Usages des terres, soutenabilité, travail : équilibre entre enjeux mondiaux et locaux

17èmes journées de recherche en sciences sociales INRAE, SFER, CIRAD
Campus Agro Paris-Saclay, 15 décembre 2023

Patrick Meyfroidt (1,2)

avec de nombreux collègues, en particulier **Cristina Chiarella** (IFAD),
FAO RuLIS team, FIBL, Dilini Abeygunawardane, Philippe Rufin…

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Outline

The goals of land use - balancing global tradeoffs & local livelihoods

Labor - the hidden dimension

Labor and farm size (How many farms and farmers do we *want* to feed the world - and themselves?)

Labor and alternative agricultures (How many farmers do we *need* to feed the world sustainably?)

Main reference / entry point: Chiarella et al. 2023

Ambio
https://doi.org/10.1007/s13280-023-01887-4

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RESEARCH ARTICLE

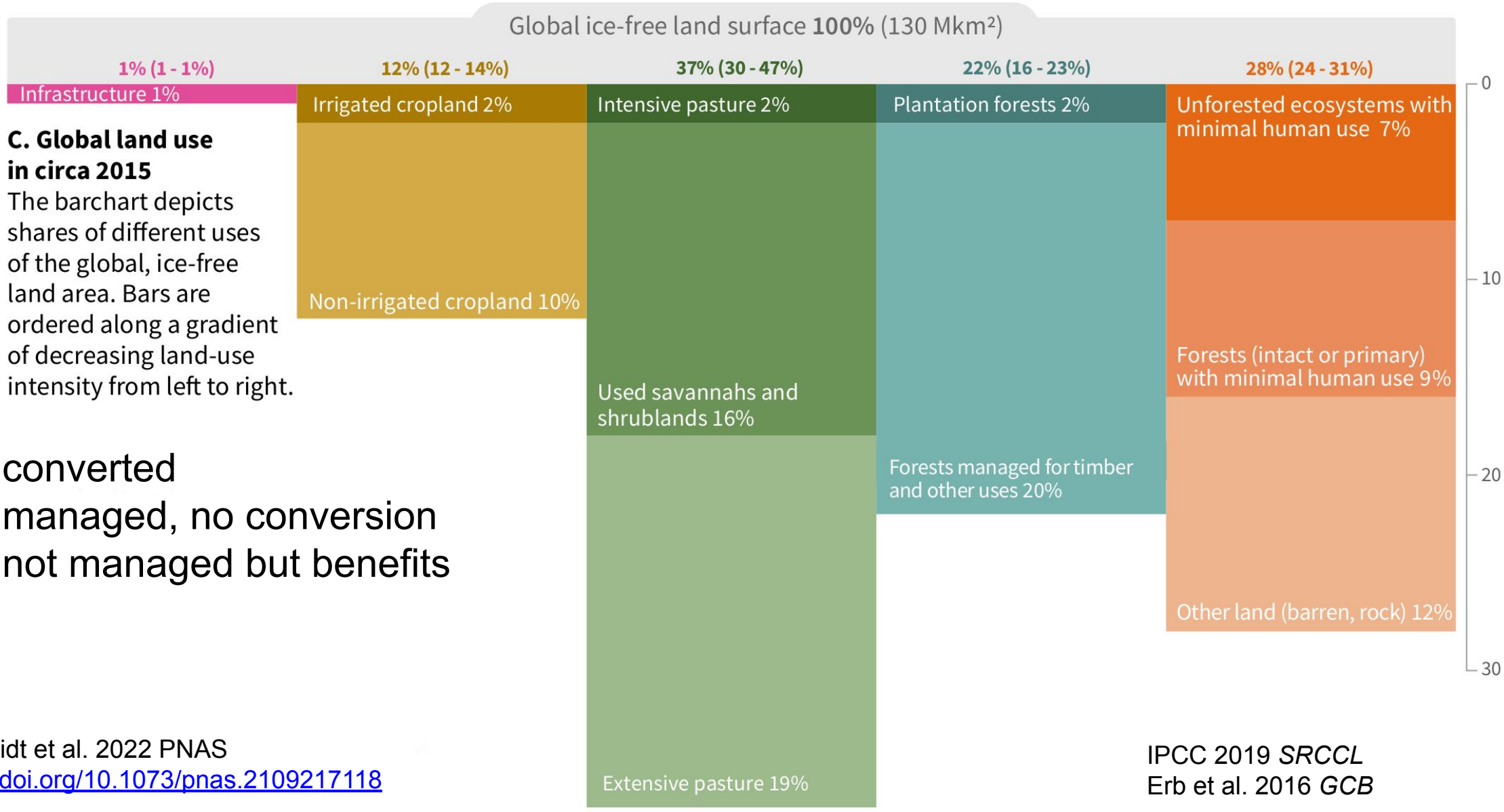
Balancing the trade-offs between land productivity, labor productivity and labor intensity

Cristina Chiarella, Patrick Meyfroidt, Dilini Abeygunawardane, Piero Conforti

https://doi.org/10.1007/s13280-023-01887-4

Land use: global goals and local impacts

Global land use & management : 13,000 Mha ice-free land



C. Global land use in circa 2015
The barchart depicts shares of different uses of the global, ice-free land area. Bars are ordered along a gradient of decreasing land-use intensity from left to right.

~24% converted
~52% managed, no conversion
~24% not managed but benefits

Meyfroidt et al. 2022 PNAS
https://doi.org/10.1073/pnas.2109217118

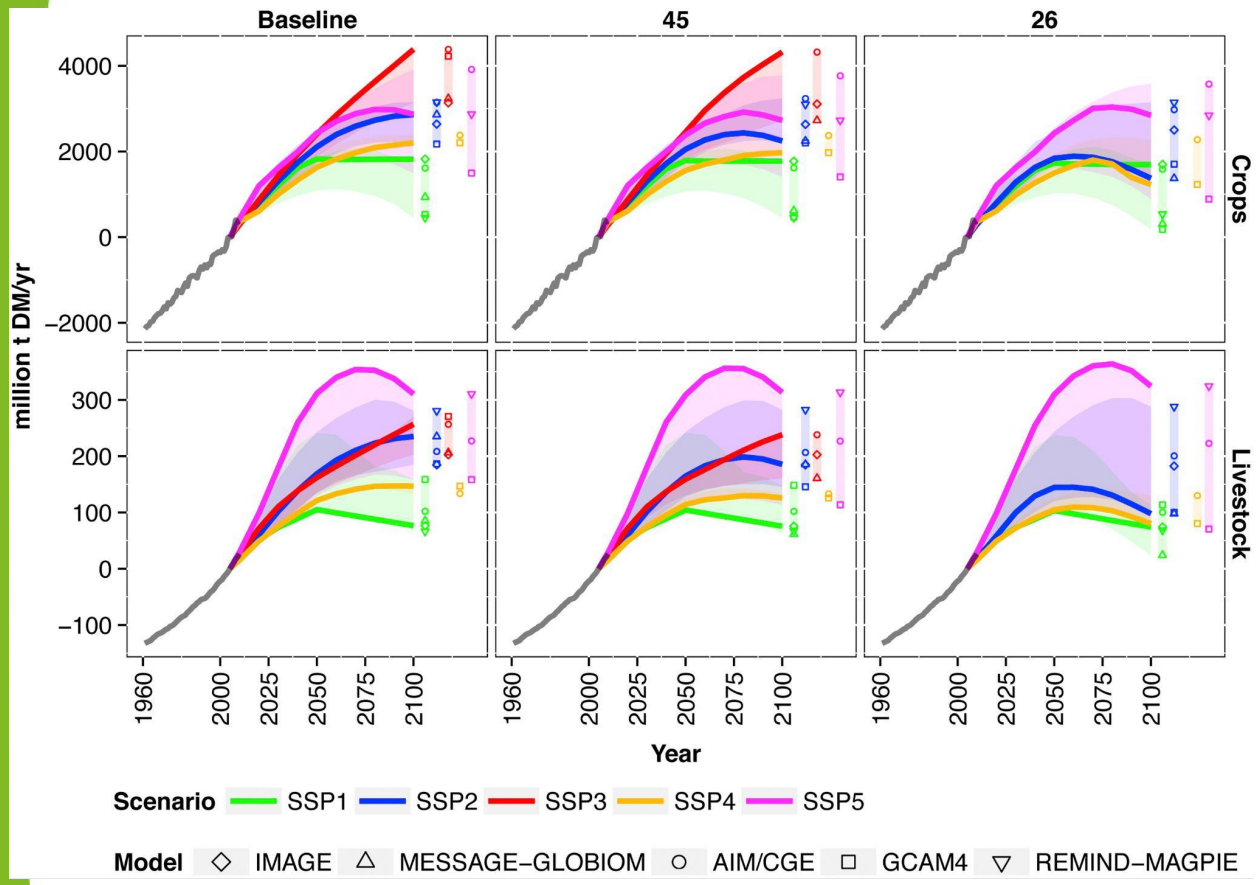
IPCC 2019 *SRCCL*
Erb et al. 2016 *GCB*

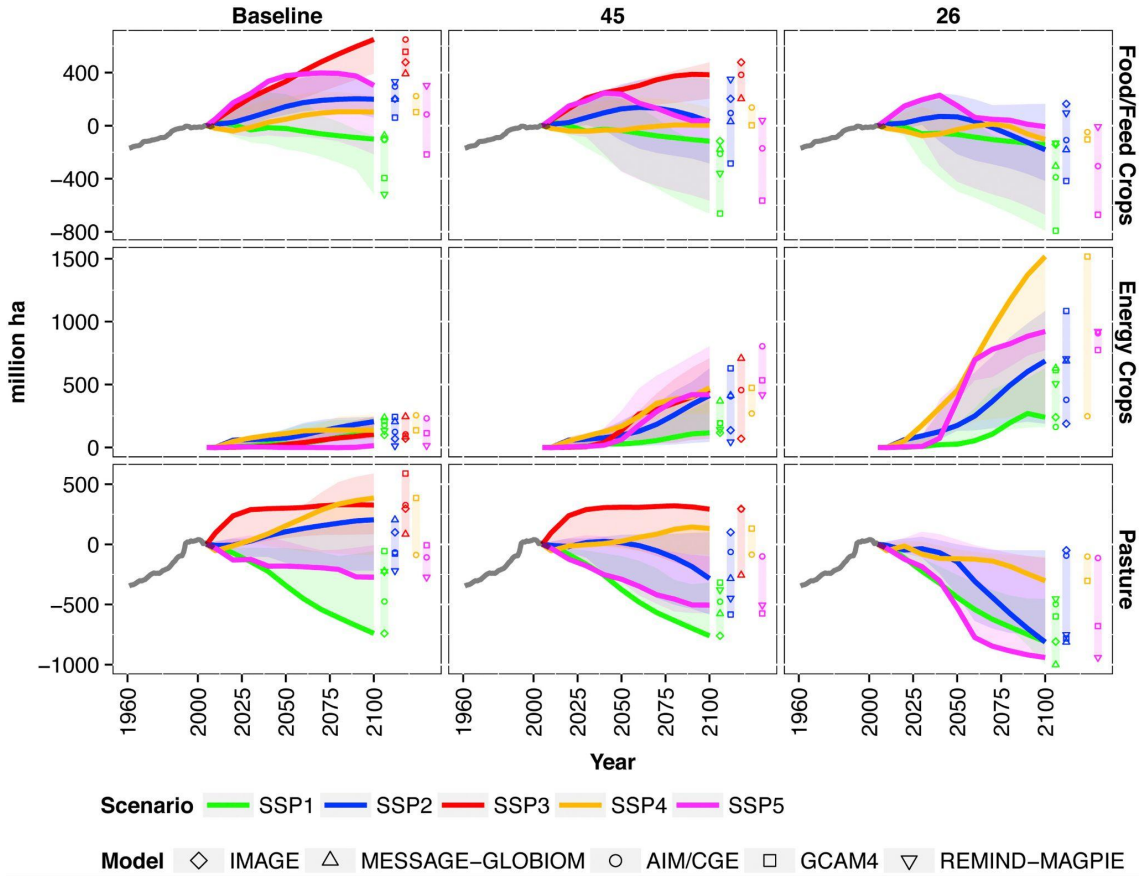
Multiple sustainability goals to balance

Food
Fiber, timber & materials
Water
Energy
Biodiversity Conservation
Carbon
Relational values (recreational, spiritual, heritage…)
etc
and Livelihoods

