



The Economics of Ecosystems and Biodiversity TEEB for Agriculture & Food Global Symposium, February 2019

TEEB AgriFood: Issues and Challenges in agro-agri-food systems
Barbara Gemmill-Herren
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The Economics
of Ecosystems
& Biodiversity

based on a decision of the German Bundestag

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Eco-agri-food system:

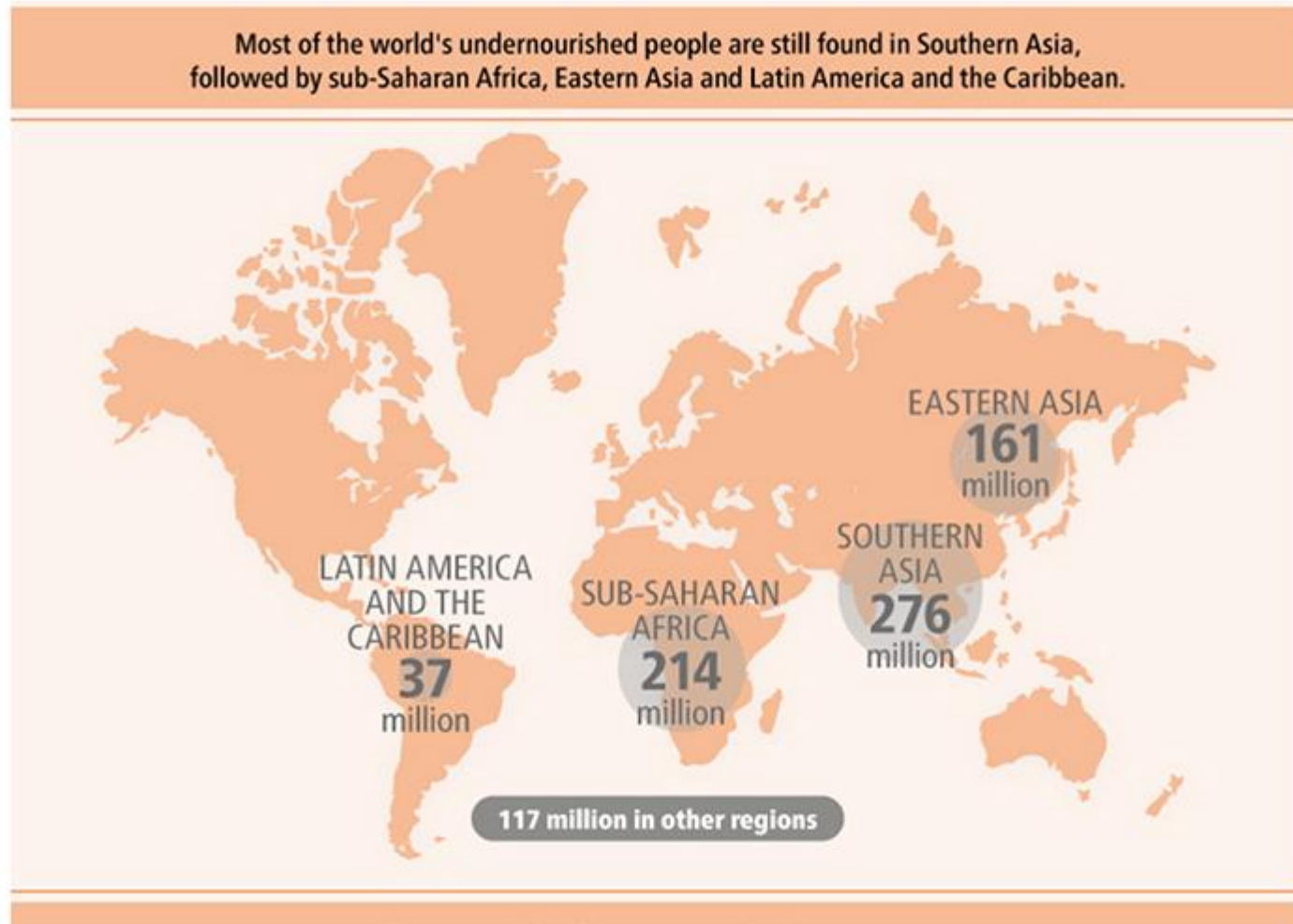
The vast and interacting complex of ecosystems, agricultural lands, pastures, inland fisheries, labour, infrastructure, technology, policies, culture, traditions, and institutions (including markets) that are variously involved in growing, processing, distributing and consuming food.

