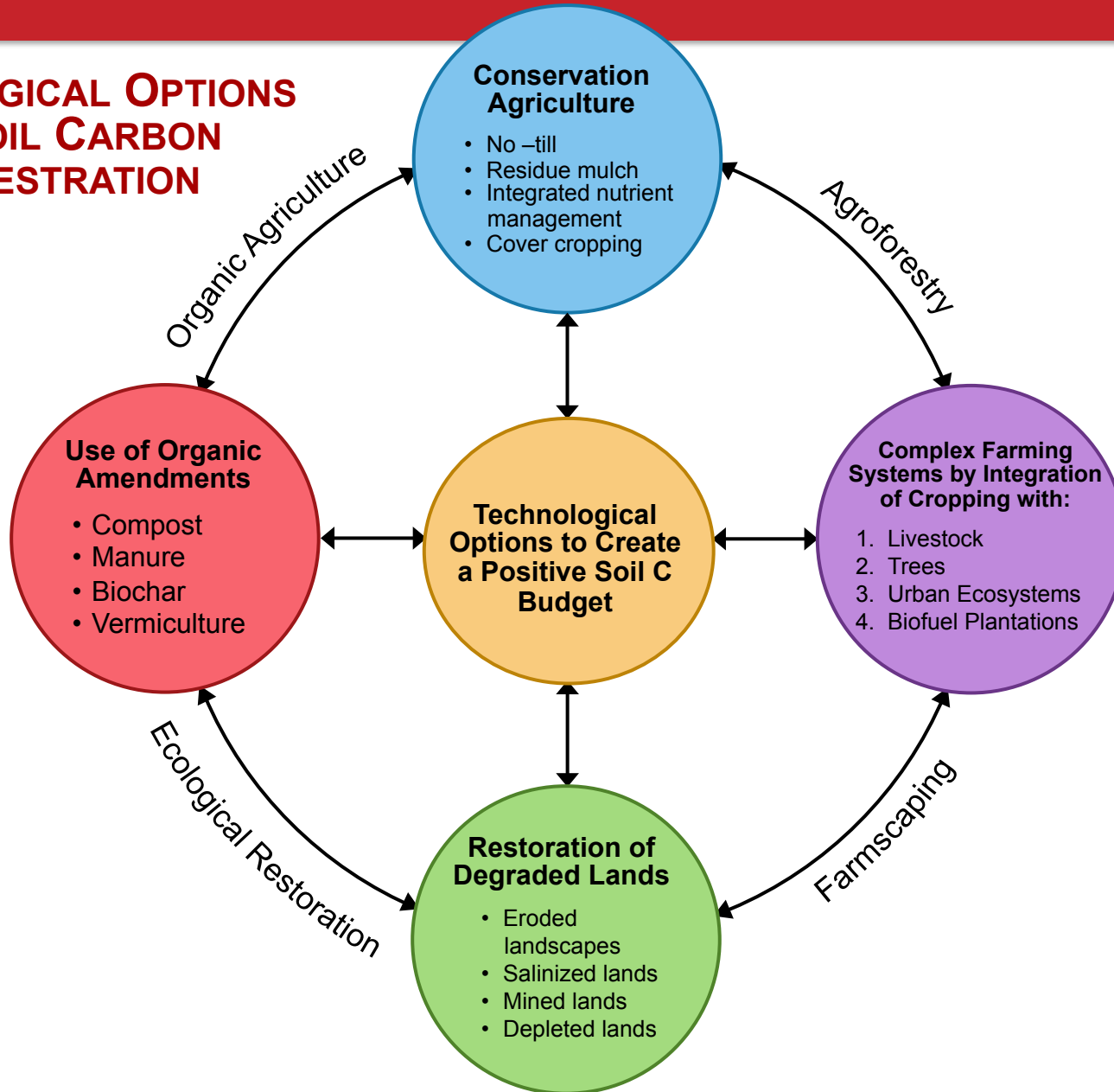
SOIL HEALTH

Soil's capacity, as a dynamic and biologically active entity, within natural and managed landscapes, to sustain multiple ecosystems services including net primary productivity, food and nutritional security, biodiversity, water purification and renewability, carbon sequestration, air quality and atmospheric chemistry and elemental cycling for human wellbeing and nature conservancy.

