

# **Food systems under population pressure and running out of fossil fuels: any options left?**

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« AS MUCH AS **PRACTICALLY** FEASIBLE,  
MAXIMISE SMALL-SCALE BIODIVERSITY,  
BETWEEN AND WITHIN SPECIES AND HABITATS,  
WILD AND DOMESTICATED ALIKE »

(Martin Wolfe, Wakelyn's farm, Fressingfield, UK)



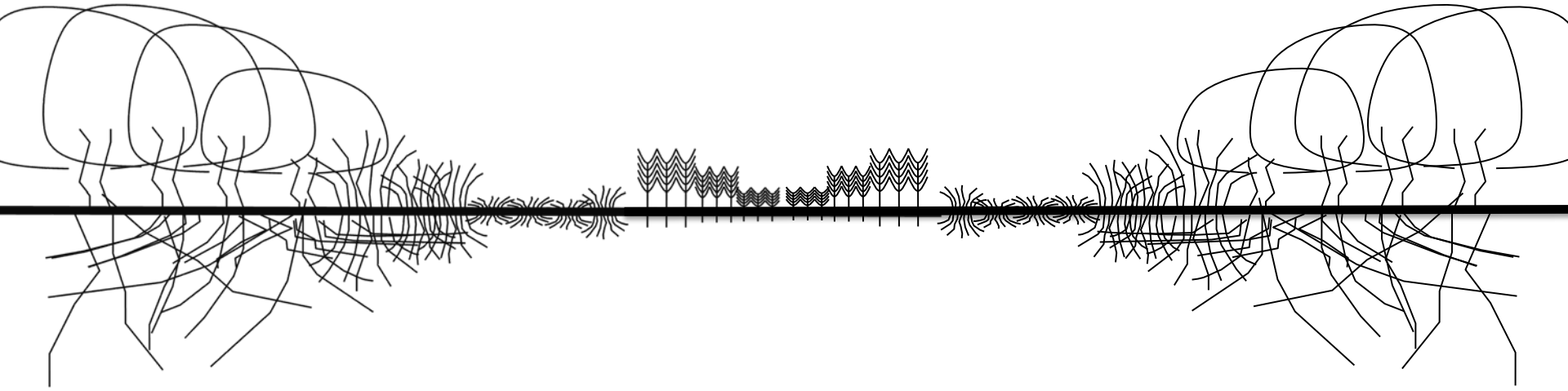
Efficiency, productivity, yield,  
intensification ...

OUTPUT ↗ ↗

=



INPUT (land, labour, **capital**) ↗



# Monocultures ⇌ Mixing species

Monoculture is **easy**,  
why complicate our lives even more?

Without industrial **inputs**,  
**output** becomes unbearably low

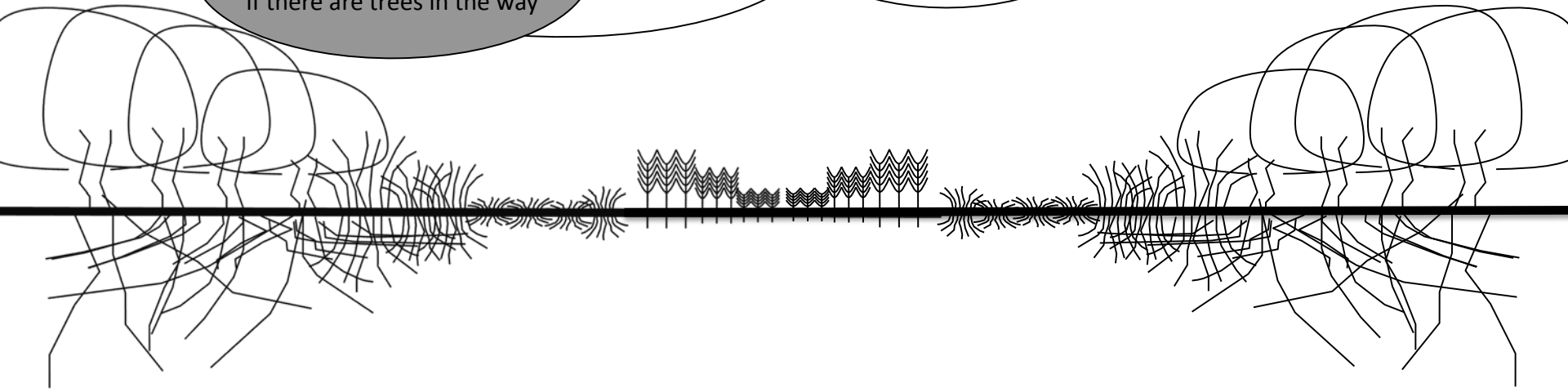
Land and labour are so expensive;  
we just have to **intensify**

