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Energy inputs in different farming systems

Energy input – agricultural production

- Human labour, draught animals, engine-driven machinery
- Operations involving human labour: planting, weeding, spraying, harvesting (horticultural commodities) and using hand tools
- Powered by draught animals (buffalos, horses, donkeys, camels or oxen): ploughing, soil preparation, water lifting, pulling inputs and threshing
- Typical farm family (solely human power) can cultivate 1.5 ha/a; 4 ha/a with animal power and >8 ha/a with tractor power
- Mechanisation is recognized as a key input to improve productivity

© Neil Palmer (CIAT). Slash and burn agriculture, Santa Cruz, Bolivia.

© Anand S. Traditional farming methods and equipment

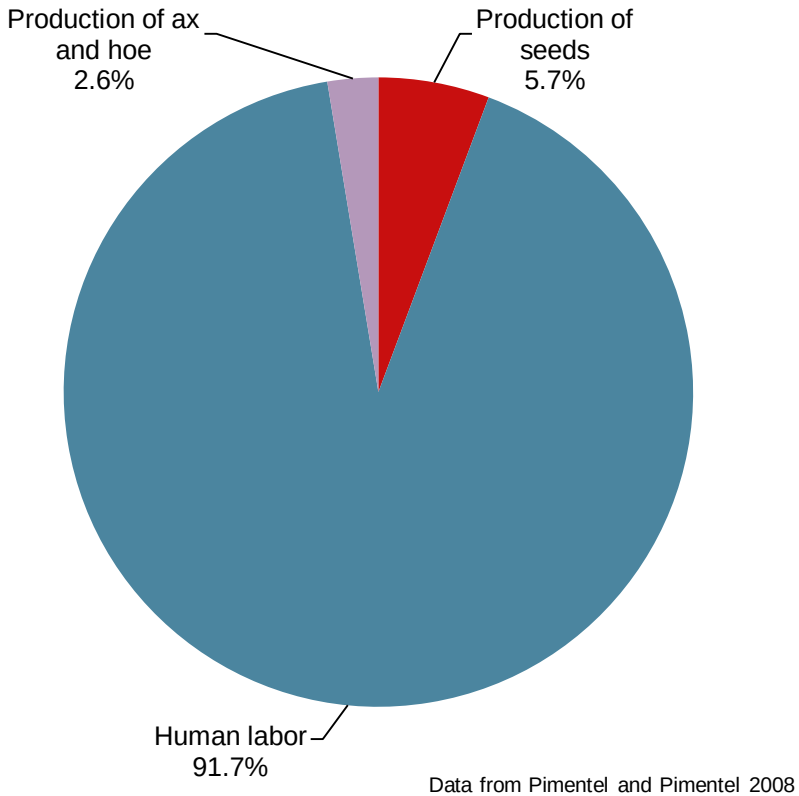
© Bill Whittaker. Corn harvest with an IHC International combine harvester, Jones County, Iowa, USA.

Energy inputs – agricultural production

Components of energy supplied by humans for corn production

Energy supplied by humans to optimize production of biomass in a **traditional shifting** cultivation corn crop in Mexico

© Neil Palmer (CIAT). Slash and burn agriculture, Santa Cruz, Bolivia.

