Agricultural systems
by design

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Key-Note

Agroecological Food System Design across Global North and South: Challenges & Methods

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Food system transformation level and agroecological principles

Transformational

Level 5: Build a new global food system, based on participation, localness, fairness, and justice

Level 4: Reconnecting the two most important parts of the food system - consumers and producers, through the development of alternative food networks

Incremental

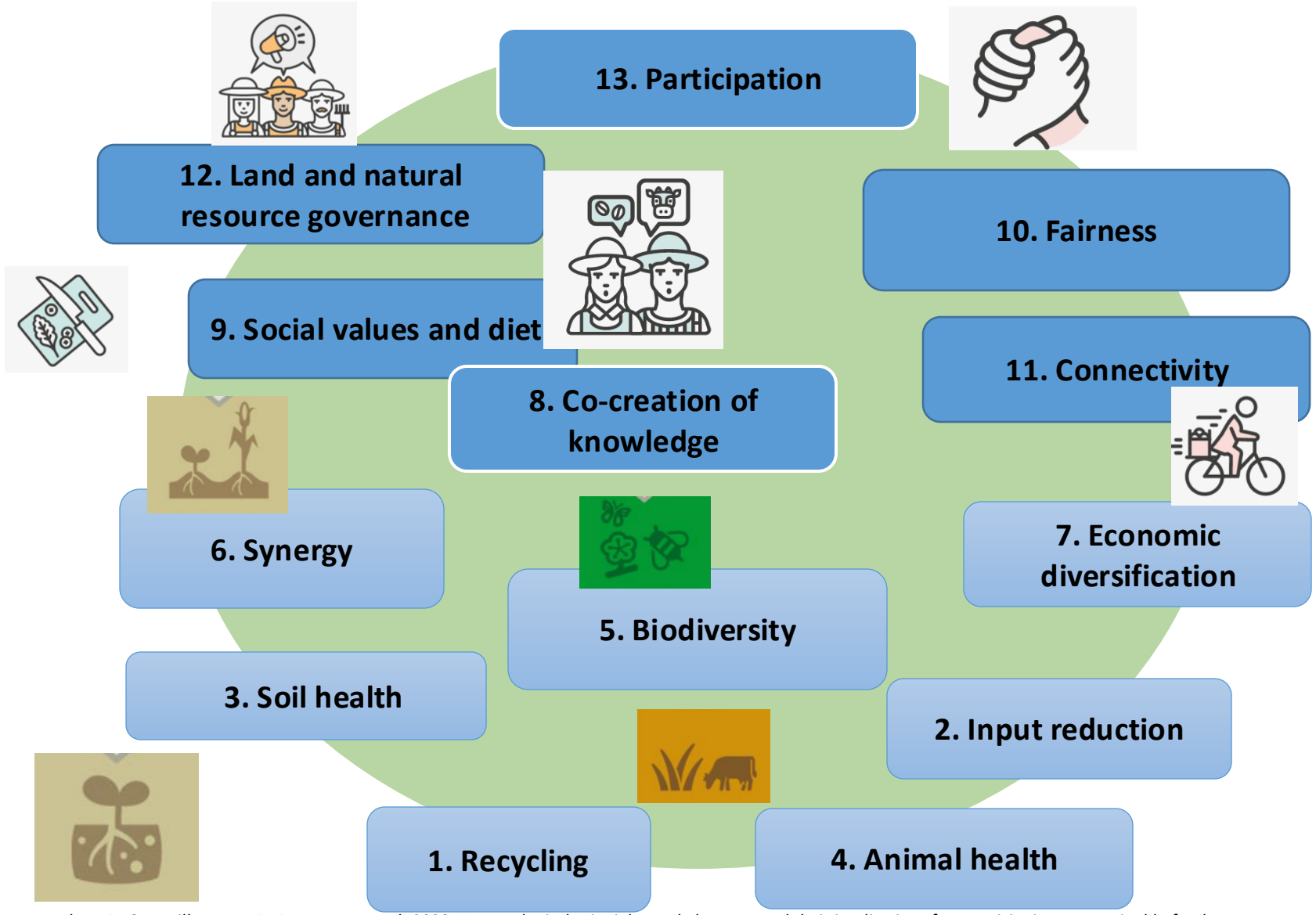
Level 3: Redesign the agroecosystem so that it functions on the basis of a new set of ecological processes that provide system resistance

Level 2: Substitution of conventional inputs and practices with alternatives

Level 1: Increase input use efficiency, reducing the use of costly, scarce, or environmentally damaging inputs.