Where are our food systems heading?



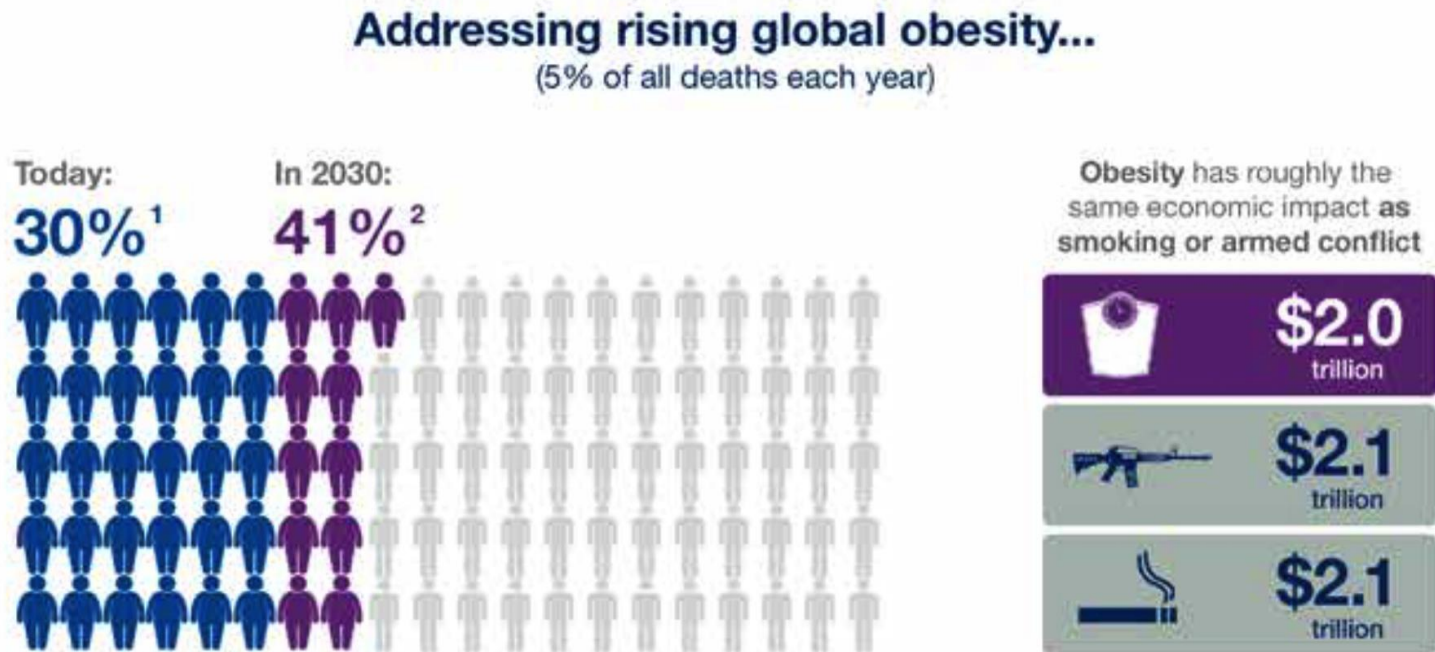
Since the 1950s, with the growing demand for agricultural produce, many farmers began using non-renewable energy-based chemical fertilizers and agricultural processes became specialized and more monocultural. Ways of processing and distributing food have emphasized low cost and high productivity while often devaluing the freshness or wholesomeness of food

Where are our food systems heading?