Trees compete with crops for **inputs**;  
how can crops **yield** well with trees  
taking away light and nutrients?

We cannot afford a **productivity**  
loss on farmland if we want  
to spare land for nature

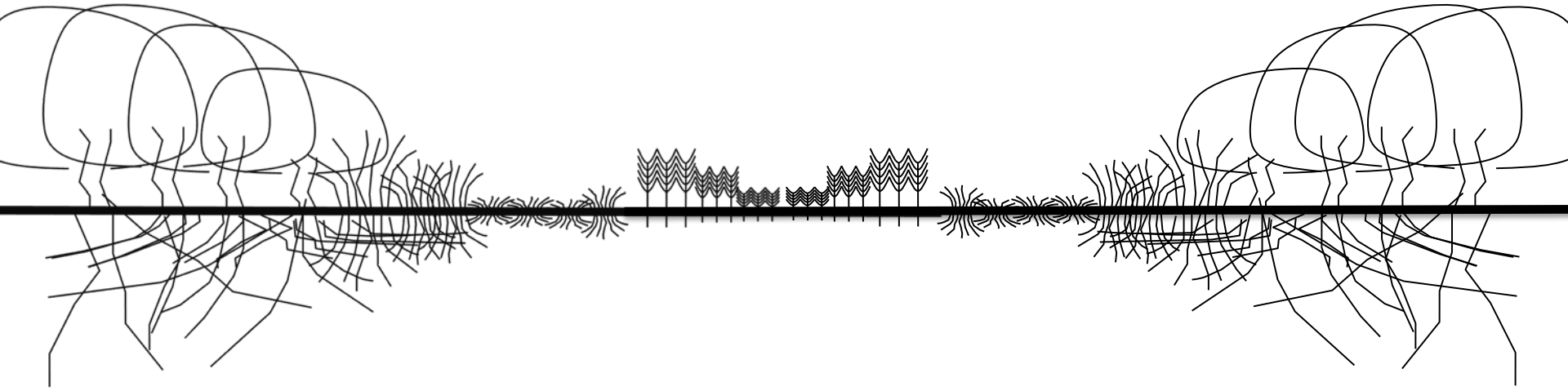
We need to inject ever  
more capital to increase  
**labour efficiency**