Food system

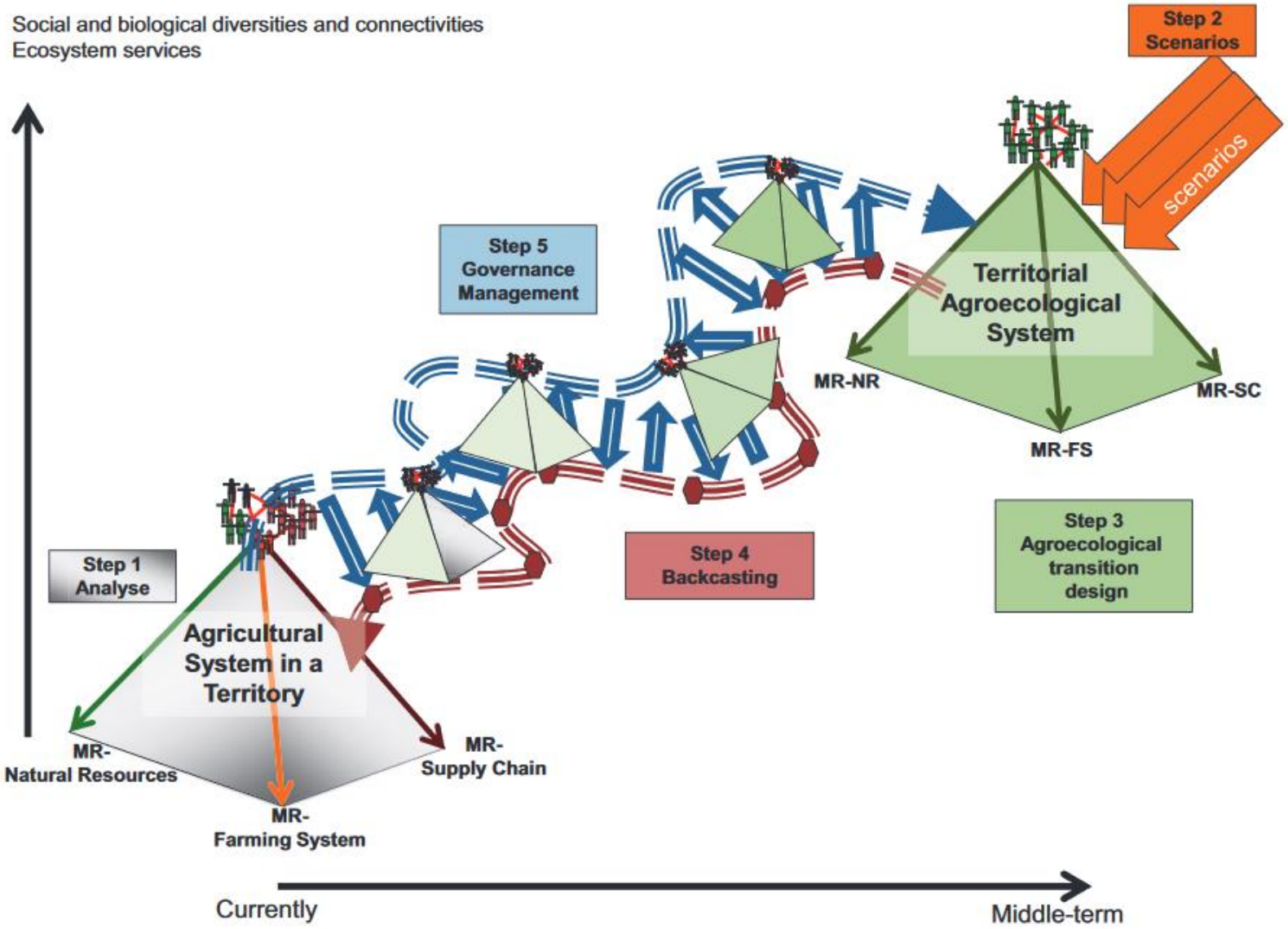
Agroecosystem



Wezel, A., B. Gemmill Herren, R. Bezner Kerr et al. 2020. Agroecological principles and elements and their implications for transitioning to sustainable food systems. A review. *Agronomy and Sustainable Development* https://doi.org/10.1007/s13593-020-00646-z . Images from: https://www.cidse.org/wp-content/uploads/2018/04/CIDSE_AE_Infographic_EN.pdf ; https://www.nature.scot/sites/default/files/2017-10/A2335481%20-%20Promotion%20of%20agroecological%20approaches%20-%20Lessons%20from%20other%20European%20countries.pdf

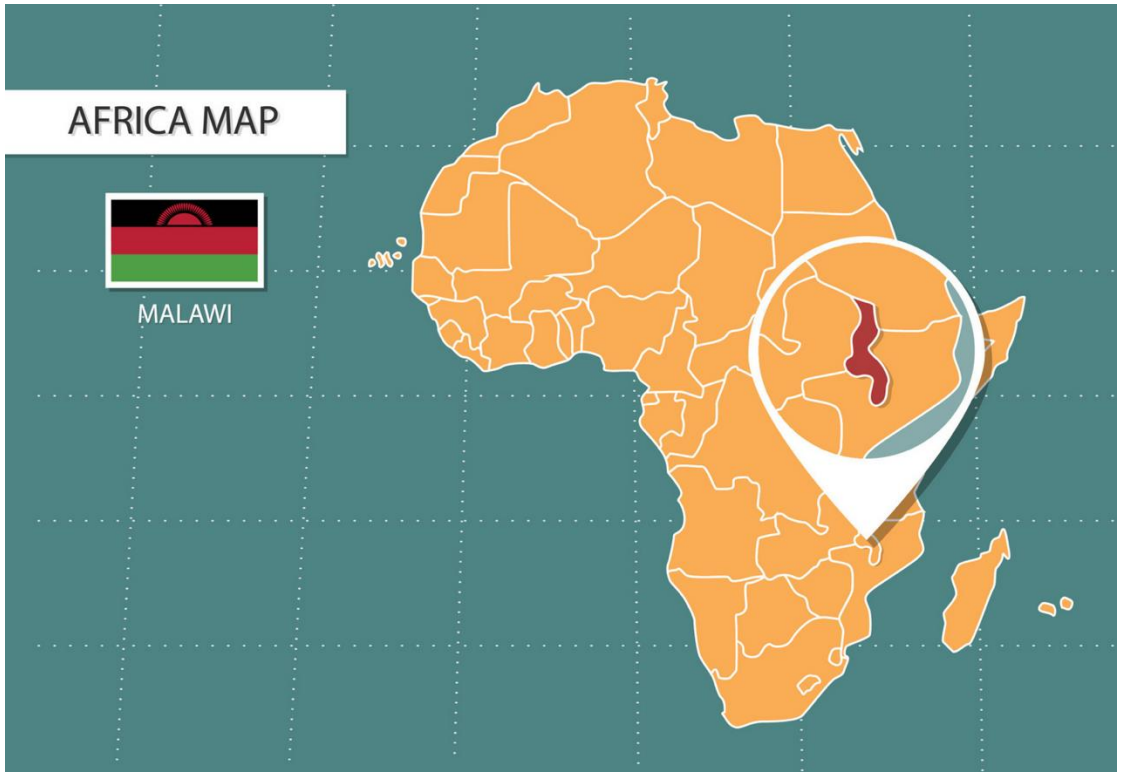
Agroecology, ecosystem-based management in fisheries, & other approaches that work with natural processes support food security, nutrition, health & well-being, livelihoods, biodiversity, sustainability and ecosystem services. These services include pest control, pollination, buffering of temperature extremes, and carbon sequestration and storage (*high confidence)*. (IPCC WGII AR6 2022, SPM C2.2)