Broad recognition that the global food system is not functioning effectively

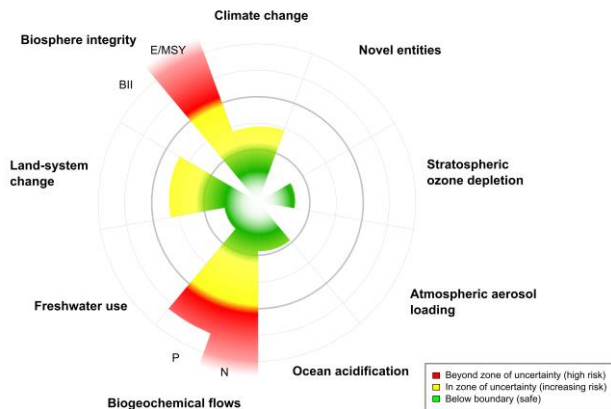
Where are our food systems heading?



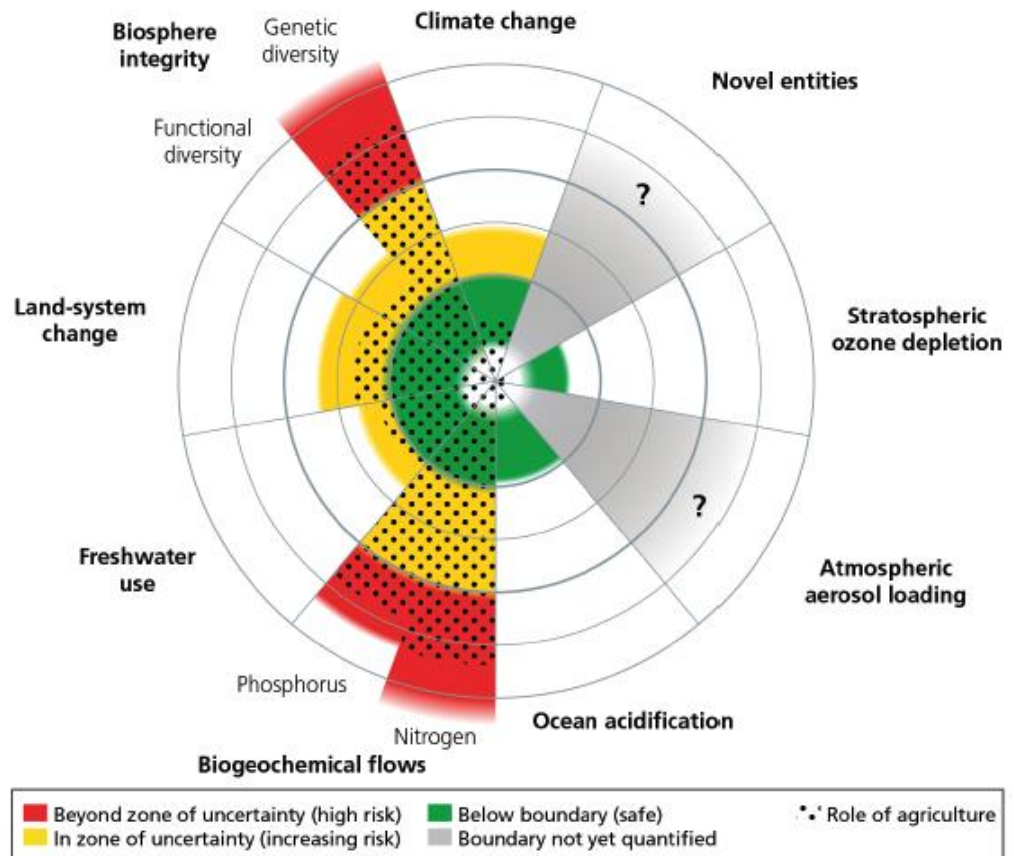
Broad recognition that the global food system is not functioning effectively

Where are our food systems heading?