Meyfroidt et al. 2022 PNAS
https://doi.org/10.1073/pnas.2109217118

Land-use futures in the SSPs



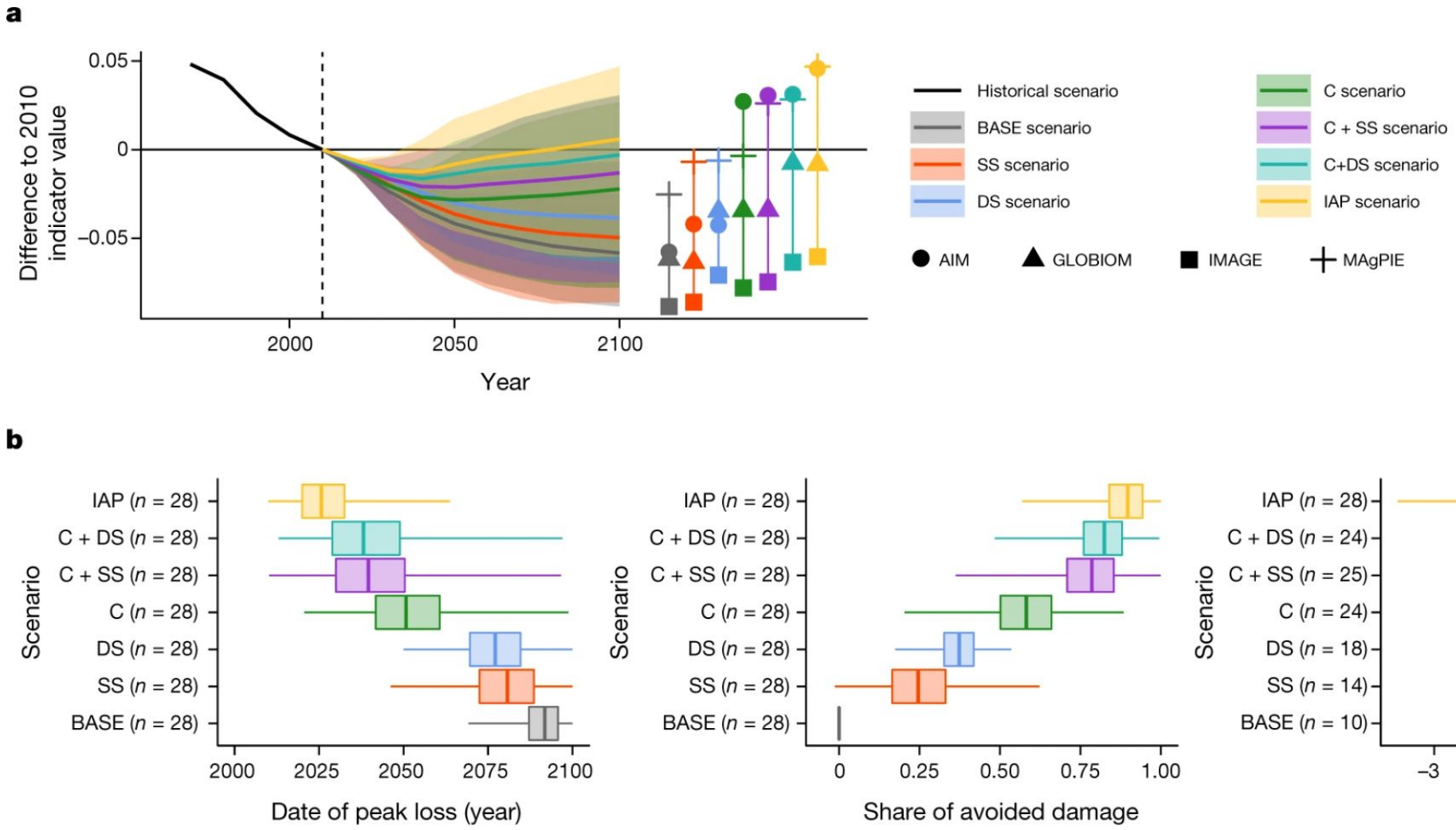


Land use & Emissions

Food supply/demand, food prices

Popp et al. 2017

Bending the curve of terrestrial biodiversity



Balancing food production and prices with biodiversity

Leclere et al. 2020

Only a subset

Table S1: Review of recent literature that uses Integrated Assessment Models (IAMs) or similar to study the relationships between environmental and social outcomes

Reference	Title	Short summary
Leclère et al. (2020)	Bending the curve of terrestrial biodiversity needs an integrated strategy	Several simulation scenarios estimated through land use and biodiversity models to show how certain conservation policies and supply and demand effects could revert biodiversity loss trends by still enabling the provision of food for the human population.
Williams et al. (2021)	Proactive conservation to prevent habitat losses to agricultural expansion	Models of future agricultural land clearance based on historical land clearance, combined with species-specific habitat of 20k species. The paper concludes that policies should target how, where and what food is produced to prevent loss of species habitat and contribute to healthier human diets.
van Dijk et al. (2020)	Stakeholder-designed scenarios for global food security assessments	Analysis of how global food security could be affected in light of four simulated scenarios characterized by high and low levels of two dimensions: natural resources use and social equality.
Popp et al. (2017)	Land-use futures in the shared socio-economic pathways	Use of IAMs for projections of possible land-use changes and their consequences for the agricultural system, food provision, prices, and greenhouse gas emissions.
Springmann et al. (2018)	Options for keeping the food system within environmental limits	Through a global food systems model, this paper simulates how expected changes in population and income levels could increase the environmental effects of the food system. Options for reducing the environmental effects are also analyzed.
Hasegawa et al. (2015)	Scenarios for the risk of hunger in the twenty-first century using Shared Socioeconomic Pathways	Simulation of five scenarios of the Shared Socioeconomic Pathways (SSPs) using Integrated Model CGE and analysis of how each will affect future hunger risk. These scenarios differ in terms of "sustainability", "fragmentation", and combinations of these across high and low-income countries.
Wirsenius et al. (2010)	How much land is needed for global food production under scenarios of dietary changes and livestock productivity increases in 2030?	Scenarios of global land use for 2030 to investigate the potential of land-minimized growth of food supply. The scenarios are related to: efficiency in animal production, decreased food waste, and dietary changes.
Tilman et al. (2011)	Global food demand and the sustainable intensification of agriculture	Projections of global demand for crop production for 2050 and evaluation of the environmental impacts of different ways to meet this demand, in terms of intensification/extensification across richer and poorer nations.
Adams et al. (2004)	Biodiversity Conservation and the Eradication of Poverty	Review of the links between poverty alleviation and biodiversity conservation. Provides a conceptual typology with four links: i) poverty and conservation are separate policy realms, ii) poverty is a critical constraint on conservation, iii) conservation should not compromise poverty reduction, iv) poverty reduction depends on living resource conservation.
Barrett et al. (2011)	On biodiversity conservation and poverty traps	Preamble of special issue on empirical papers that explore link between biodiversity conservation and poverty traps. Papers in special issue are characterized as: i) those that explore the relationship between protected areas and poverty, and ii) new economic, social, and political approaches to achieve biodiversity conservation and social improvement.
Grace et al. (2016)	Integrative modelling reveals mechanisms linking productivity and plant species richness	Provides evidence, by analysing global grassland plots, that accumulation of biomass leads to a negative effect of species richness, species richness increases productivity, and climate and soils richness increase productivity.
Liang et al. (2016)	Positive biodiversity-productivity relationship predominant in global forests	Analysis in 44 countries that shows that a loss in biodiversity leads also to a loss in forest productivity.

Chiarella et al. (2023) *Ambio*

Focus of global sustainability

- Land use as a(n environmental) sustainability issue - deforestation, land use impacts on carbon, biodiversity, etc.

- Land use as a food provider for broader food systems / societies (global food production/security)

- >> Need for intensification & land sparing, increasing **land productivity**

(+ emissions on farms etc,
+ actions on food demand, regimes…)

Chiarella et al. (2023) *Ambio*

Labor productivity & income, poverty

- Farm-level accounting: labor as an input, more labor = lower efficiency, productivity

- Impact evaluation often assess impacts on the "treated", e.g. households that have experienced a certain intervention
(an investment project, new agricultural technique, land tenure change, insertion into newly developed economic sectors or activities...)

- Focus on SDG 2.3 *"double the agricultural productivity and incomes of small-scale food producers..."*
Indicator 2.3.1: Volume of **production per labour unit** by classes of farming / pastoral / forestry enterprise size

- >> reflected in income, poverty or **labor productivity** as a proxy

Chiarella et al. (2023) *Ambio*

Labor demand - the hidden dimension

Change the perspective

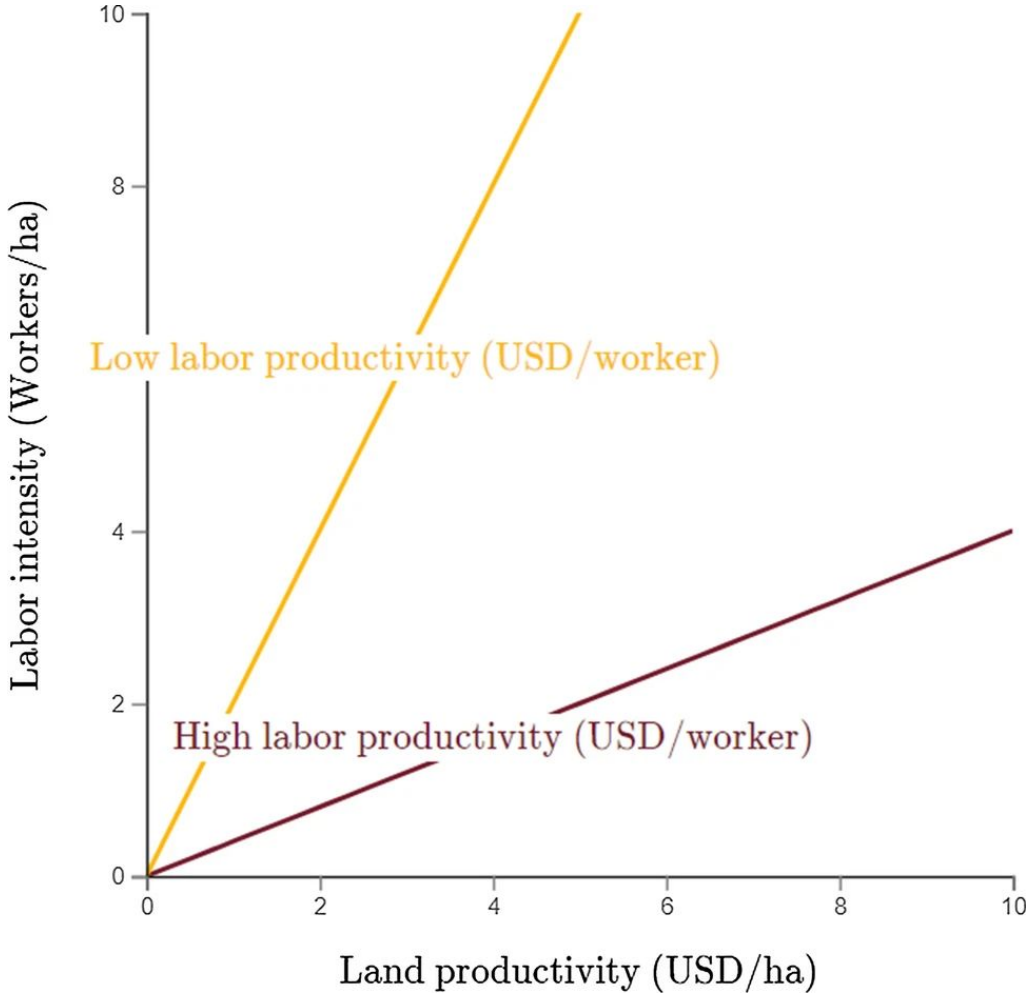
Food production /= Food security
Increase food production as much as you want, you won't fix food security

Land use as a livelihood provider - doesn't matter what you grow or where it ends up (food waste, leisure crops...), as long as you can live out of it

>> Labor (whether on one's own farm or as wage labor)
>> "Refuge sector"

Meyfroidt (2017) *GFS*
Meyfroidt et al. (2019) *COSUST*
Chiarella et al. (2023) *Ambio*

The land-labor productivity-intensity identity



$$Labor\ productivity = \frac{Land\ productivity}{Labor\ intensity}$$

$$\frac{Y}{L} = \frac{\frac{Y}{A}}{\frac{L}{A}}$$

>> Not explicitly including labor intensity (demand) implies treating it as an adjustment variable

Chiarella et al. (2023) *Ambio*

The future ahead?

- “Farming without farmers”, "A World Without Farmers"? (Lewis Path / structural transformation / ecomodernism / smart farming)
- Or Lewis Trap? (farmers trapped in low productivity agriculture, divergence between farm and non-farm sectors) (Dorin, Hourcade, Benoit-Cattin 2013)
- Or an alternative path with some higher quantity & quality of labor in agriculture?

e.g. also Losch (2022) FSFS https://doi.org/10.3389/fsufs.2022.862249

Exploratory works: labour requirements

Fig. 3 Total labour requirements (AWU) in the current and future agricultural mechanisation scenarios.