Lal (2016)



TECHNOLOGICAL OPTIONS FOR SOIL CARBON SEQUESTRATION





DROUGHT OF 2012



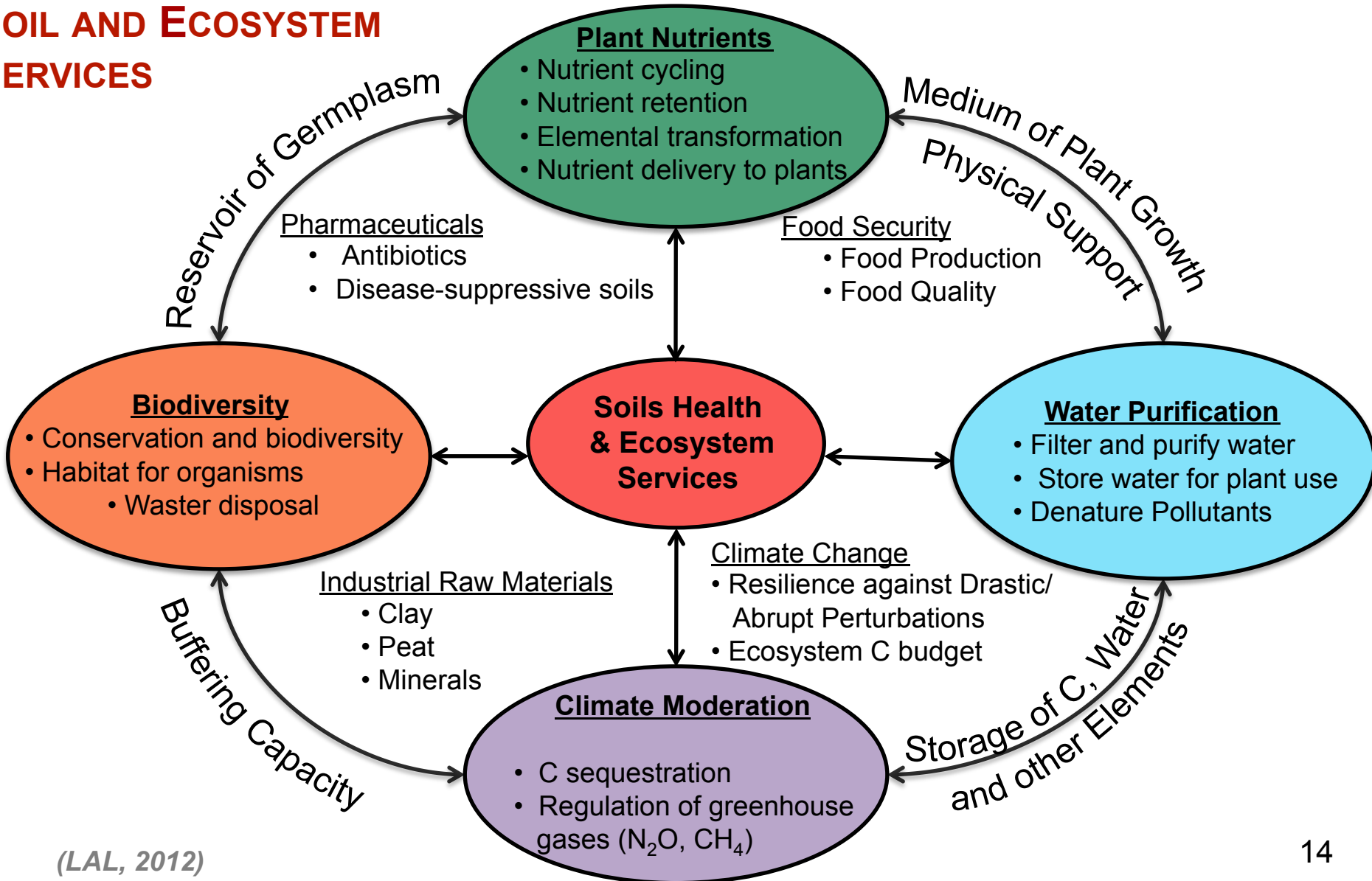
Corn with no residue.