Move away from use of renewable resources:



From Rockstrom et al 2015



From Campbell et al 2017

Global external forces and economic pressures

- *The impact of loss of connections to local communities:* Many modern agricultural systems, as they trend toward monocultures oriented to external markets through the purchase of industrial inputs to sell commodities for profit have ceased to use local labour, and dispensed with the benefits received from biodiverse landscapes,
- *Impacts of food prices on the dynamics of food systems: volatility of prices:* Volatility of prices, compromising food security for the most vulnerable
- *Consumer behaviour, changing diets and new trends:* Processed, prepared foods may require a higher use of agricultural commodities to create a given number of calories

Invisible flows of resources: Global trade

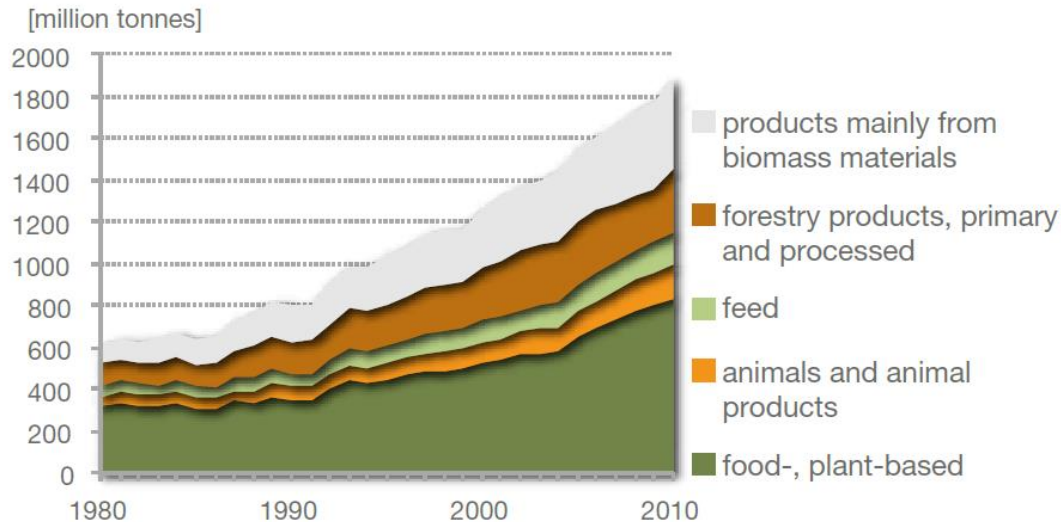


Trade, in itself, is neither a threat nor a panacea when it comes to food security, but it can pose challenges and risks that need to be considered in policy decision-making

The hidden costs of the global food trade are largely not known or recognized by policy makers. It is such externalities and invisibles that are a focus of true cost accounting in agriculture and food.

Invisible flows of resources

Trade in biomass by main sub-category, 1980–2010



Source: (Dittrich, 2012); note: trade is based on exports, because export statistics of biomass are more complete in terms of country and commodity, and have a better coverage than imports.

- Global biomass use stood at 5 billion tons in 1900; by 2010, biomass trade had increased to 21 billion tons.
- Overall, around 15 per cent of all biomass materials globally extracted are redistributed through foreign trade.
- As biomass is transported in large volumes across the world, the underlying agricultural production acts like a “mining” process in several parts of the world.

Invisible flows of resource

Shifting Hotspots

Regions of greatest nitrogen use (*red*) were once limited mainly to Europe and North America. But as new economies develop and agricultural trends shift, patterns in the distribution of nitrogen are changing rapidly. Recent growth rates in nitrogen use are now much higher in Asia and in Latin America, whereas other regions—including much of Africa—suffer from fertilizer shortages.