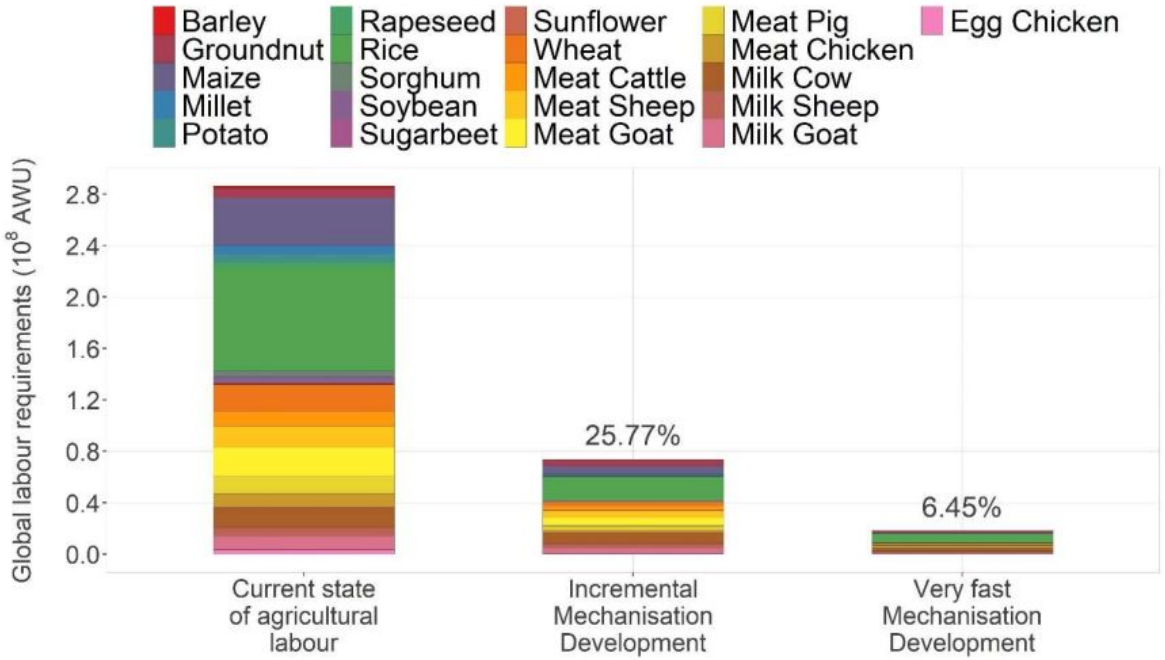
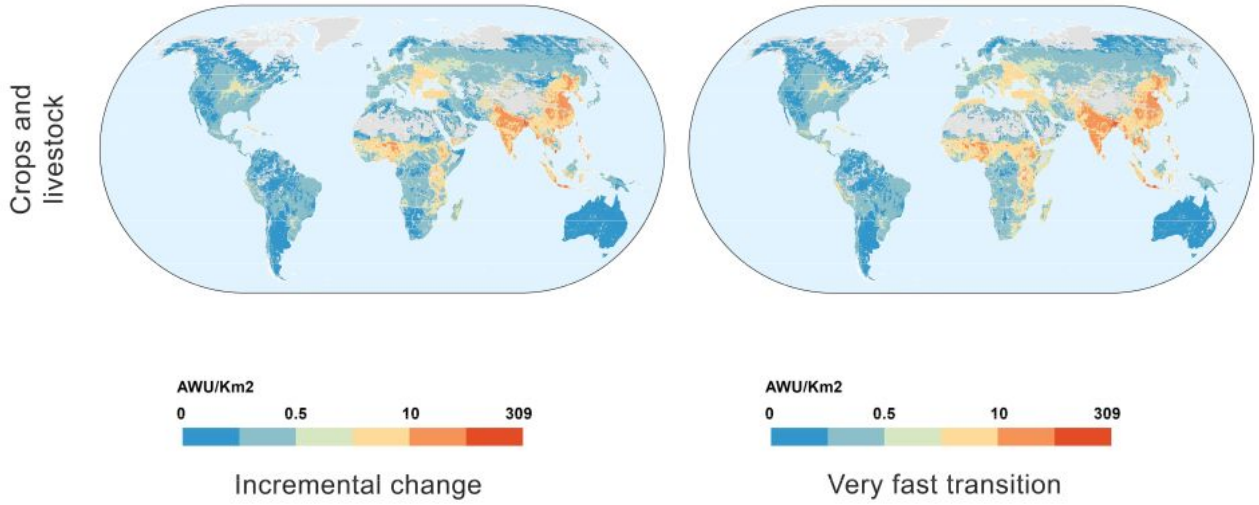


Fig. 4 Potential release of labour per square kilometre (AWU / Km^2).



Global farm labour requirements **reduced by ~74%**
~286 M AWU -> ~74 M AWU
!! but in fact **650 M people** !!

Vittis et al. (2022) preprint

Exploratory works: number of farms

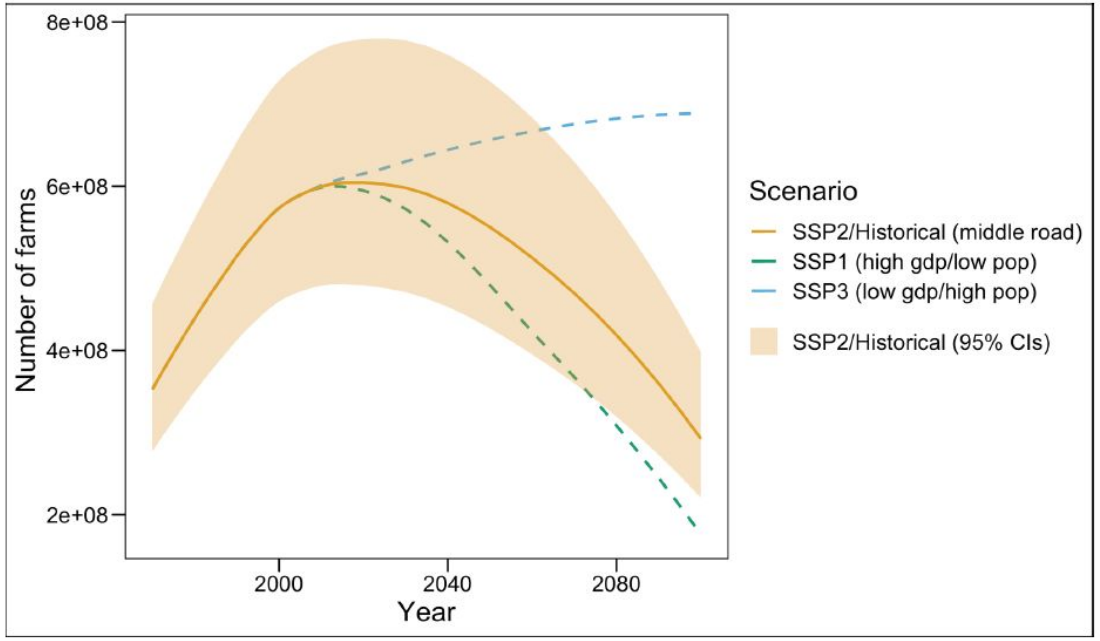
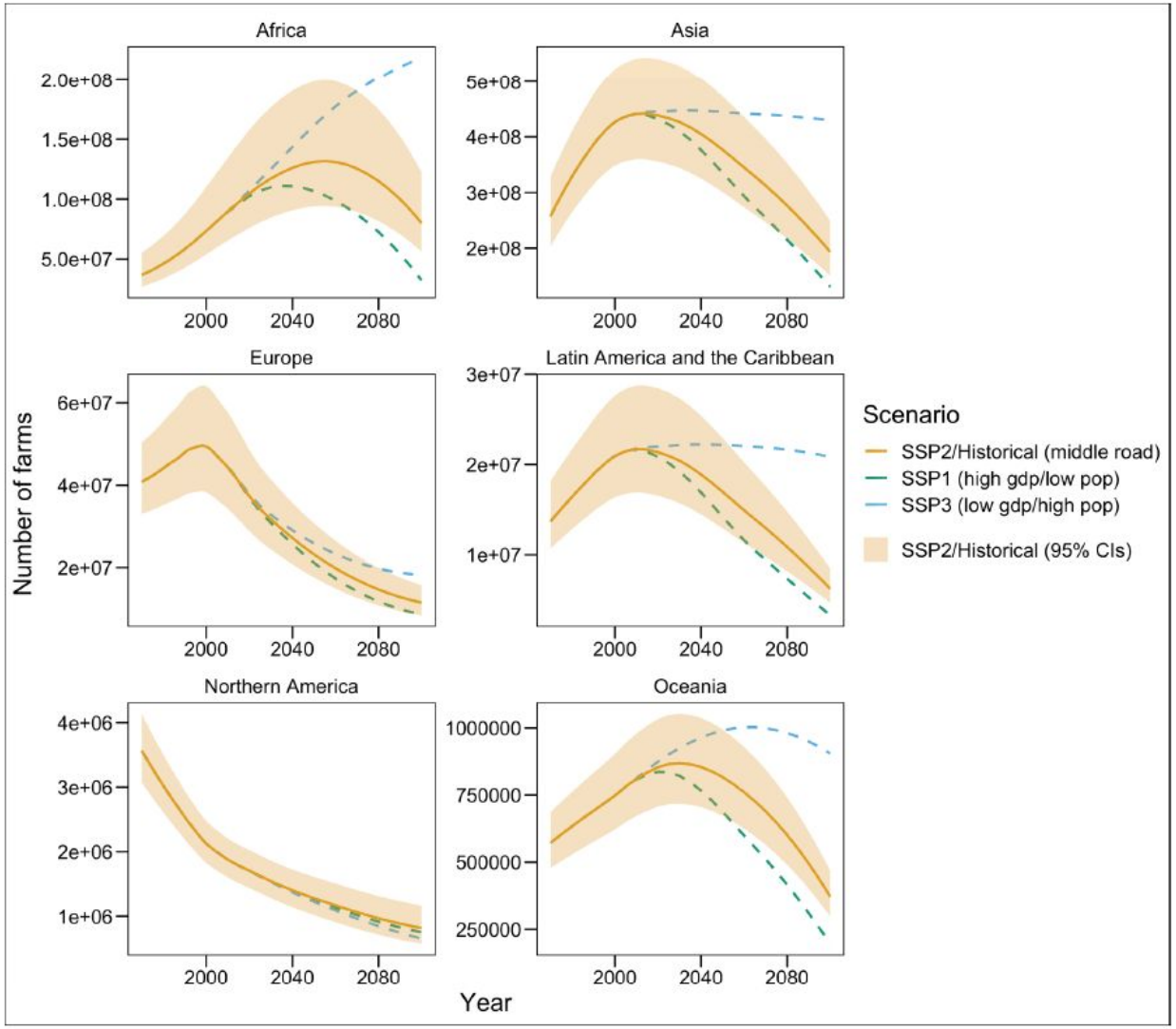


Figure 3. The global historical and future evolution of farms (1969-2100).