Field operations become  
less **efficient**  
if there are trees in the way



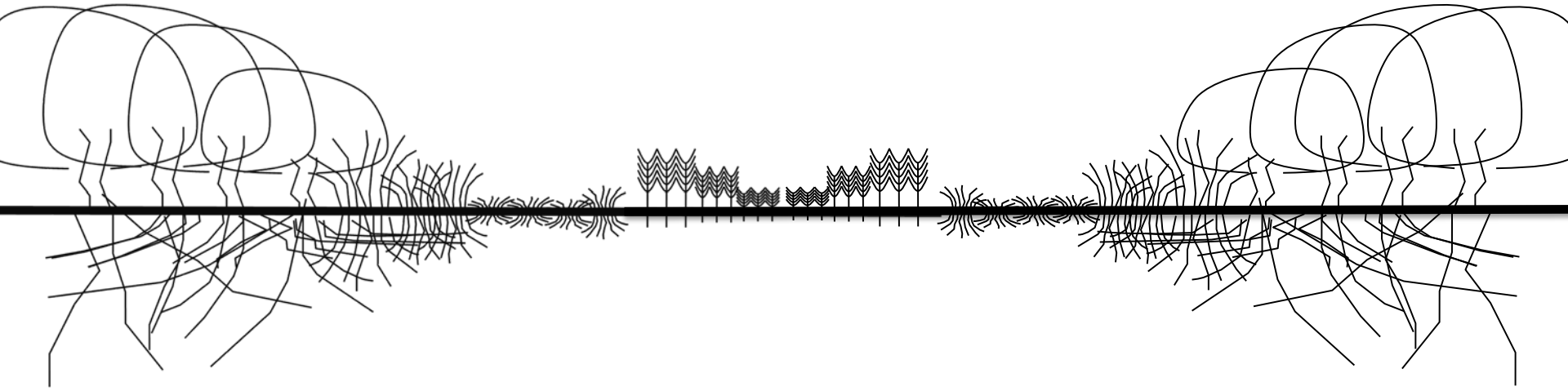
# Outline

- 1. What are the options for producing food?**
2. How do we replenish soil fertility?
3. What is ecological intensification?



Energy efficiency (unitless)

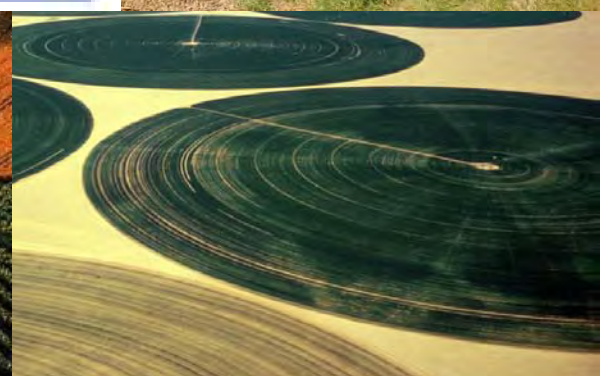
$$= \frac{\text{OUTPUT (food energy, J)}}{\text{INPUT (extra energies used, J)}}$$







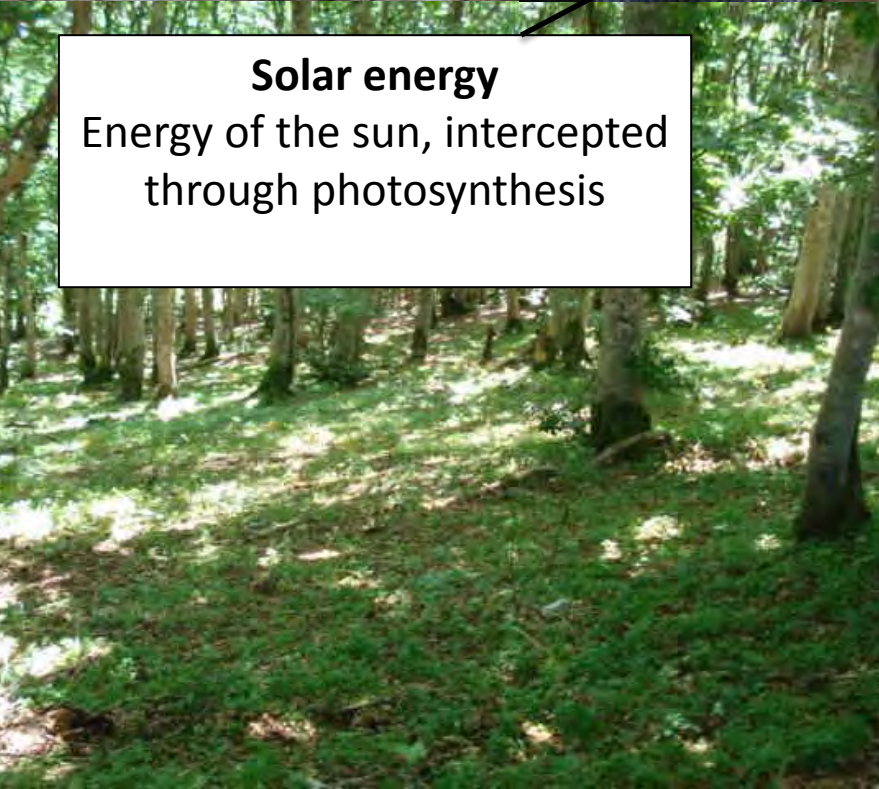
**Non-living energy**  
Cultural energy from non-living  
sources: fossil fuels, nuclear energy