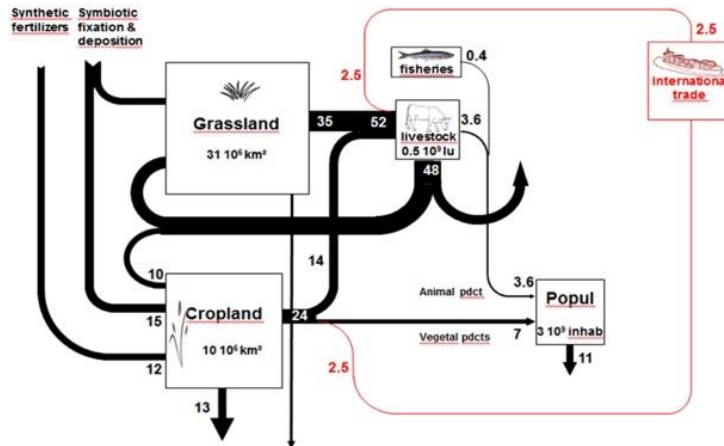
SOUTHERN BRAZIL: Rapid population growth and industrialization around Sao Paulo, poor civic sewage treatment and vibrant sugar cane production all contribute to this new South American nitrogen hotspot.

NORTH CHINA PLAIN: More vigorous application of fertilizer has produced stunning increases in maize and wheat production, but China now has the highest fertilizer inputs in the world.

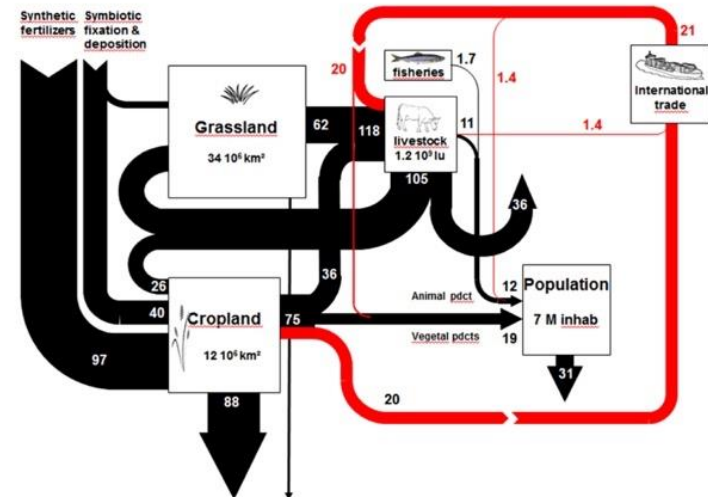
- Nutrient concentration in several regions of the world as a result of agriculture's increased biomass production and consumption is producing a nitrogen and phosphorous cascade with environmental and social impacts.

Invisible flows of resources

World, 1961 TgN/yr



World, 2009 TgN/yr



- International trade of food and feed products has profoundly affected flows of nitrogen in the form of vegetable or animal protein between continents
- The largest component of traded agricultural commodities is animal feed, entering from countries producing feedstuffs to countries where the proportion of meat in the human diet is high or rapidly increasing, and which have intensive animal production facilities.

Invisible flows of resource



Accumulated exported nutrients (N, P, K, Ca, Mg, S) in soybeans and sub-products (oil, meals), from Argentina to the rest of the world, between 2007-2017. Source: own elaboration with data from MAGyP.

- Argentina has historically amassed and exported large amounts of nutrients for worldwide consumption, being a large food and biomass supplier to the world and relying on the high productivity of its fertile soils.
- A continuous process of soil's nutrient depletion has been ongoing since 1961
- This soil exhaustion represents a 'hidden cost' or environmental intangible since the export of nutrients from soils as natural capital remains unaccounted for.

Cracking under pressure: conflict and disasters



- Over 30 years, the typology of crises from catastrophic, short-term, acute and highly visible events to structural, long-term and protracted situations resulting from a combination of multiple contributing factors, especially natural disasters and conflicts.
- FAO accounting for damage to crops and livestock after disasters: 58 million hectares of crops were damaged, and 11 million livestock lost due to disasters occurring between 2003 and 2013
- in 1990, only 12 countries in Africa were facing food crises, of which only four were in protracted crisis. 20 years later, 24 countries were facing food crises, with 19 of these having been in crisis for eight or more of the previous 10 years

What kinds of farm operations are currently “feeding the world”?