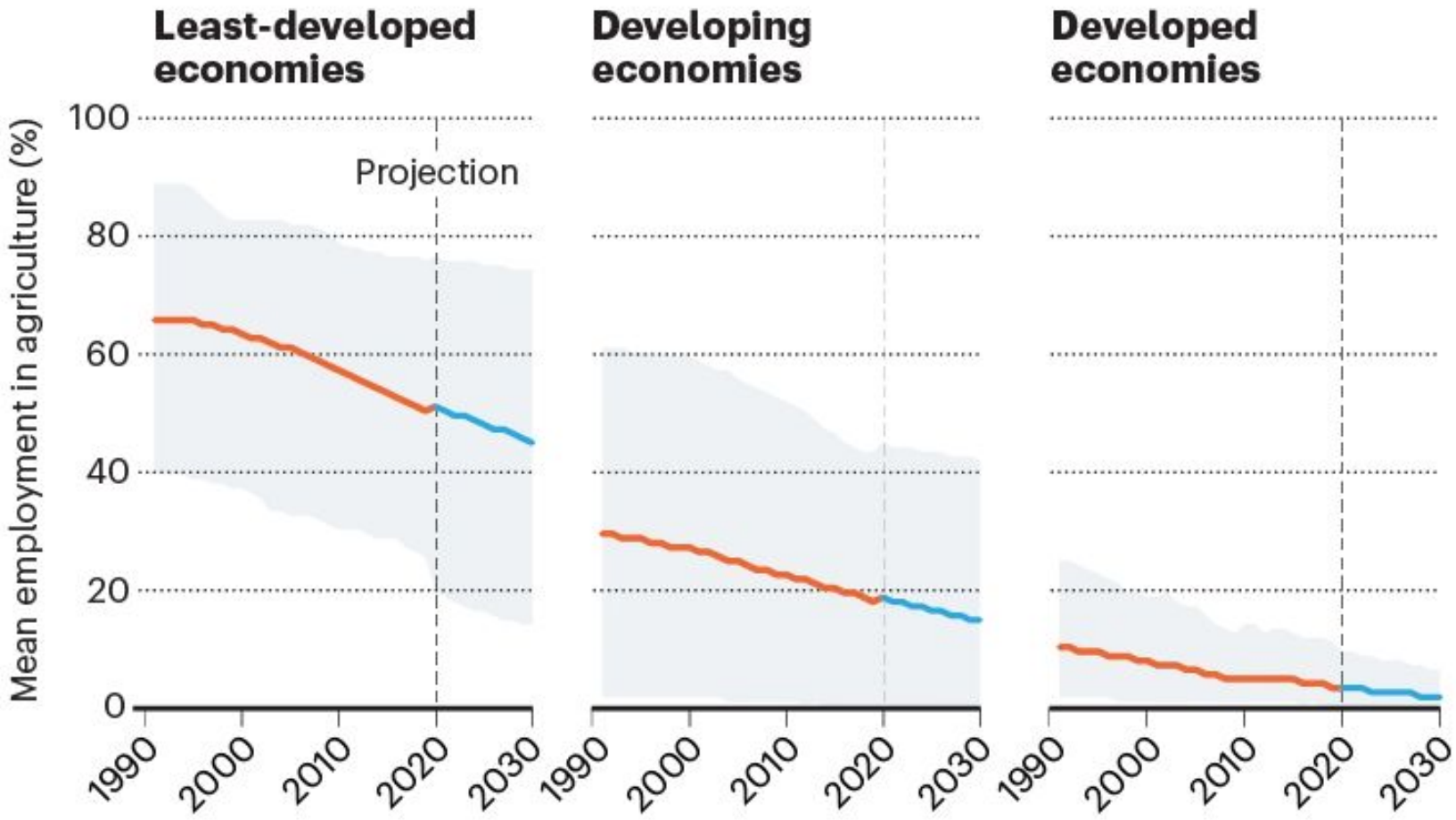


616 M in 2020 -> 272 M in 2100

Mehrabi et al. 2023 *Nature Sustainability*

THE DECLINE OF FOOD-PRODUCTION JOBS

Millions of jobs in food production have been lost globally in the past 30 years, and the trend is projected to continue. The problem is worse in least-developed economies, where many people depend on jobs in agriculture.



Grey shading shows variation in % employment among 180 countries in United Nations development categories; see Supplementary information. Country categorizations are as defined by the UN.

Source: ILO

Brondizio et al. 2023
Nature

Off-farm labor absorption?

"Mothers wanted more of their children to seek livelihoods elsewhere than stay in the village"

Yet, the mothers are concerned about the viability of that strategy also:

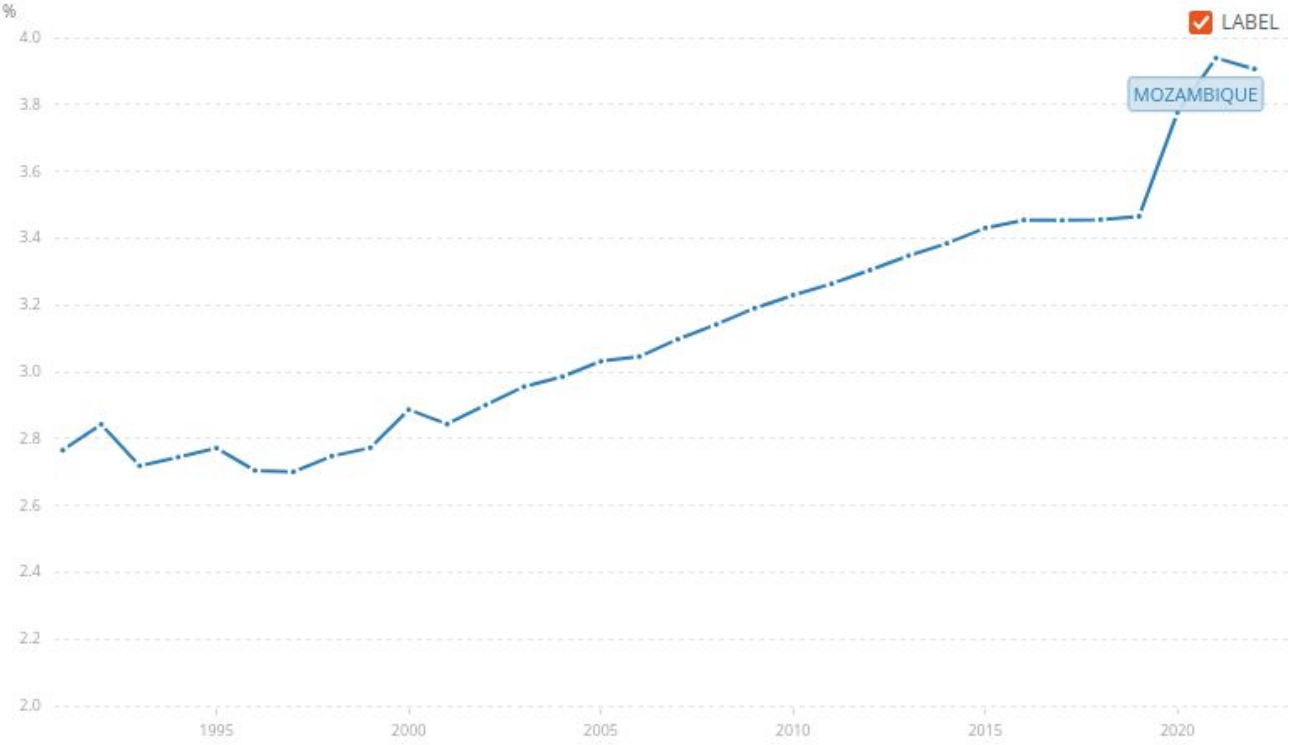
"mothers' doubts about the future availability of off-farm jobs are warranted: by some estimates, the Ugandan economy would need to generate ≥700,000 new non-farm jobs annually to keep up with growth in the labor force, far beyond the current increment of 75,000 (World Bank, 2021)."

(Lroe et al. 2022)

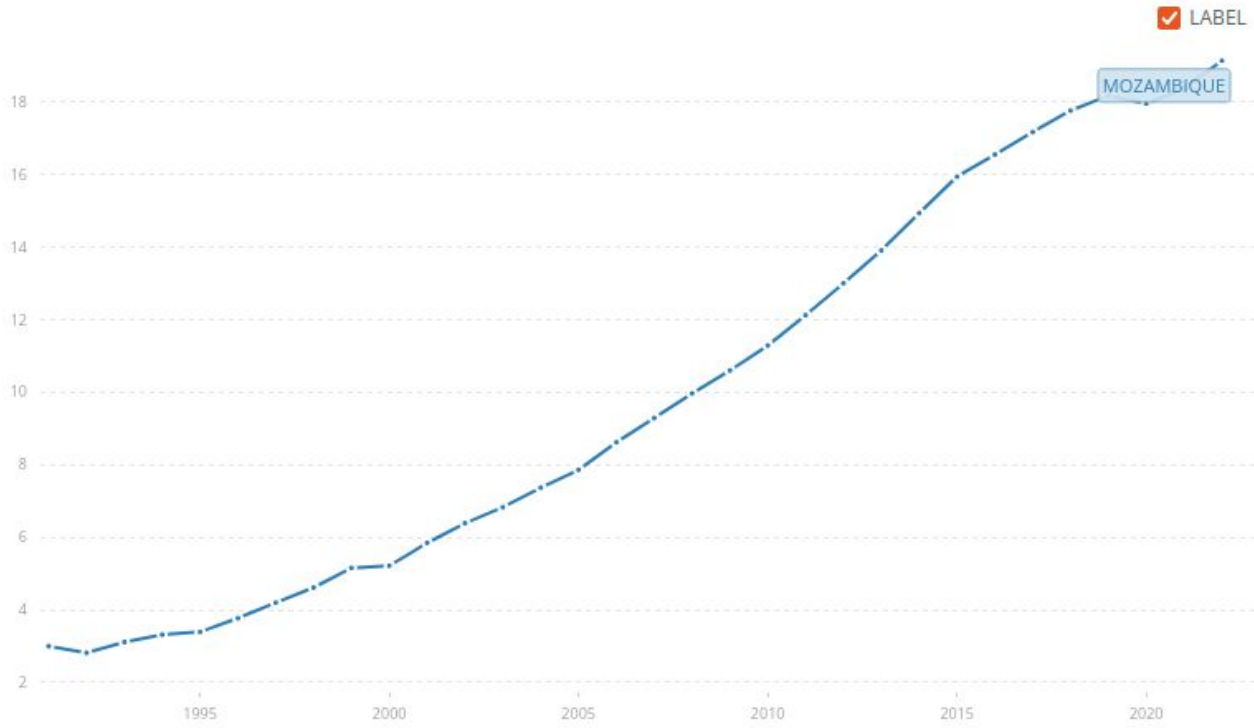
Unemployment rate 1991-2022, SSA & LDC

https://ilostat.ilo.org/data/

Mozambique: unemployment versus economic growth



Unemployment rate



GDP/cap
(constant 2015 USD)

https://ilostat.ilo.org/data/

https://data.worldbank.org/indicator/NY.GDP.PCAP.KN?locations=MZ

Living in slums?

Contrasted outcomes for those who abandon farming and try to make a better living in cities, and often end up in slums - ! cases from quite “absorbing” economies !

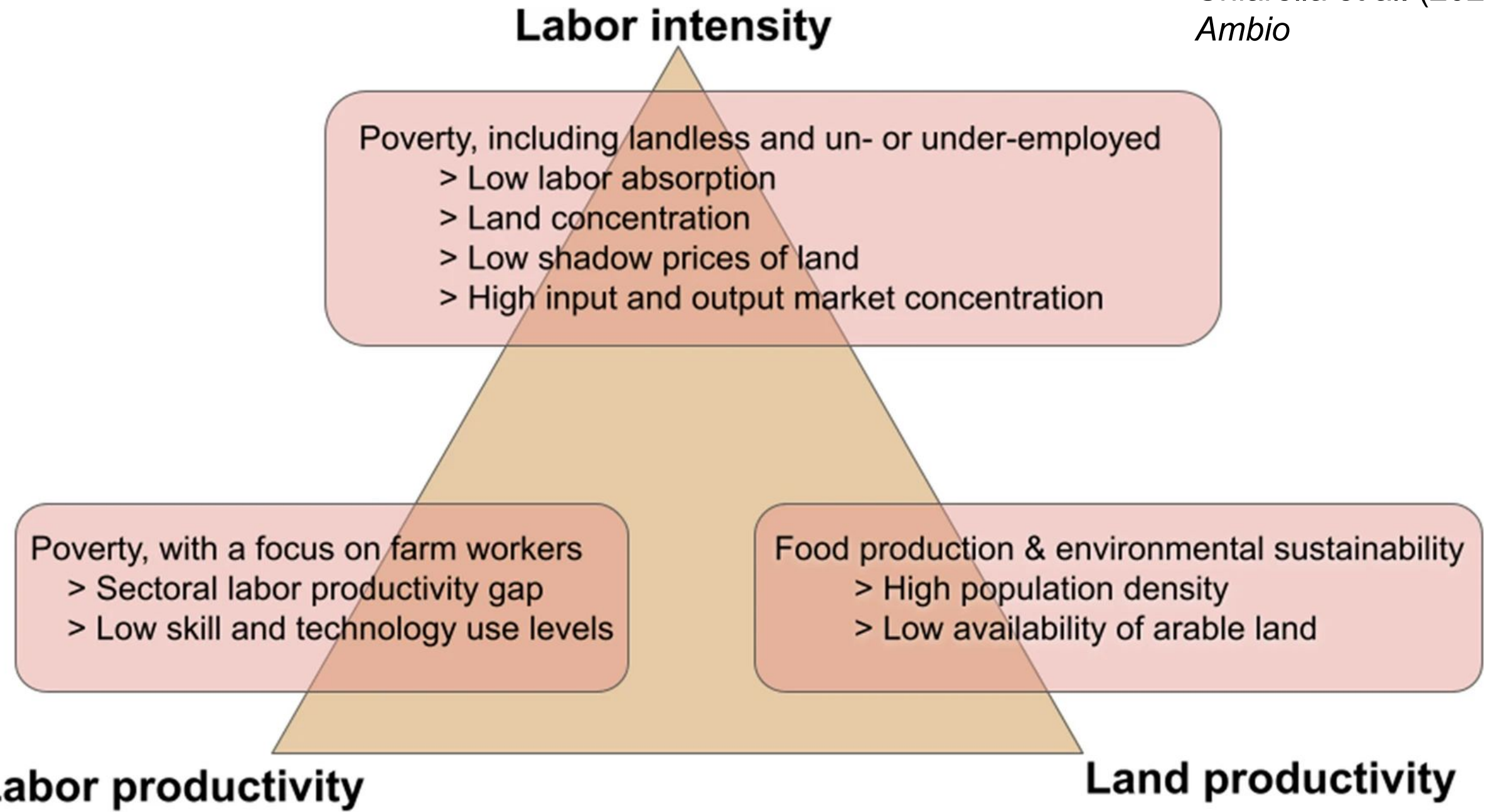
Pakistan: people moving experience mental distress and even though their consumption levels rise, their subjective well-being decreases (Chen et al. 2019).