Agroecological Transition framework @ territorial level



(Duru et al. 2015)

Case Studies: Global South and North



Images from: https://www.vecteezy.com/vector-art/17740376-malawi-map-in-africa-zoom-version-icons-showing-malawi-location-and-flags; https://www.mygermancity.com/allgaeu-map https://walkinginfrance.info/short-walks/luberon/

Challenges: Global South Context

- Debt loads, global financial instability, limited government funding makes government highly dependent on international funding;
- International funding and national subsidies often focus on agricultural intensification of staples;
- Climate change impacts can be severe, affect transport infrastructure and food production e.g. floods, drought.
- Increased concentration of agri-food system on retail side also works against redesigning farming systems.
- Food prices, cost of living can make local markets unstable.

Storm Freddy: Malawi declares state of disaster as more than 200 killed

14 March 2023 Share Save

Peter Jegwa in Lilongwe & Will Ross in London
BBC News

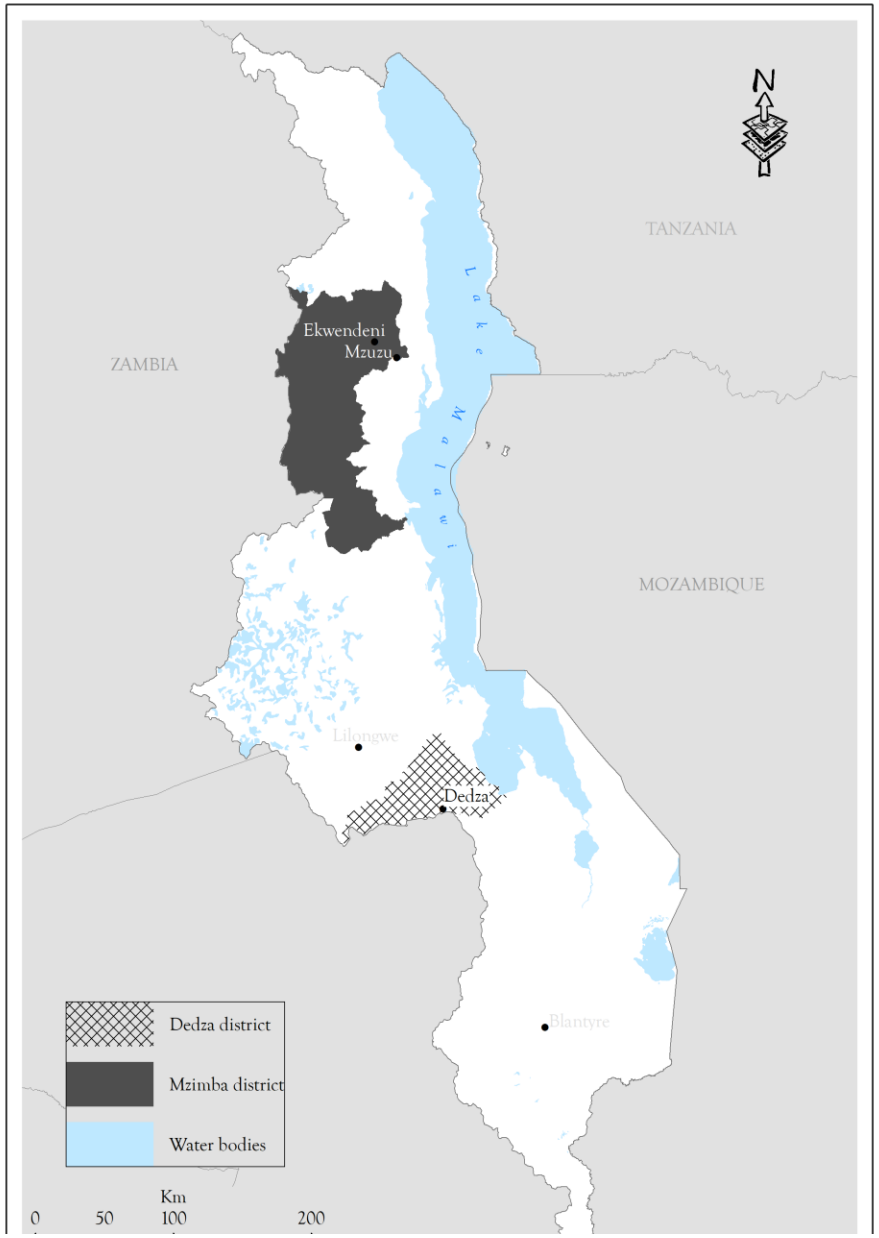
EPA

The destruction of roads and bridges has hampered relief efforts

Photo source: https://www.bbc.com/news/world-africa-64938811 and author.