Food system feature	“Traditional” food systems	Intermediate/mixed food systems	“Modern” food systems*
Estimated number of people in system	~1 billion	~4 billion	~2 billion
Principal employment in food sector	In food production	In food production	In food processing, packaging and retail
Food production system	Diverse, mixed production system (crops and animal production) by smallholders; local and seasonal production with varied productivity and diverse benefits; low input farming systems. Food systems are the main source of energy.	Combination of diverse, mixed production system and specialised operations with a certain degree of inputs, including fossil fuels, by both local smallholder farmers and larger farms often further away. Less dependence on seasonal foods.	Few crops dominate (i.e. largely monoculture); specialization and high productivity; high external inputs, including fossil fuels. Food production consumes more energy than it delivers. Overall, the system produces a wide array of foods that are available globally.
Typical farm	Family-based, small to moderate	Combination of smallholder farms and larger farms / fishery operations	Industrial, larger than in a traditional setting

What kinds of farm operations are currently “feeding the world”?

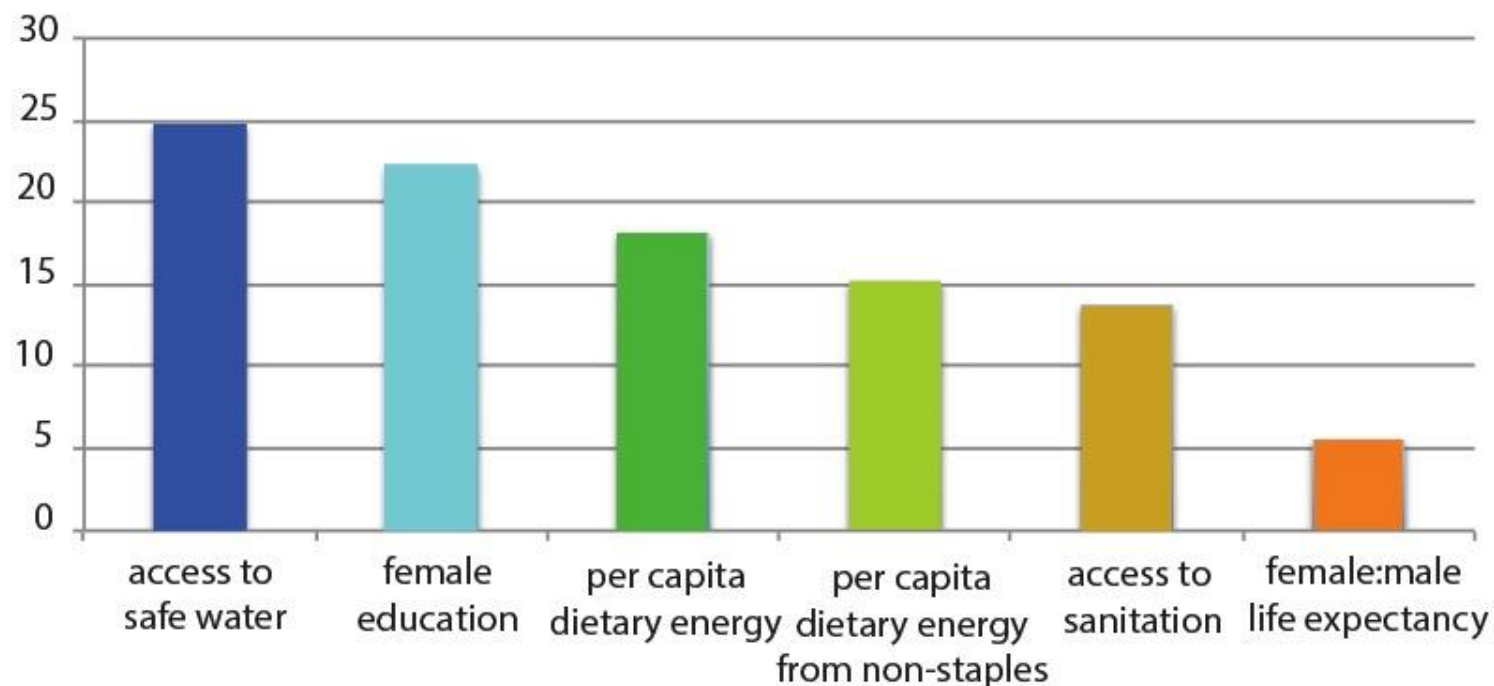


Globally, **small and medium farms** (below 50 ha) produce 51–77 percent of nearly all commodities and nutrients examined (including vegetables, sugar crops, roots and tubers, pulses, oil crops, livestock, fruit, fibre and cereals), with key regional differences.



The diversity of agricultural and nutrient production diminished as farm size increased, but regardless of farm size, it is shown that **areas of the world with higher agricultural diversity produce more nutrients.**

Pathways to sustainability for agriculture and food systems



Contributions of underlying determinants to reducing hunger

IFPRI study (Smith and Haddad 2014) across 116 countries from 1970 to 2012

Working with nature: biogeochemical flows



While the use of nitrogen in agriculture has increased 8-fold from 1960 to 2000, yet there extremely low N use efficiency resulting in the global nitrogen flows noted earlier.

However, there are many ecosystem-based measures that can reduce this **“leakiness”**. For example:

Finding other sources of nitrogen other than the extremely labile nitrogen in conventional fertilizers, drawing on the ecological process of nitrogen fixation through crop rotation and cover crops.

Facilitate the ecosystem service of nutrient cycling through applications of compost and organic manure, enhance the capacity of soils to hold and supply plant nutrients, and improve nitrogen capture by crops.

Working with nature: biogeochemical flows