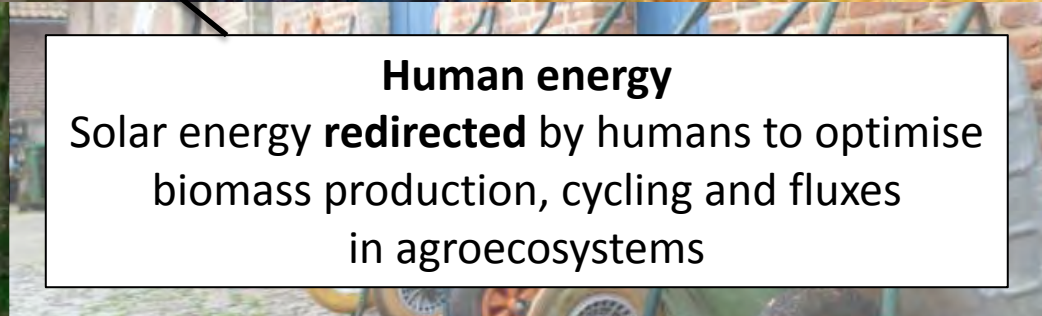




**Living energy**  
Energy from living organisms



**Solar energy**  
Energy of the sun, intercepted  
through photosynthesis



**Human energy**  
Solar energy **redirected** by humans to optimise  
biomass production, cycling and fluxes  
in agroecosystems