Mumbai: higher subjective well-being of smallholders having migrated to slums versus staying in rural areas (Coulibaly and Managi 2022).

Agricultural investments

Context dependence

Chiarella et al. (2023)
Ambio



Farm size

Farm size and labour requirements

Large-scale
~2000 ha and >

Seasonal labor: 0.1 p/ha/day
Permanent: 0.04 p/ha/day

Medium-scale
~20 ha

Seasonal labor: 2 p/ha/day
Permanent: 1 farmer + 0.05 p/ha/day

Small-scale
~1 ha

Seasonal labor: 2 p/ha/day
Permanent: 1 family

Numbers from Baumert et al. 2019 *WD*, Central Mozambique

Data

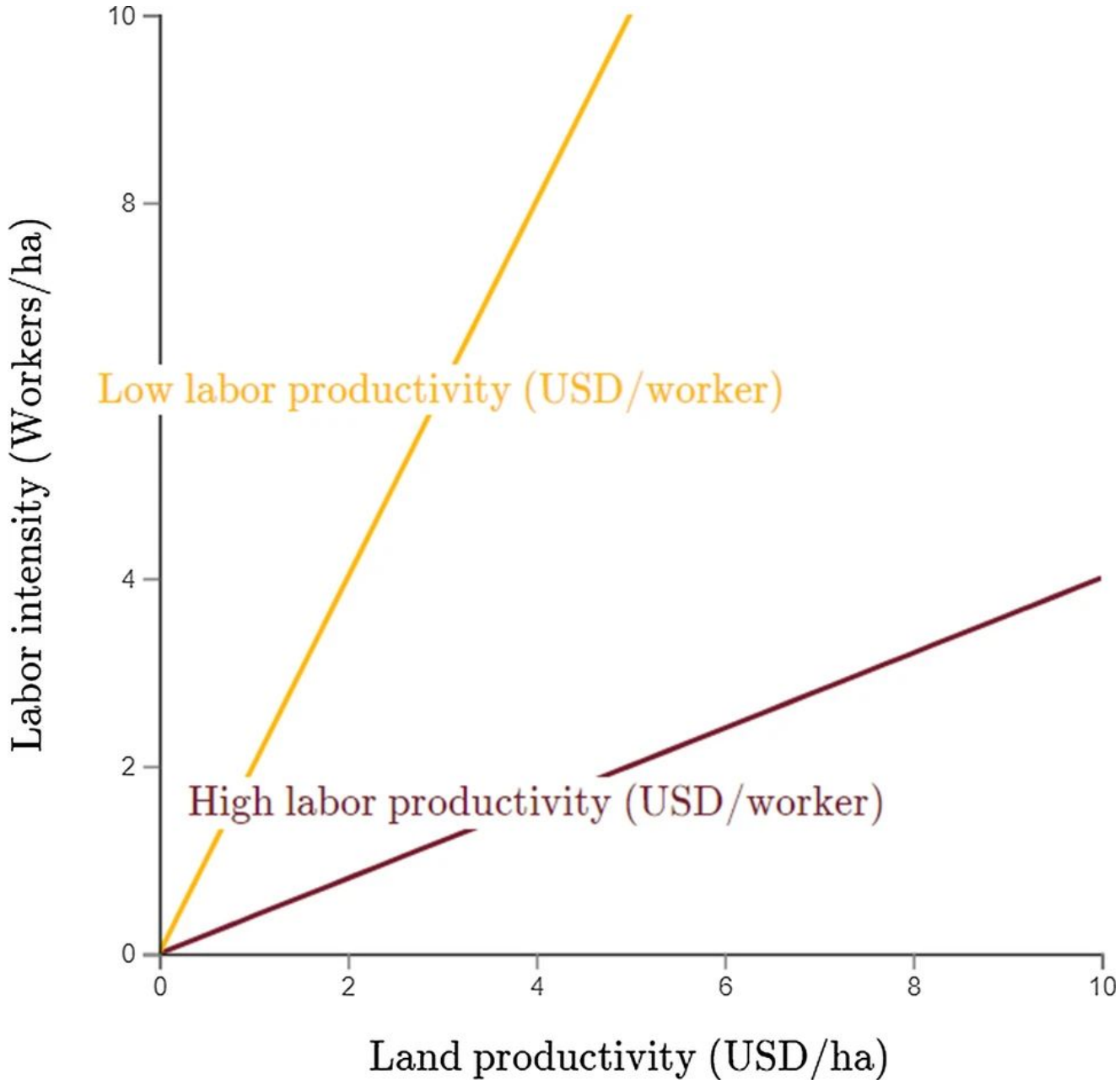
RuLIS data from FAO (P. Conforti and team), 32 countries

Labor intensity data only: Burkina Faso, Ethiopia, India, Malawi, Mali, Niger, Nigeria, Panama, Tanzania, Uganda

Other variables: + Albania, Armenia, Bangladesh, Bolivia, Bulgaria, Côte d'Ivoire, Ecuador, Georgia, Ghana, Guatemala, Iraq, Kenya, Kyrgyzstan, Mozambique, Nepal, Nicaragua, Pakistan, Peru, Rwanda, Serbia, Timor-Leste, Vietnam

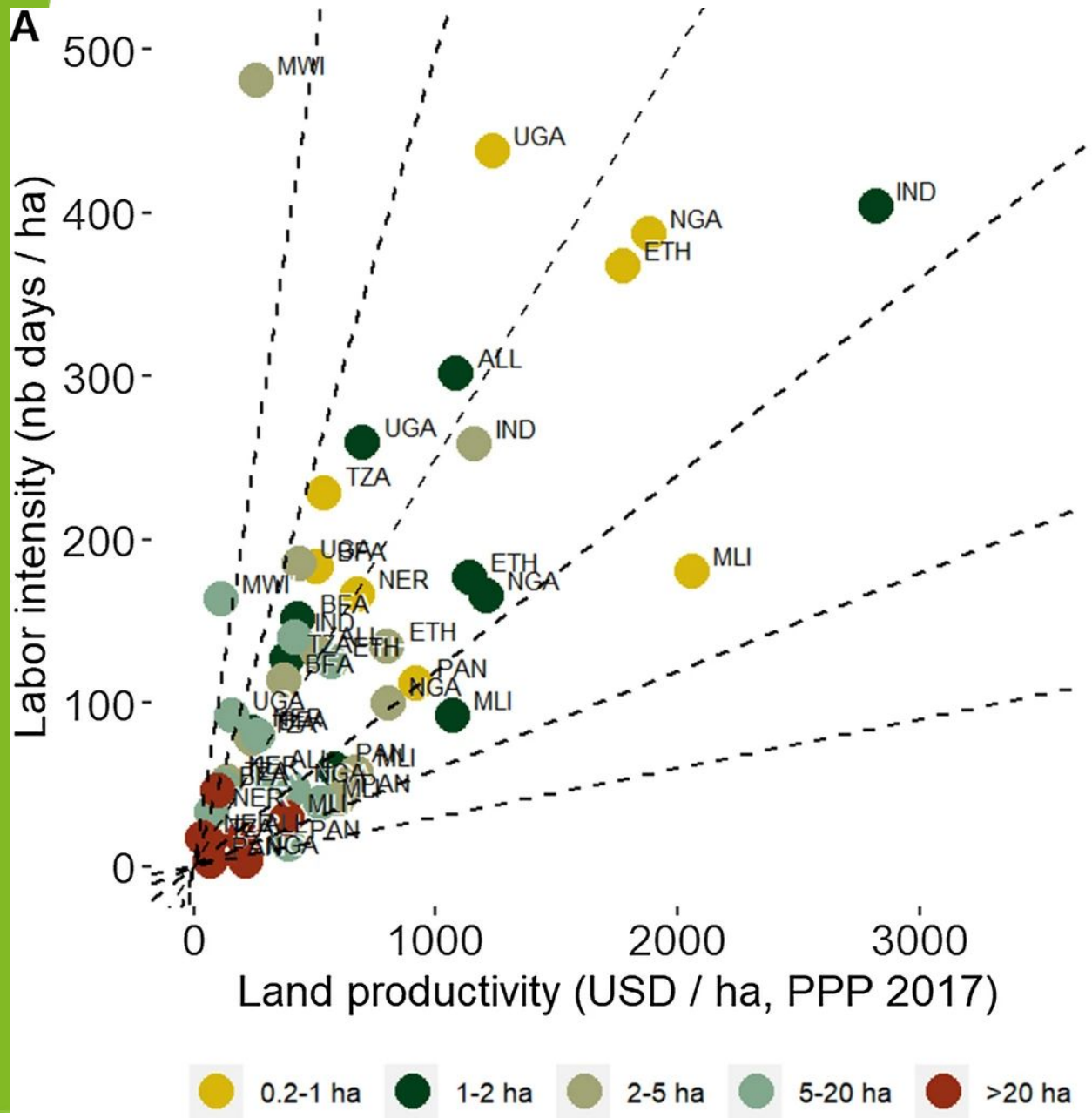
Surveys between 2005 and 2020.