Measures on a landscape level can recapture lost nitrogen from fields by applying watershed-level strategies, such as encouraging diversity in agricultural landscapes, including hedgerows, vegetated strips and riparian habitat



Analyses of whole food systems have shown considerable opportunities to reduce nitrogen contamination of ecosystems while sustaining food productivity, including modifying trade patterns to become more localized.

Working with nature: controlling pests and disease



Pest and diseases of crops and livestock are some of the most challenging problems facing farmers throughout history. It is increasingly recognized that the approach that industrialized, modern agriculture has taken to controlling pests – through application of pesticides in sprays or seed treatments generates far more problems than it solves.

Global pesticide use has grown over the past 20 years to 3.5 billion kg/year, amounting to a global market worth \$45 billion. Pesticide and herbicide resistance continues to grow even as the toxicity of pesticides increases. Losses to pests and disease are estimated at 20-40 per cent of global crop yields

Working with nature: controlling pests and disease



Thus the science of pest and disease control is increasingly returning to its original roots: recognizing first that not all insects or microorganisms are pest or disease agents, and that there is almost always a subcritical level of both herbivores and pathogens in agroecosystems. Ecological approaches work to restore those balances when they become critical, through a host of careful monitoring, use of cultural techniques and on-farm diversity, choice of appropriate varieties and introduction of natural enemies.

Working with nature and communities: localising food processing, for local benefits



The invisible services that local trade and food systems support include: (i) **availability of a diversity of food locally grown** under presumably more amicable agricultural practices with lower external inputs; (ii) lower negative impacts on the environment; (iii) fresh produce available seasonally in local markets; (iv) positive inter-relationships between producers, processors and consumers, and a shared construction of knowledge among them; (v) better community ties and a feeling of positive dependency; (vi) **more and better quality jobs generated locally**; (vii) economic spill over at the community and possibly regional level; (viii) identity preservation among the local communities; (ix) local community networks strengthened; and (x) **stronger relationships and social economy with the larger territory.**

In conclusion:

The potential of the Eco-agri-food system, if invisible flows are made visible, and the capacity to generate positive flows, as well as to pay for the negative externalities is recognized, is tremendous.



THANK YOU