Corn with 100% residue

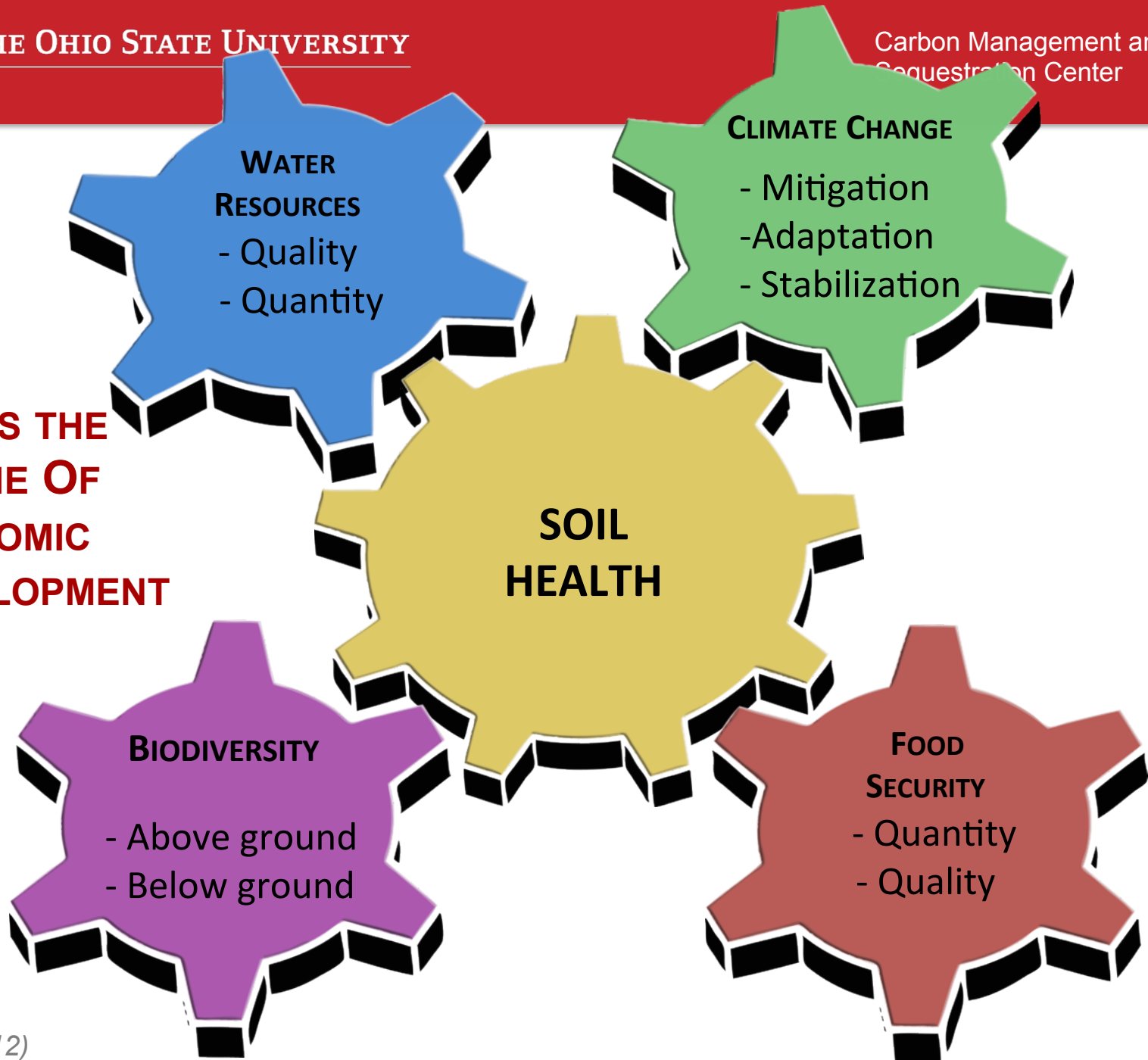


SOIL AND ECOSYSTEM SERVICES



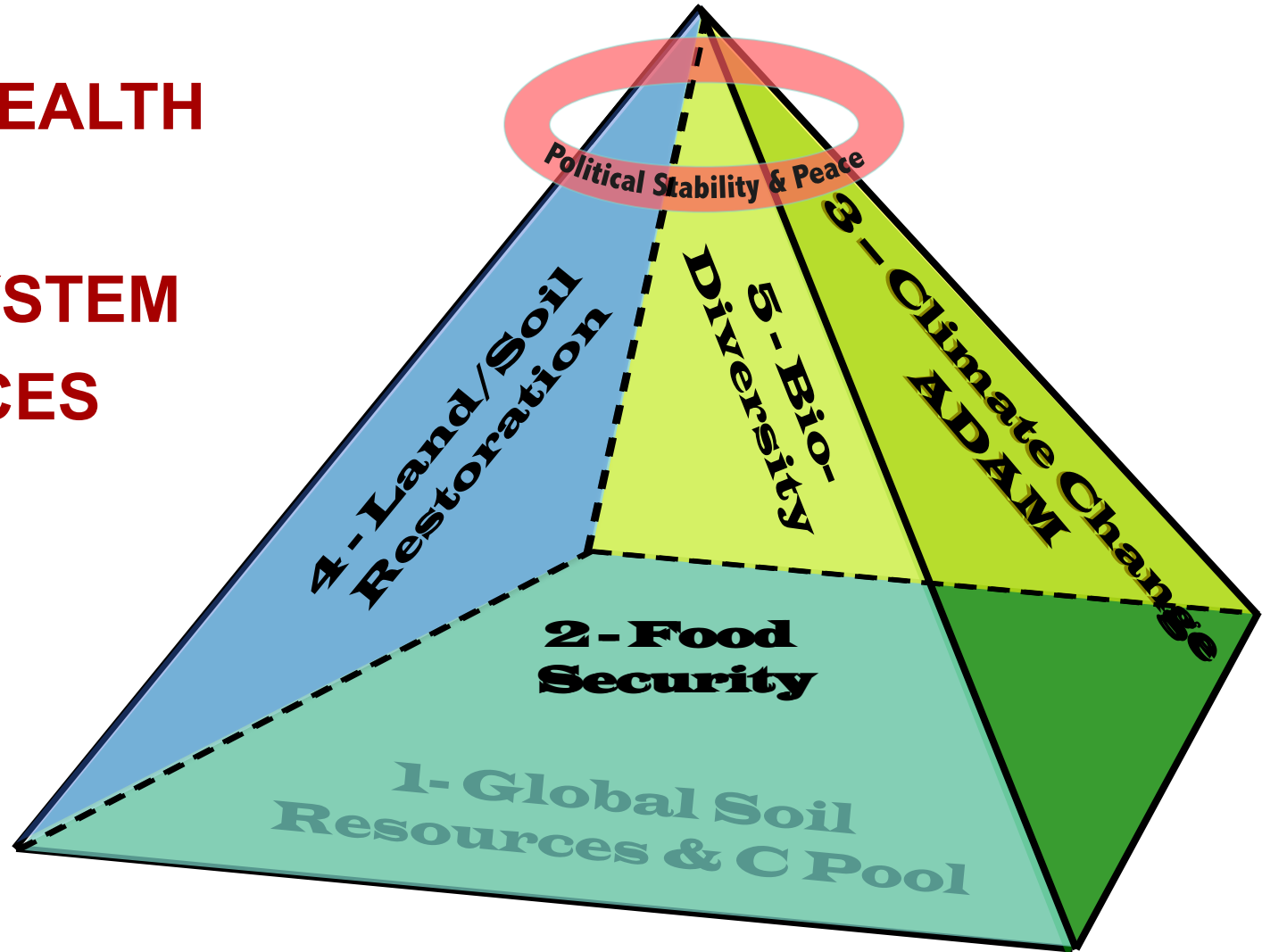


**SOIL IS THE
ENGINE OF
ECONOMIC
DEVELOPMENT**





SOIL HEALTH AND ECOSYSTEM SERVICES





A HEALTHY AND AN ECO-EFFICIENT SOIL





HEALTHIER SOILS AND ECONOMIC PROFITABILITY

- Healthier soils do not always translate to higher monetary gains or higher yields (e.g., in CA systems).
- It may be prudent to accept yield reduction by 5 to 10% for sustaining health of soils and ecosystems.
- Globally, humans waste ~1 Gt of food grains per year, which is a crime against nature.

There is no justification for always aiming at the maximum potential yield and then let it waste, decompose and emit GHGs.