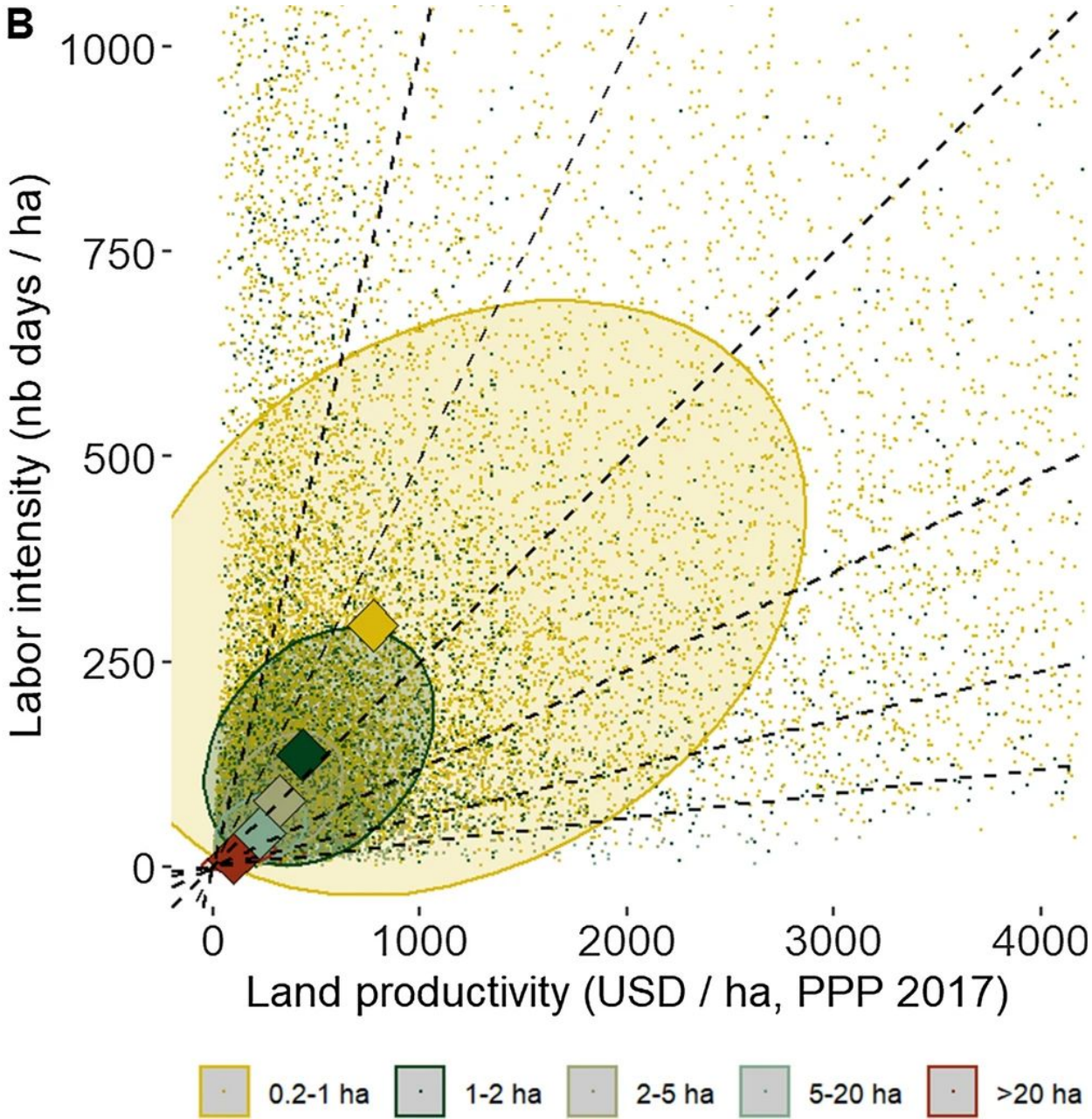
Tradeoff space



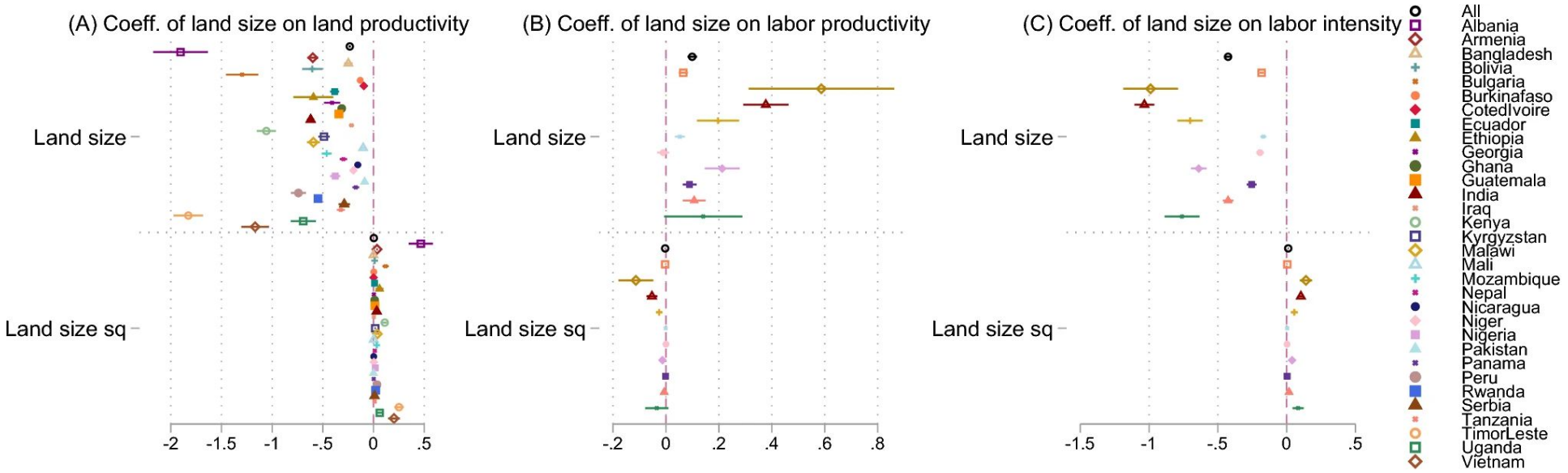
The tradeoff space across farm size ranges

Chiarella et al. (2023) *Ambio*





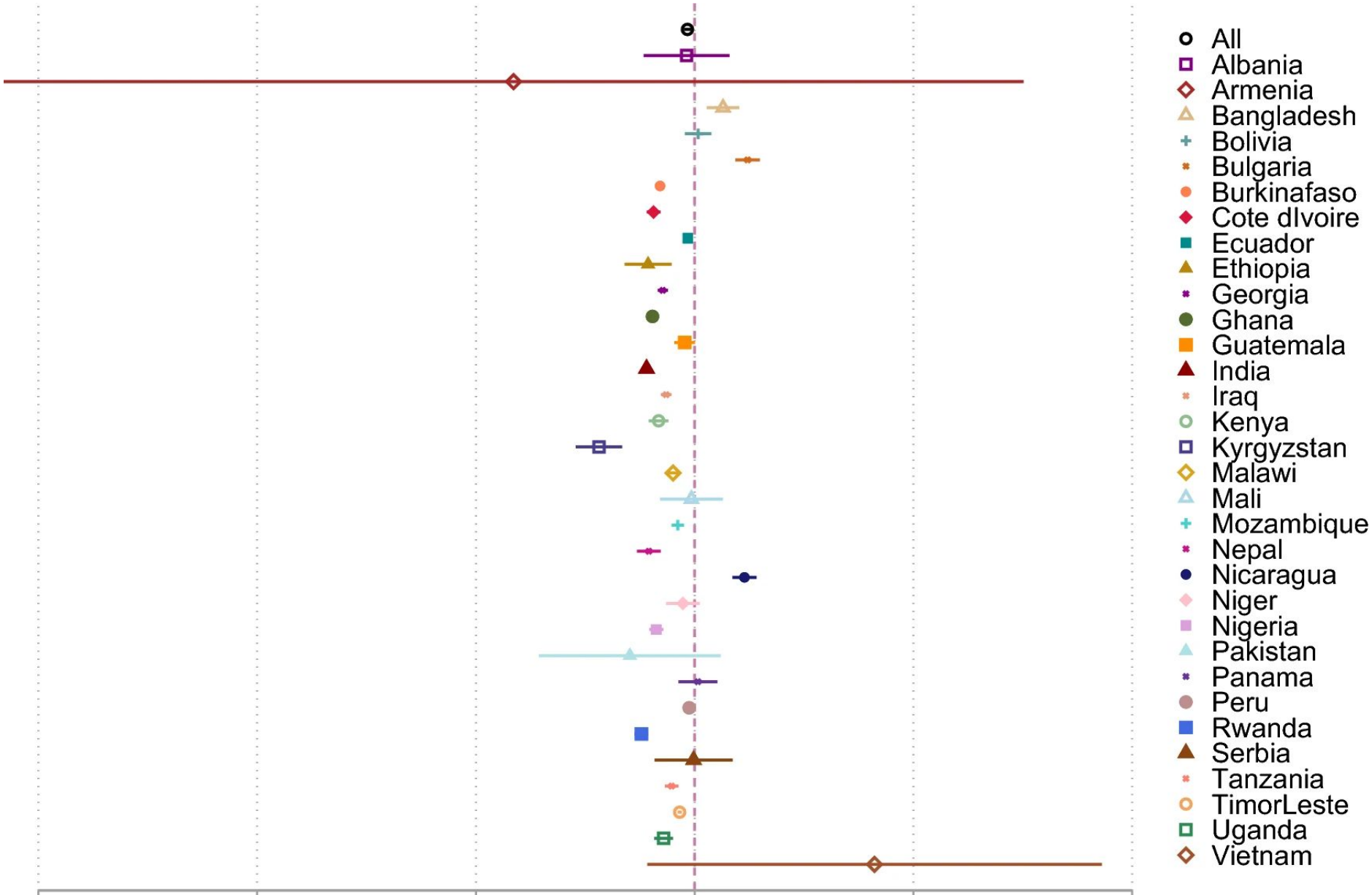
Effect of farm size on land & labour productivity, & labour intensity



Turning point 2-77 ha, median 11 ha

Chiarella et al. (2023) *Ambio*

Effect of farm size on inefficiency



Chiarella et al. (2023) *Ambio*

Farm size / consolidation & labor outcomes in India:

Are There Too Many Farms in the World? Labor Market Transaction Costs, Machine Capacities, and Optimal Farm Size

Andrew D. Foster

Brown University and National Bureau of Economic Research

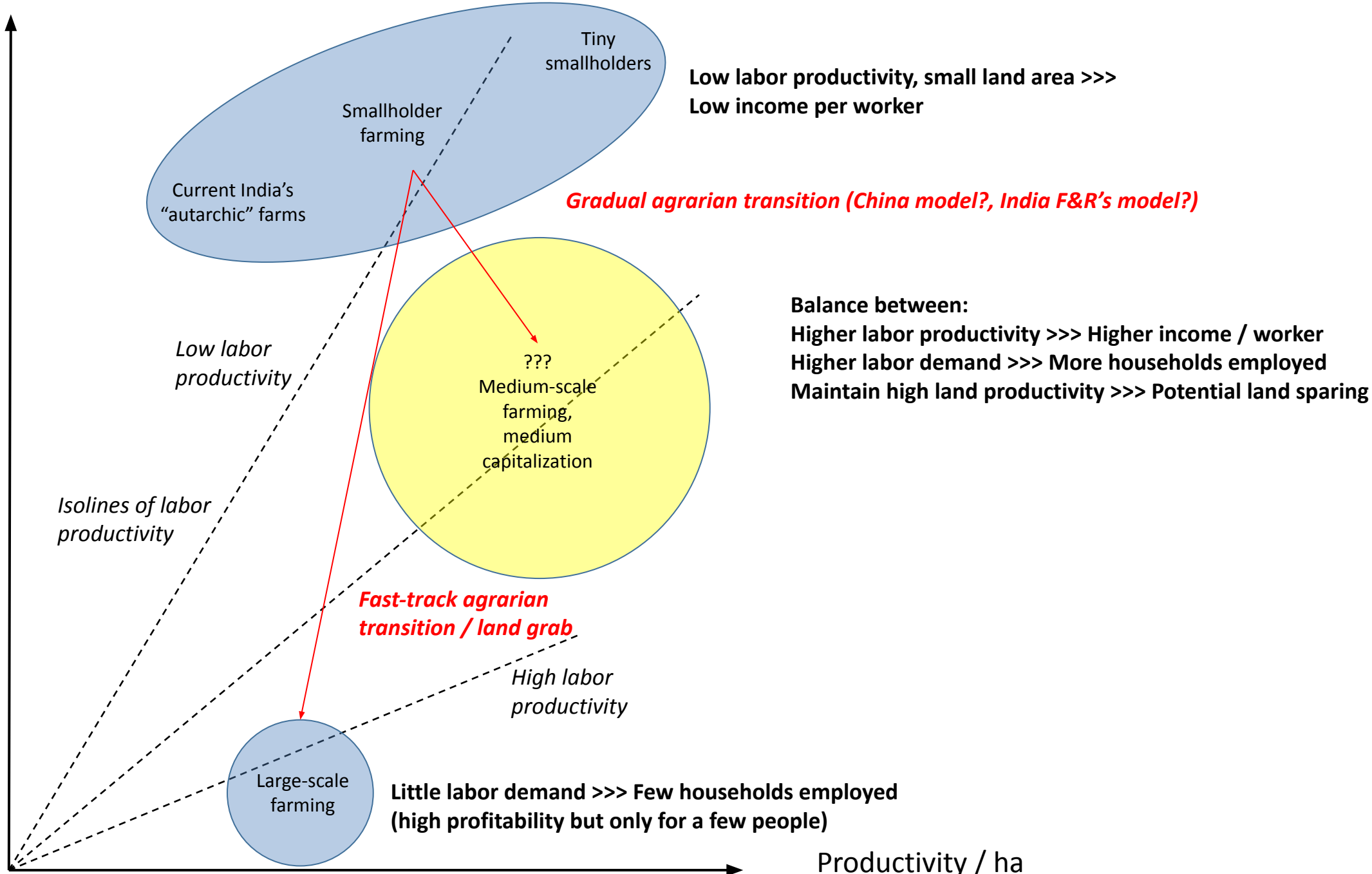
Mark R. Rosenzweig

Yale University and National Bureau of Economic Research

- Transaction costs in labour markets (hiring people for working < 1 day on small fields) in small (but not the smallest) farms
- U-shaped curve of profitability against farm size
- Shifting farm size from av. 1.25 ha to **~9.7 ha**:

+ 42% increase in agricultural output
+ 68% in income per farm worker
- 87% in farm numbers! (95 M to 12.4 M)
- 16% labor requirements
- 8.6% farm wages if no increase in other sector's employment, mainly landless affected

Foster & Rosenzweig (2022)


Number of workers / ha
Tiny smallholders
Smallholder farming
Current India's "autarchic" farms
Low labor productivity, small land area >>>
Low income per worker
Gradual agrarian transition (China model?, India F&R's model?)
Low labor productivity
???
Medium-scale farming, medium capitalization
Balance between:
Higher labor productivity >>> Higher income / worker
Higher labor demand >>> More households employed
Maintain high land productivity >>> Potential land sparing
Isolines of labor productivity
Fast-track agrarian transition / land grab
High labor productivity
Large-scale farming
Little labor demand >>> Few households employed
(high profitability but only for a few people)
Productivity / ha