Case Study 1: Malawi

- Maize-based with legumes, tubers, tobacco
- Mixed farming, ~50% have poultry, pigs or goats
- Low soil fertility, semi-humid agroecosystem
- Unimodal rainfall, ~1000-1500 mm/year
- Majority smallholder farms (3.85 million ha), average farm size in crop production 0.74 ha
- Chronic food insecurity, 50% live in poverty
- Average household size ~4.8 people
- Gender inequality and high child malnutrition
- Reliance on synthetic fertilizer; govt promoted fertilizer and monoculture maize with input subsidies but have increased in price at various time periods.



Source: Benson, T. and J. De Weerdt. 2023. Employment options and challenges for rural households in Malawi An agriculture and rural employment analysis of the fifth Malawi Integrated Household Survey, 2019/20 https://massp.ifpri.info/files/2023/04/Working-Paper-40-Apr2023-revised.pdf

Background: Child malnutrition & gender issues

Gender dynamics: additional labour to bury residue;
New decision-making about farm management

Farm Design I: Intercropped Legume Diversification and addressing Gender Inequities

Limited N contribution

- Maize & pigeonpea
- Pigeonpea & groundnut
- *Mucuna* rotation
- *Tephrosia* rotation

All rotated with maize

Pigeonpea

High N contribution

Groundnut (peanut)

Edible legumes for improved nutrition

Alternative market source

Reduce fertilizer costs

Improve soil health

Knowledge co-creation | **5. Biodiversity** | **3. Soil health** | **2. Input reduction** | **9. Social values and diets**

Participatory Approach

- Farmer Research Teams selected by communities, 1 man & 1 woman
- Test on their farms and teach other farmers
- Meet monthly to discuss issues
- Field days
- Farmer exchanges
- Annual workshops

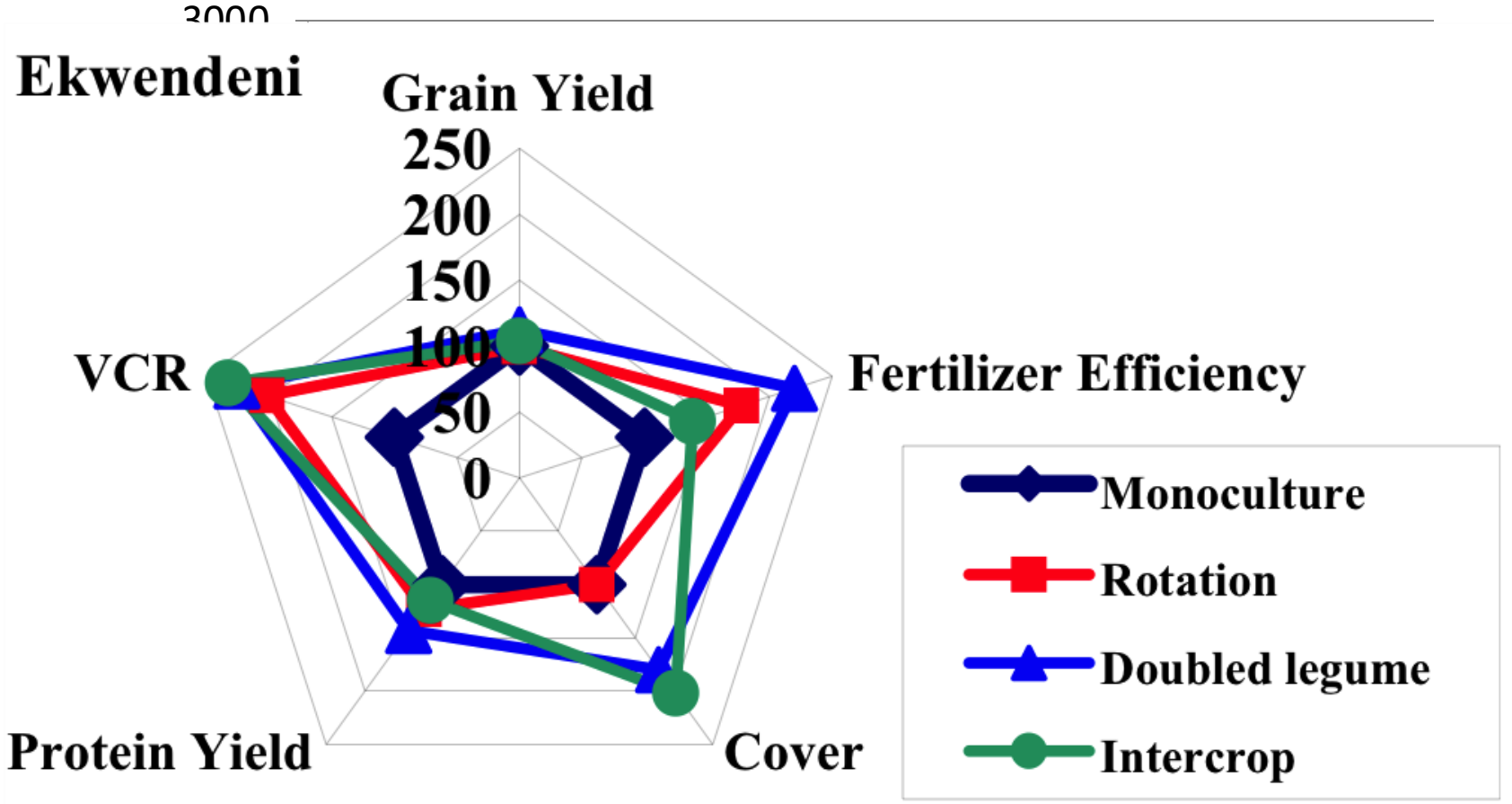
Research Methods

- ~150 semi-structured interviews
- 40 focus groups
- 4 surveys (2001, 2002, 2005, 2006): pre/post,control-intervention cross-sectional design of 350+ households
- 9 anthropometric surveys (2001-2007)
- Annual agricultural data from 100+ farmers
- *Iterative process*: changes to research and activities changed based on results.