Energy inputs for food production

```
graph TD; A[Energy inputs for food production] --> B[Living energy<br/>Energy from living organisms]; A --> C[Non-living energy<br/>Cultural from non-living sources:<br/>fossil fuels, nuclear energy]; B --> D[Solar energy<br/>Energy of the sun, intercepted<br/>through photosynthesis]; B --> E[Human energy<br/>Solar energy redirected by humans to optimise<br/>biomass production, cycling and fluxes<br/>in agroecosystems];
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**Living energy**

Energy from living organisms

**Non-living energy**

Cultural from non-living sources:  
fossil fuels, nuclear energy

*= industrial and financial capital*

*= third production factor*

**Solar energy**

Energy of the sun, intercepted  
through photosynthesis

*= natural capital*

*= land, first production factor*

**Human energy**

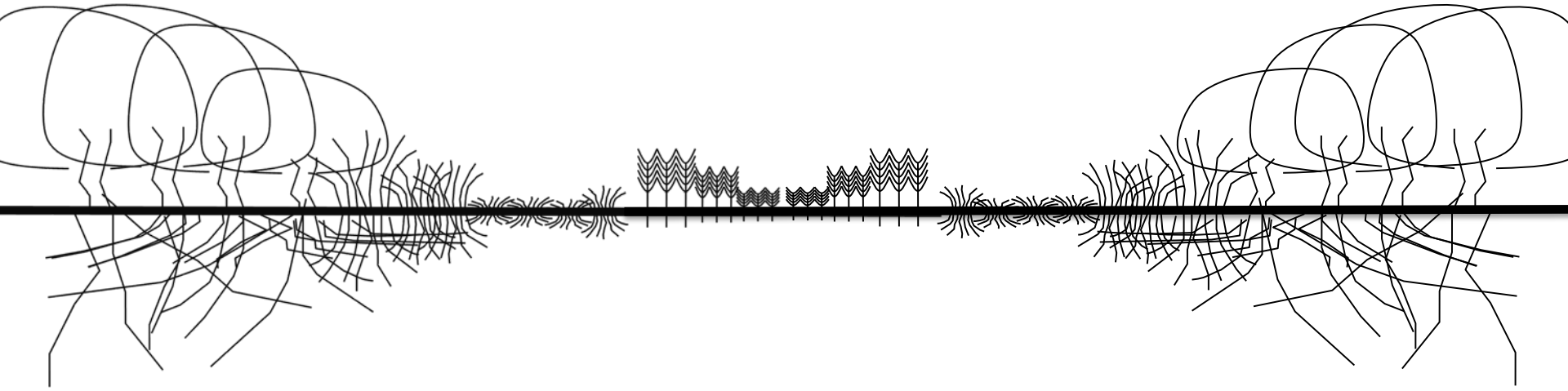
Solar energy **redirected** by humans to optimise  