Labor & alternative agricultures

Narratives on alternative agricultures

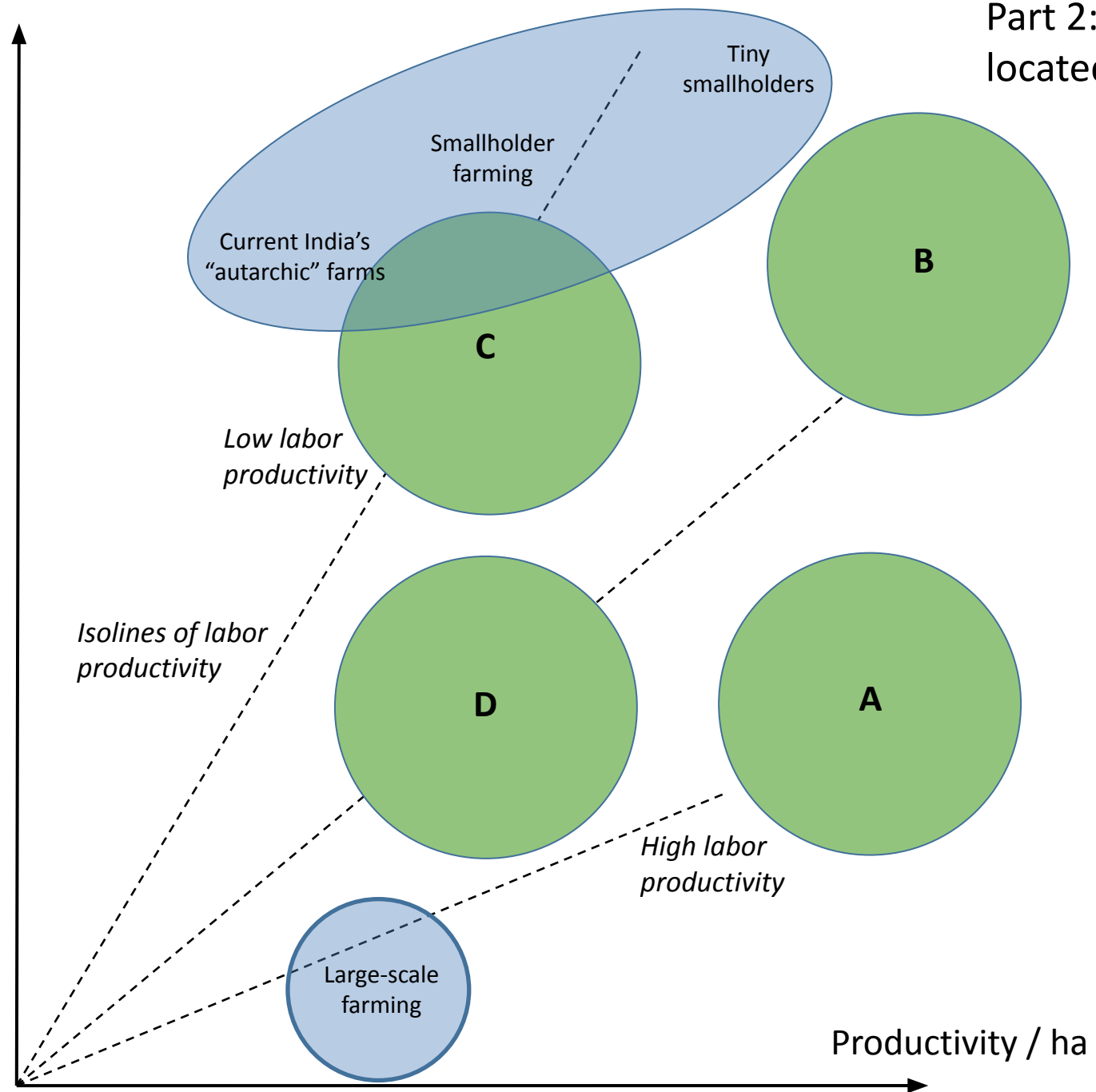
- Post-fossil fuel agriculture? What about mechanization and fertilizers?

- Ecomodernism: Greater levels of external energy coming from nuclear power or renewables. Modernization would ‘liberate’ farm workers from hard work, and replace them with technological innovations. >> “super” Lewis Path

- Agroecology: Agriculture independent of external inputs of energy. Energy replaced by intensive knowledge and human labor. High employment density. But whom? A World where we are all (part-time) farmers?
- Agroecology: "Nature does the job" ? (same appeal as smart/digital farming to avoiding drudgery of farm labor)

How many farmers do we *need* to feed the world sustainably?

Part 2: Where are alternative agricultures located in this tradeoff space? (Meta-analysis)



Hypothetical locations of agroecological / alternative agricultures, and conventional agriculture:

A: "Nature does the job": High labor productivity.
Drawback: Less labor demand.
(**= Ecomodernist *"World without farmers"***)

B: "Provides a lot of rural jobs".
Drawback: Lower labor productivity, so low living standards.

C: "Land sparing vs Land sharing" postulate: If agroecology is more nature-friendly (i.e., "sharing"), it has to be less land productive (negative relation between biodiversity and yields)

D: Hypothetical location of "Conventional" intensification in the agroecology vision: Conventional agricultures decreases labor demand, and has lower land productivity than agroecology.

Case studies in Africa and EU - organic

African case studies (from FIBL - thanks!!)

Five case studies in Ghana and Kenya of organic management.

Main crops: bananas, maize, beans, roots, coffee, cocoa, macadamia, millet

Sample of 1646 farms. 316 organic (certified and non-certified), 1329 non-organic.

Organic farms were exposed interventions promoting organic agriculture -3 years prior to data collection.

Organic and conventional farms randomly selected in each stratum.

2014-2017 - 5 cropping seasons

European farms (FADN)

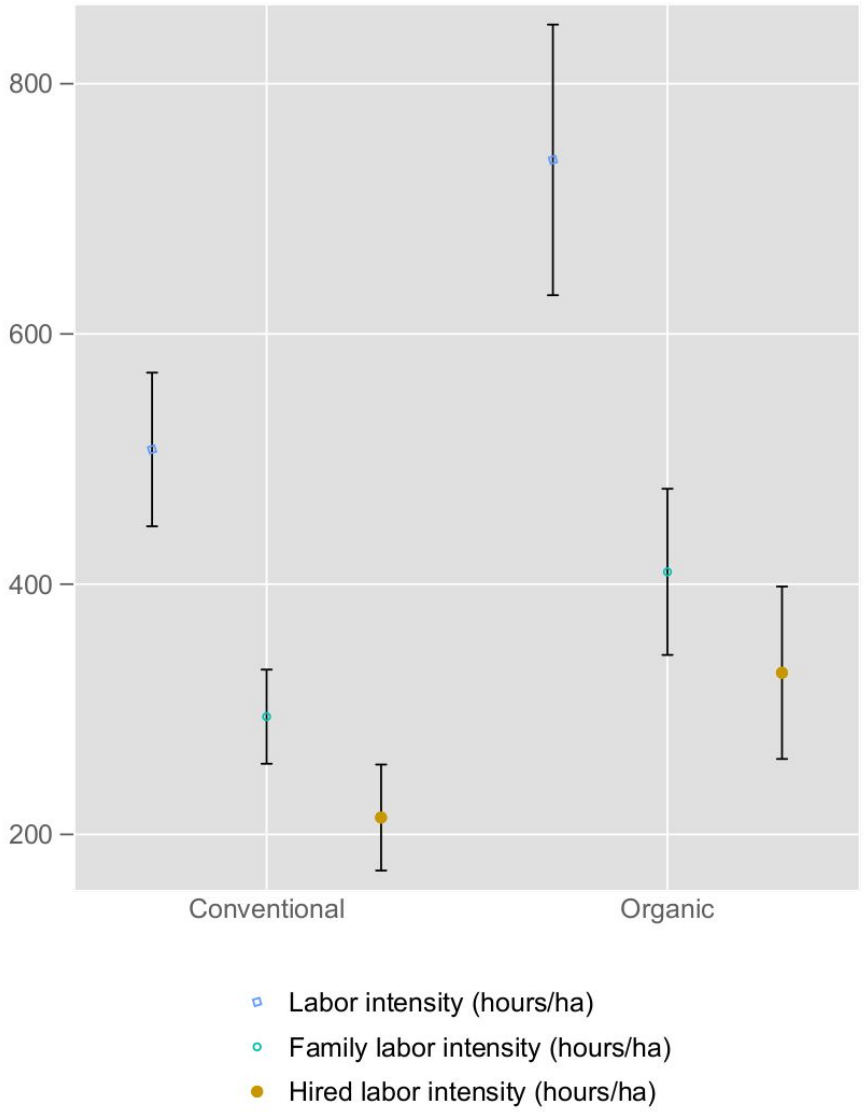
82866 farms
5736 strictly organic

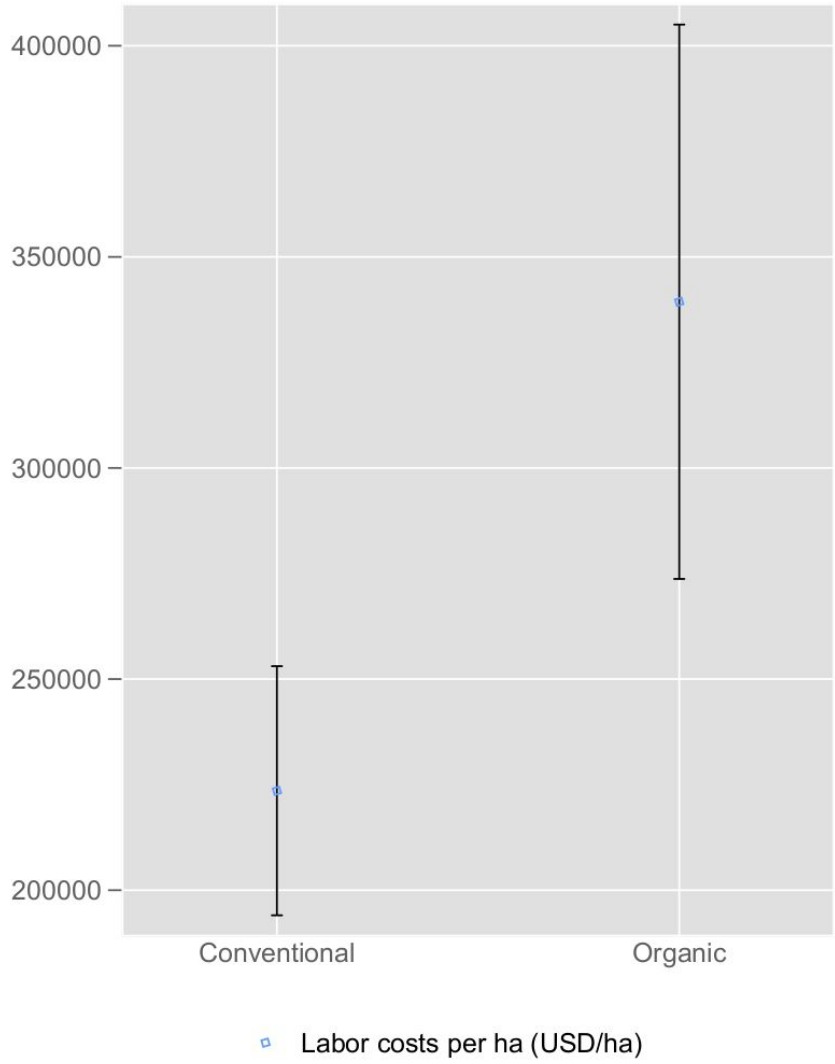
BEL BGR CYP CZE DAN DEU ELL
ESP EST FRA HRV HUN IRE ITA
LTU LUX LVA MLT NED OST POL
POR ROU SUO SVE SVK SVN UKI