Community education strategies

- Recipe days
- Small group discussions

Legume Diversification Increased Maize Yield, Soil Cover & reduced farm costs

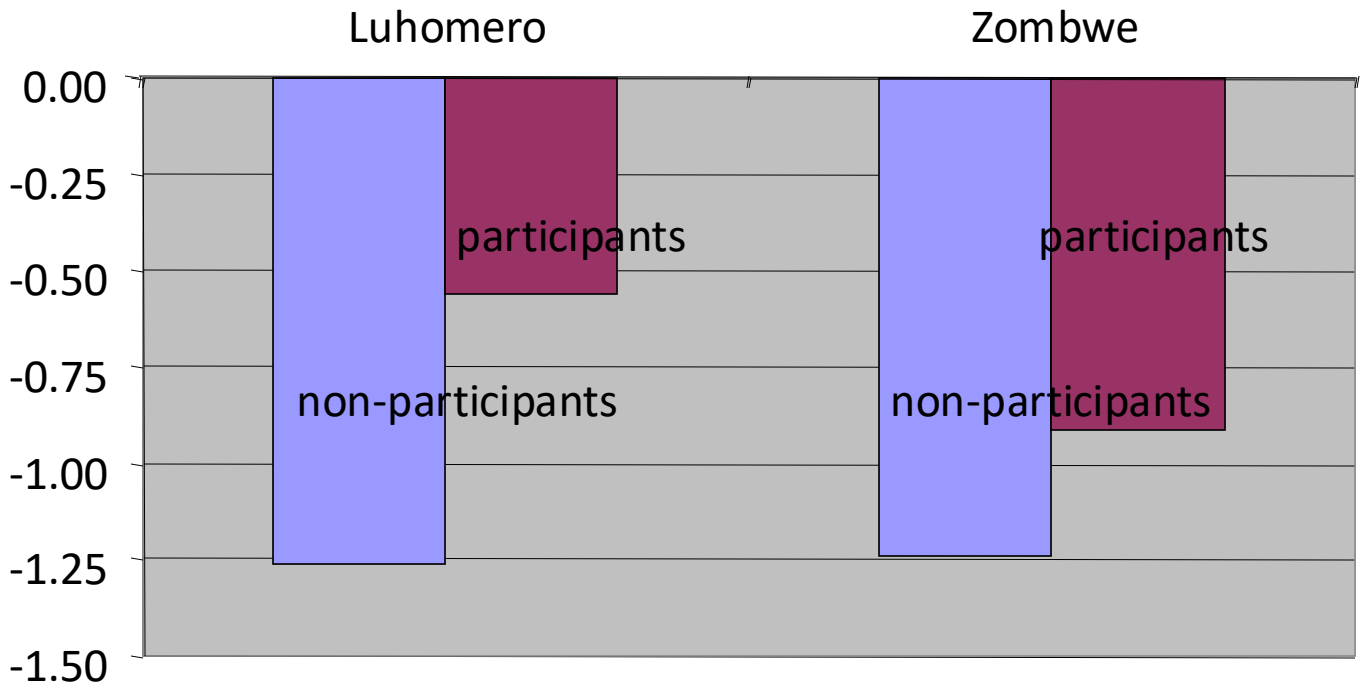


Source: S. S., M.J. Blackie, R.A. Gilbert, R. Bezner Kerr, G.Y. Kanyama-Phiri. 2010. 'Biodiversity can support a greener revolution in Africa' *Proceedings of the National Academy of Sciences* 107(48):20840-20845

Diversification improved child growth with participatory approaches, attention to equity

Participation in community-based nutrition activities, including recipe days, was necessary to impact child growth.

Child growth in first year participating villages, participating households vs non-participating households



Source: Bezner Kerr, R., Berti, P.R. and Shumba, L. (2010) 'Effects of Participatory Agriculture and Nutrition project on Child Growth in Northern Malawi' *Public Health Nutrition* 14(8):1466-1472

Farm Design 2: Diversification, Compost/manure + Farmer-to-Farmer exchanges

5. Biodiversity

1. Recycling

3. Soil health

6. Synergy

- Agroforestry (fruit & leguminous trees)
- Double intercropped legumes (pigeonpea, groundnuts)
- Compost and intensive animal manure application
- Crop diversification e.g. sorghum, finger millet, cowpea.
- Farmer-to-farmer learning, exchange and farmer experimentation.

Participatory Experimental Design: Malawi & Tanzania

Research Question: Can agroecological methods be used to improve food security, nutrition, livelihoods and well-being of smallholder African households?

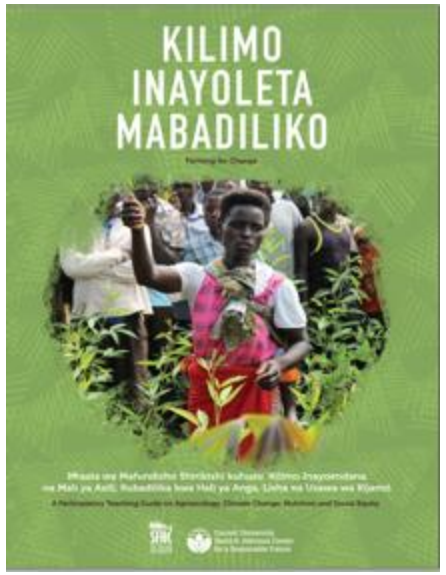
6000 households in Malawi, pre-post / control

588 households in Tanzania, pre/post and delayed intervention, cluster randomized trials

400 households in Malawi, food insecure, 20 villages, Pre-post design

8. Co-creation of knowledge

Testing Community-based educational activities *devised by farmers*



11. Connectivity

10. Fairness

- Developed integrated curriculum (agroecology, climate change, nutrition, social equity) aimed at farmers in southern Africa;
- Theatre, hands-on activities, story-telling, small group discussions.
- Developed by farmers, scientists, NGO staff.