biomass production, cycling and fluxes  
in agroecosystems

*= social and human capital*

*= human and animal labour,  
organisation, learning, cooperation,  
second production factor*

# Outline

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- 2. How do we replenish soil fertility?**
3. What is ecological intensification?

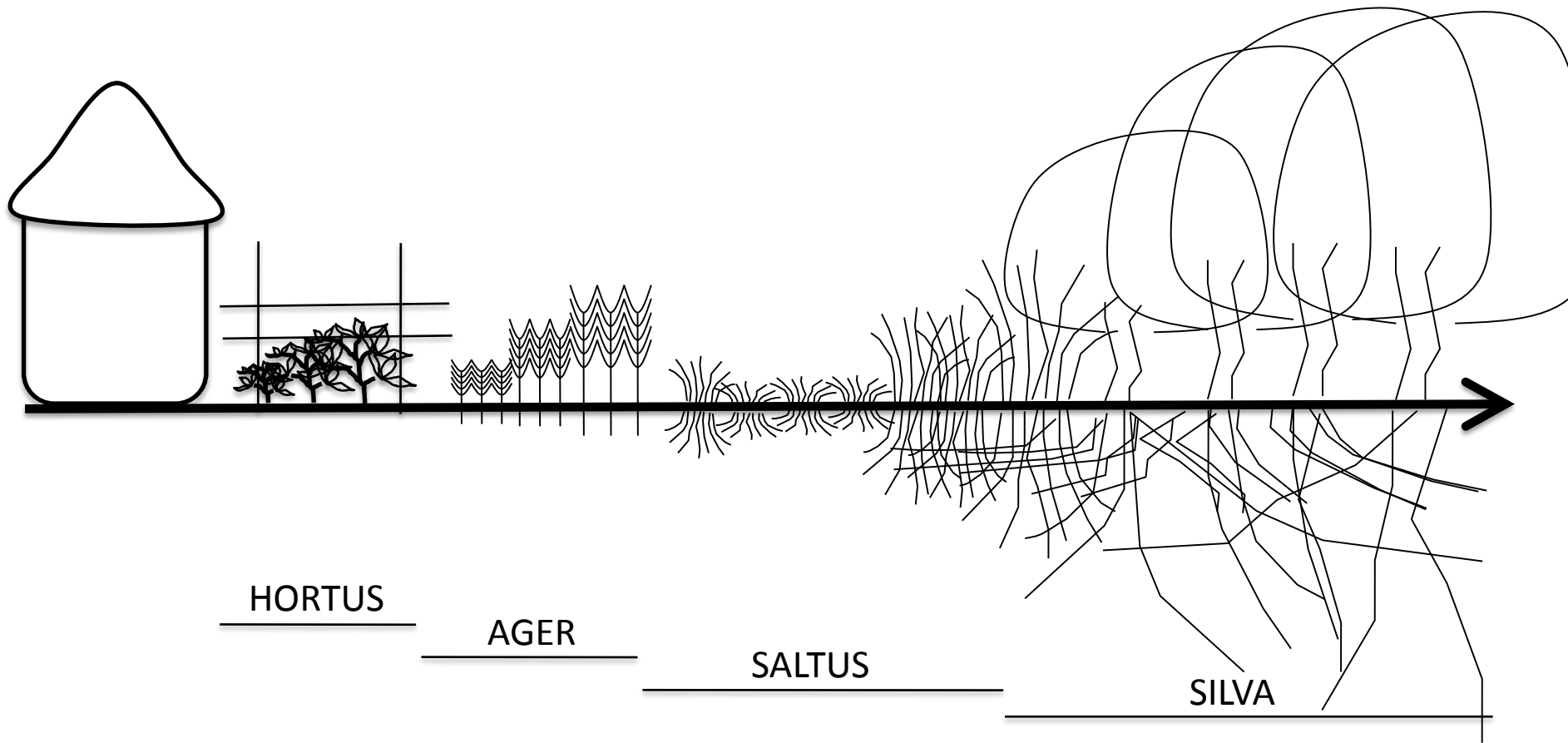




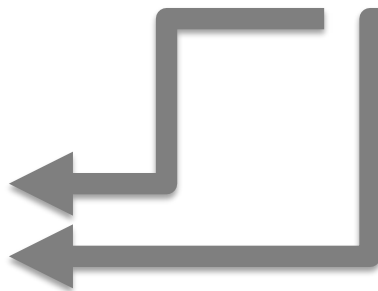
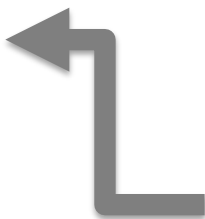
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**SINK**

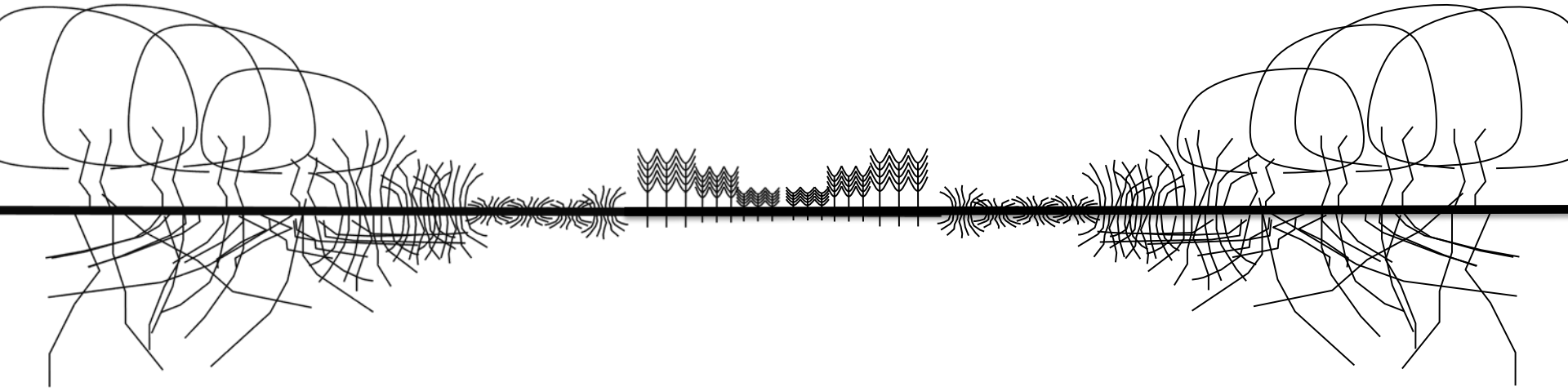


**SOURCE**



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# Let's remember:

- Which efficiency we privilege is a matter of context and **perceived** scarcity
- Energy efficiency matters most
- Redesign: food systems make wise use of perennial vegetation
- The options left are the ones we left behind
- The 21th century will make ecological intensification happen