Year 2019

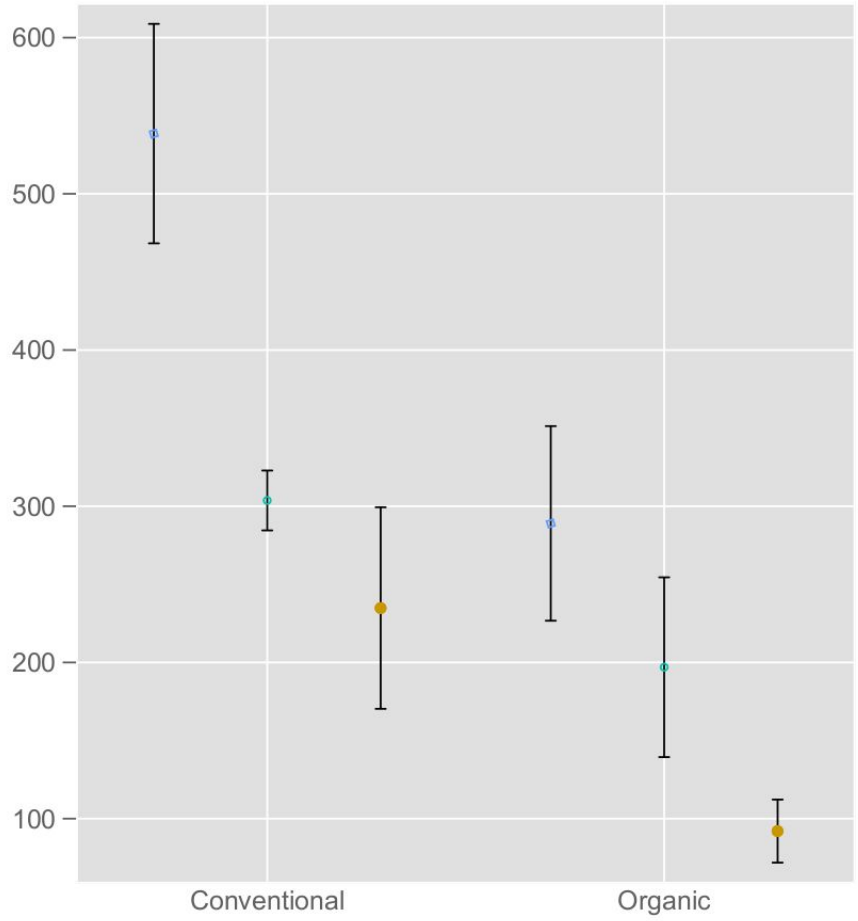
Farms producing field crops (31.8%), horticulture (5.2%), wine (5.4%), other permanent crops (8.4%), milk (15.6%), livestock (15.2%), granivores (6.1%), mixed (12.4%)

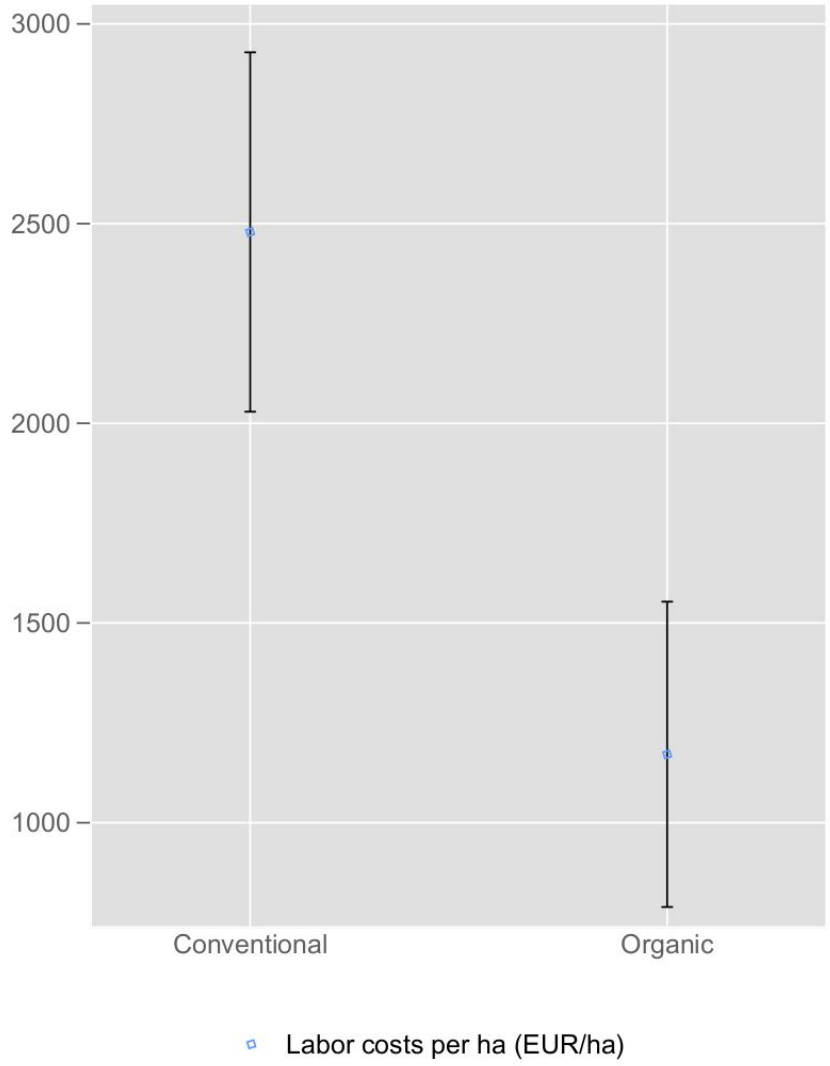
African data: Organic farming is more labor intensive



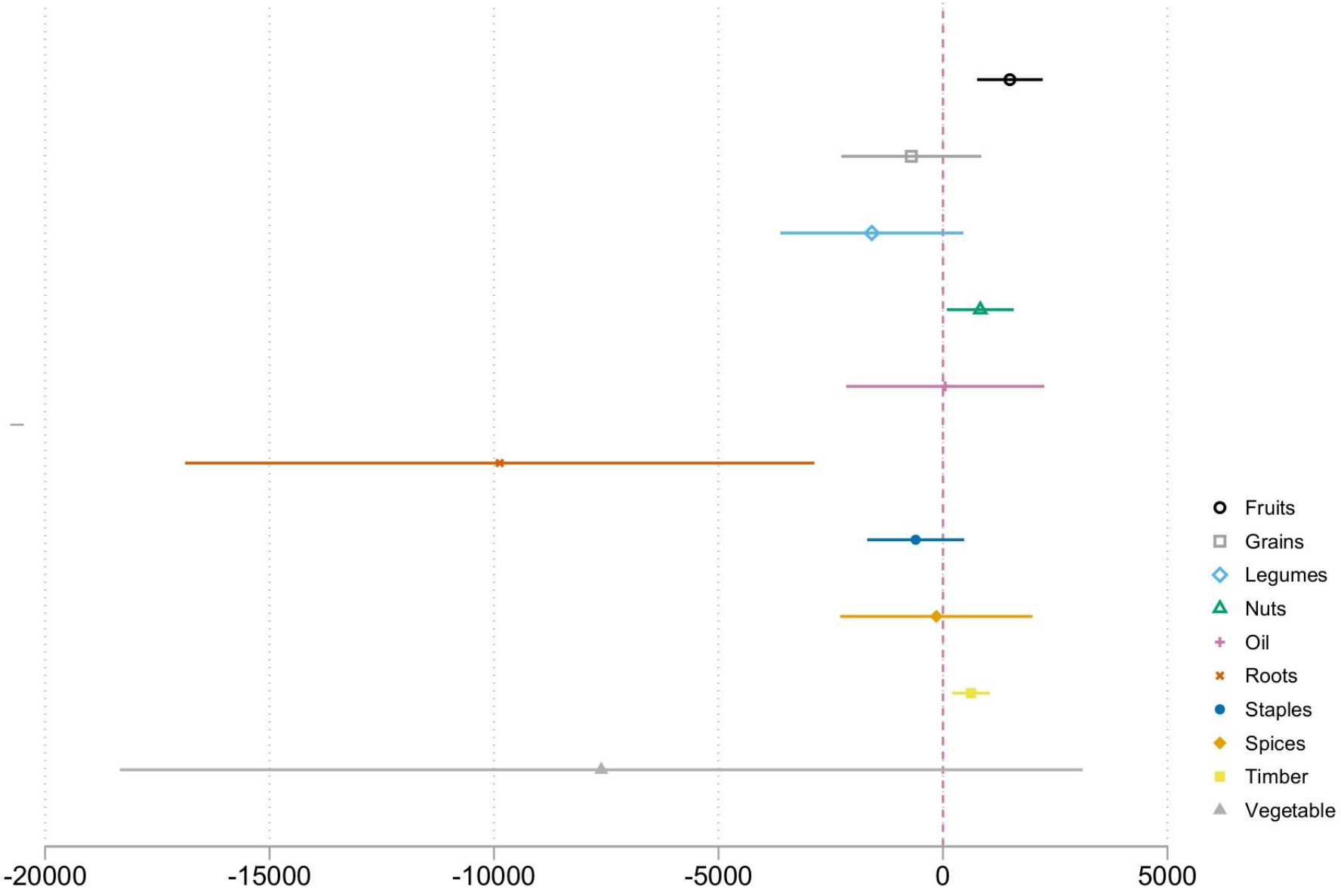


European data: Organic farming is less labor intensive

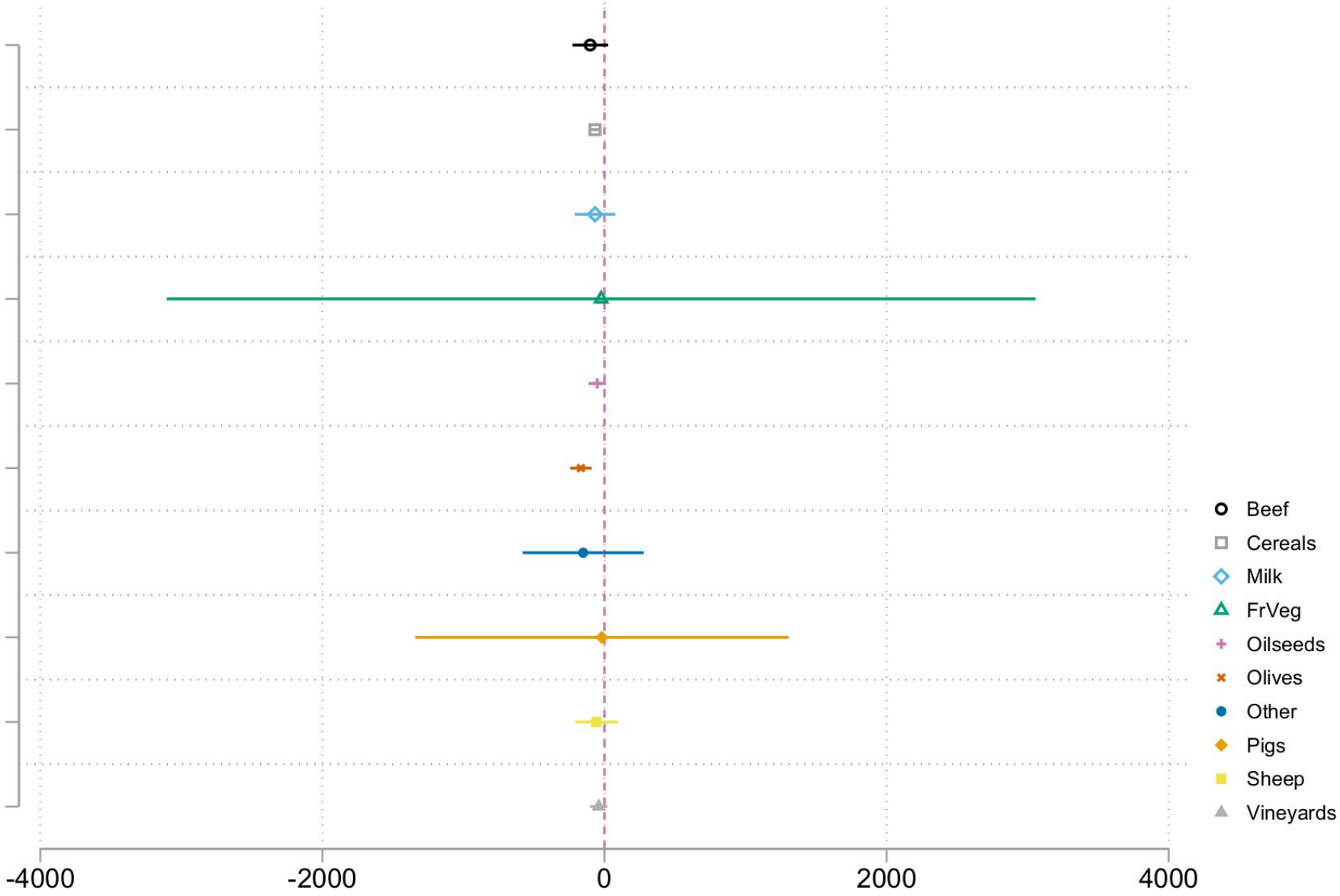




African data per crop types, with controls



European data per crop types, with controls



Conclusion

Global goals on land use - land and labor productivity

Labor - the missing dimension - reconsider the importance of labor as a land use goal, acknowledge its current adjustment variable status, and the limited absorption capacity of many low-income economies

~~How many farms and farmers do we want to feed the world~~ >> How many farmers should there be to eradicate food insecurity?

Labor and farm size as a proxy, lever, indicator; context-dependence

Labor and alternative agricultures: How many farmers do we *need* to feed the world sustainably? How does it make us reconsider the place of agricultural labor? Hidden subsidy of labor?

Bonus questions

Is it possible to combine intensive-labor agriculture with “modern” lifestyles?

What percentage of the population should be farming in a post-fossil fuel agriculture?

Can we have complex societies with labor-intensive or post-fossil fuel agriculture?