Bezner Kerr, R., et al. 2019. Farming for change: Developing a participatory curriculum on agroecology, nutrition, climate change and social equity in Malawi and Tanzania, *Agriculture and Human Values* 36 (3): 549-66. Bezner Kerr, R. et al.. 2016. "Doing Jenda Deliberately" in a Participatory Agriculture and Nutrition project in Malawi. 2016. In: *Transforming Gender and Food Security in the Global South*. London: Routledge; Satzinger, F, et al. 2009. Farmers integrate nutrition, social issues and agriculture through knowledge exchange in northern Malawi. *Ecology of Food and Nutrition* 48 (5): 369-82.

Agroecological practices significantly improved crop diversity, food security & dietary diversity

Increased **food security** and **dietary diversity** in all studies. **Crop diversity, compost application** & participation in agroecology positively associated with food security.

In Malawi: women's dietary diversity higher for those in participatory agroecology intervention

A household was 32% less likely to be severely food insecure per additional food crop grown.

In Tanzania: Agroecology households 1.38x more likely to use sustainable soil health practices

Children in agroecology households 1.48x more likely to have min. acceptable diet

Kangmennaang, J. et al. 2017. Impact of a participatory agroecological development project on household wealth and food security in Malawi. *Food Security* 9: 561-576 Madsen, S., et al. . 2021. Explaining the impact of agroecology on farm-level transitions to food security in Malawi. *Food Security* Santoso, M.V., R. Bezner Kerr, et al. 2021. A nutrition-sensitive agroecology intervention in rural Tanzania increases children's dietary diversity and household food security but does not change child anthropometry: results from a cluster-randomized trial. *Journal of Nutrition.* Owoputi et al. 2022. Does Crop Diversity Influence Household Food Security and Women's Individual Dietary Diversity? A Cross-Sectional Study of Malawian Farmers in a Participatory Agroecology and Nutrition Project. *Food and Nutrition Bulletin*. 43(4):395-411.

Longer term and Landscape-level Changes

- Two years after project ended, 90% of surveyed participants (n=600) using agroecological practices;
- Follow—up study in 2 villages found agroecology-practising farmers **had significantly more land** under fallow and less land under cultivation;
- Agroecology-practising farmers **valued biodiversity and ecosystem services of forests** more.
- Soil agroecological practices had positive landscape-level impacts on some types of **biodiversity** e.g. butterfly species richness, wasp abundance.

Kansanga, M., et al. 2020. Determinants of smallholder farmers' adoption of short-term and long-term sustainable land management practices. Renewable Agriculture and Food Systems. Kpienbaareh, D., et al.. 2022. Assessing Local Perceptions of Deforestation, Forest Restoration, and the Role of Agroecology for Agroecosystem Restoration in northern Malawi. *Land Degradation and Development*. Vogel, C. et al. 2023. The effects of crop type, landscape composition and agroecological practices on biodiversity and ecosystem services in tropical smallholder farms. *Journal of Applied Ecology* 60 (5):859-874. Vogel, C, et al. 2022. Local and landscape scale woodland cover and diversification of agroecological practices shape butterfly communities in tropical smallholder landscapes. *Journal of Applied Ecology*.

Multiple Pathways to Food Systems Change

Agroecological practices reduced farm/hhold costs:

- Saved money on foods previously purchased & fertilizer, **invested in animals as a source of savings;**
- No longer had to work off-farm, instead could invest in own farm and in **dry season vegetable gardens;**
- Led to significantly **higher farm income.**

Addressing gender inequity also mattered:

- In Malawi, farmers who **discussed farming with their spouse** were 2.4X more likely to be food secure & have diverse diets.
- In Tanzania participation in peer-to-peer agroecology intervention increased odds of **men doing household tasks** and reduced odds of **women's depression.**

Madsen, S., et al. . 2021. Explaining the impact of agroecology on farm-level transitions to food security in Malawi. *Food Security*. Santoso, M.V., et al. 2021. A nutrition-sensitive agroecology intervention in rural Tanzania increases children's dietary diversity and household food security but does not change child anthropometry: results from a cluster-randomized trial. *Journal of Nutrition*; Cetrone, H. M. et al. 2021. Food security mediates the decrease in women's depressive symptoms in a participatory nutrition-sensitive agroecology intervention in rural Tanzania. *Public Health Nutrition*; Bezner Kerr, R., et al. 2019. Participatory agroecological research on climate change adaptation improves smallholder farmer household food security and dietary diversity in Malawi. *Agriculture, Ecosystems and Environment* 279: 109-121. Kangmennaang, J., et al. 2017. Impact of a participatory agroecological development project on household wealth and food security in Malawi. *Food Security* 9: 561-576.

Farm Design III: Territorial Changes

- Value-added products e.g. flour; peanut butter;
- 4 regional agroecological markets;
- Natural forest regeneration and reforestation at farm and community scale;
- Gender transformative approaches to address systemic inequities;
- Converting food waste with Black Soldier Flies.

Participatory research critical design feature

Farmers participating in **farmer-to-farmer learning activities** in Malawi increased their knowledge, and significantly more likely to practice and sustain agroforestry, composting, mulching & legume intercrops.

Attention to social inequalities, such as gender division of labour and decision-making, and community-based educational activities important for ensuring positive impacts on nutrition.

Snapp, S. S. et al. 2023. Participatory action research generates knowledge for sustainable development goals. *Frontiers in Ecology and Environment* 21(7): 341–349, doi:10.1002/fee.2591 (including figure). Kansanga, M., et al. 2020. Determinants of smallholder farmers' adoption of short-term and long-term sustainable land management practices. *Renewable Agriculture and Food Systems*

Case Studies 2 & 3: Farm Design in European Context

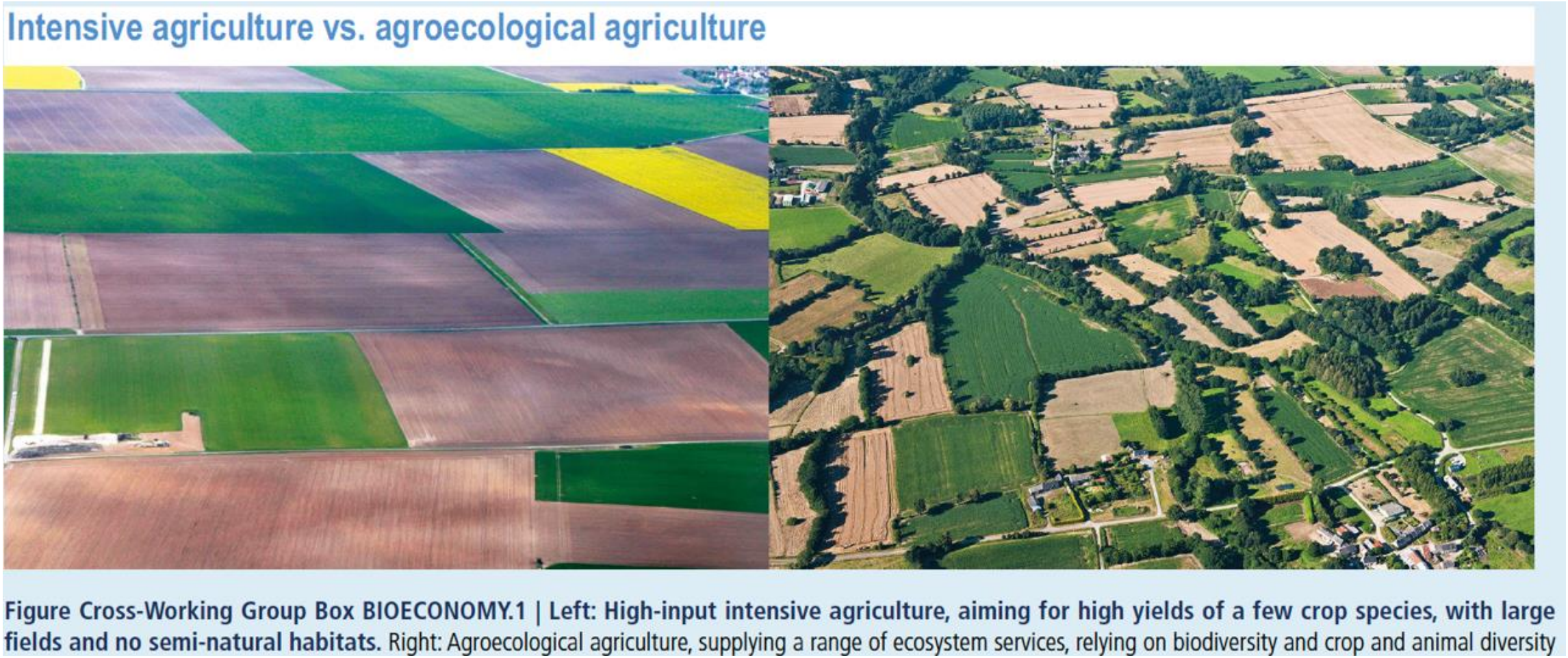


Figure Cross-Working Group Box BIOECONOMY.1 | Left: High-input intensive agriculture, aiming for high yields of a few crop species, with large fields and no semi-natural habitats. Right: Agroecological agriculture, supplying a range of ecosystem services, relying on biodiversity and crop and animal diversity

Photo credit: IPCC 2022, Chapter 5.

(some of the) Challenges in Global North Context

- Political economic barriers, including shifting political priorities;
- Lock-ins (e.g. infrastructure, subsidy programs);
- Knowledge gaps in shifting farm designs;
- Dominance of large companies on retail and input side influences potential;
- Declining employment in rural areas, out-migration;
- Loss of quality of life in rural areas;
- Social norms around convenience, fast food.

Case Study 2: Luberon Territory, France

Agriculture, Culture and Biodiversity Conservation

- Cultural history and terroir tied with agricultural production
- Natural and cultural heritage preserved by Regional Nature Park
- Initiatives for environmental protection, rural development.
- Collaboration agreement between park and communities.
- Promotion of local food production and consumption. Many terroir products.

Slides 22-27 adapted from Dr. Alexander Wezel. (Buckner 2022, Gruber 2018)

Luberon farming system features

2. Input reduction

5. Biodiversity

6. Economic Diversification

11. Connectivity

- Cover crops in vineyards
- Reduced pesticide use
- Flowering meadows
- Mixed livestock – crop systems
- Farmer cooperatives

Photos from: https://www.parcduluberon.fr/en/nos-actions/developpement-economique/agriculture/maec/

5. Biodiversity

6. Economic Diversification

9. Social values and diets

11. Connectivity

1. Recycling

13. Participation

12. Land and Natural Resource Governance

Links between Biodiversity Conservation & Regional Agricultural Heritage

Parc naturel régional du Luberon

Embedded food system supported by different actor groups who organize farmers' markets, CSAs, local product shops, local labels, quality labels/geographical indications, specific terroir products and products from the territory.

Pain du Luberon au blé meunier d'Apt

Agricultural systems by design

Some terroir products contributing to Luberon's food system transformation

Case Study 3: Allgäu region, Germany

- Characterized by large amount of permanent grassland
- Important area for biodiversity conservation and tourism
- Initiatives for rural development including ‘eco-model’
- Promoting local dairy products and organic food
- Strong cultural identity with the region

Diverse mixed farming systems

- Average farm size 20-25 ha, ~50 cows, mixed crops
- Often combine tourism and farming
- Intercrops, legumes, cover crops in crop rotation
- Extensive seasonal grazing in mountainous areas;
- Increased conservation of meadows, marshes
- High proportion of organic production
- Soil erosion measures
- Attention to animal welfare
- Farmer exchanges, workshops

Fig. 2 Prealpine landscape of the Allgäu (in the *foreground*) and the Alps (in the *background*)

Allgäu region, Germany: Embedded food system

Strong regional identity of local residents connected to agrifood system.

- Many local food initiatives – cultural identity provides regional market opportunities for farmers and food enterprises.
- **Networks and processess to promote regional development – exchanges of knowledge, ideas and experiences important**;
- Local supermarket Feneberg established VonHier brand for local organic products = in 1990s (in part as a response to Mad Cow Disease);
- Association Pro Nah in region promotes short supply chains through links to higher food quality and quality of life.
- Other food initiatives e.g. Village shop with citizen participation in Krugzell; Bio-Ring Allgäu creates free booklet with local organic food initiatives;
- Labels such as LandZunge, VitalZunge and Allgäuer Alpgenuss increase awareness for regional products.
-

(Gruber 2018)

Diversity and availability of local food products

- More than 400 different regional products sold under VonHier brand;
- Must be within radius of 100 km of Feneberg;
- 600+ organic farmers and 2 processing enterprises part of brand;
- Minimum of 6 food box schemes in region, some deliver up to 50 km away;
- Farmers' markets in ~30 towns in Allgäu region;
- Regiomaten – vending machines for local products – make local food accessible.

(Gruber 2018)

Collective Catering with local, organic food

- Organic model region started in 2016, with stakeholders from municipality, agriculture and catering companies brought together;
- Seminars and workshops encouraged collaboration;
- School volunteered to be ‘pilot’ school;
- Serves up to 30% local and organic food;

(Gruber 2018)

Challenges in the Global North cases

Luberon

Allgäu, Germany

- Increasing tourism and urban development may degrade habitats and reduce species richness;
- Pressure for agricultural intensification or abandonment;
- Loss of traditions and customs;
- Declining number of smallholders.

How to do Agroecological (re)Design of Farming Systems

- Study **complex social-ecological dynamics** of regional food system;
- Identify agroecological practices that are **relevant, feasible and effective**;
- Work to align **political-economic realities with farming system re-design**;
- Establish **participatory, iterative processes** to build relevance, acceptability, insights;
- **Local market** opportunities, **unique socio-cultural** features can sometimes support re-design;
- Build in regular **dialogue and governance systems** between stakeholders in farming system.

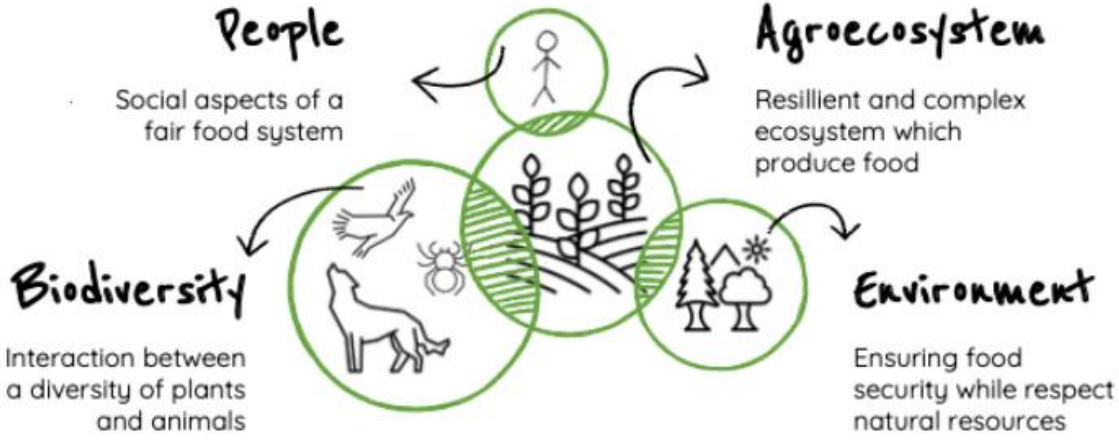


Figure 7: Agroecology: principles and concepts of an ecological and fair food production system

Some ideas drawn from Duru, M., Therond, O. & Fares, M. Designing agroecological transitions; A review. *Agron. Sustain. Dev.* **35**, 1237–1257 (2015). https://doi-org.10.1007/s13593-015-0318-x; Image from: Vegezzi, F. 2021. Urban AgroEcosystem Network UAEN - Agroecological frameworks for the Barcelona city transition toward biocity. Masters Thesis. DOI: 10.13140/RG.2.2.23450.93127.