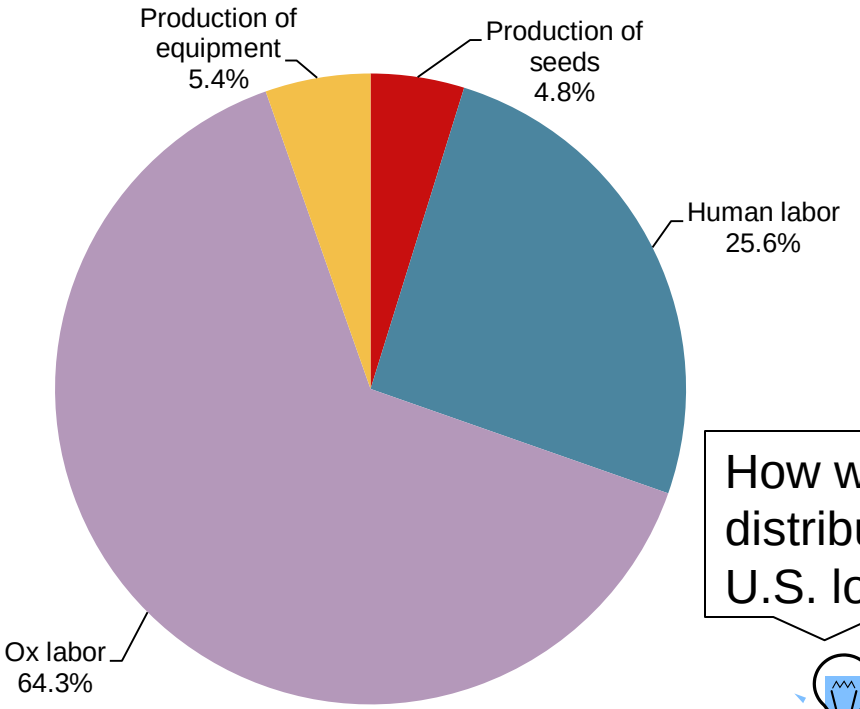


Data from Pimentel and Pimentel 2008

Components of energy supplied by humans for corn production

Energy supplied by humans into a **traditional corn production system using animal labour**

© Anand S. Traditional farming methods and equipment



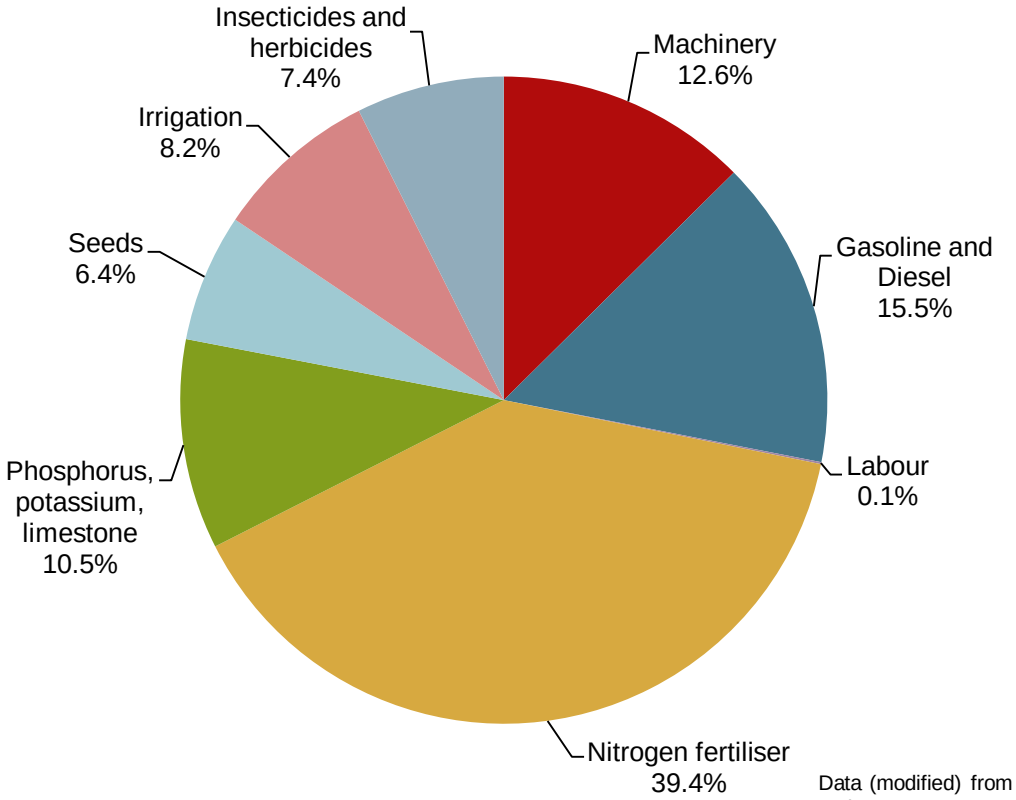
How would the distribution in the U.S. look like?

Data from Pimentel and Pimentel 2008

Components of energy supplied by humans for corn production

Energy supplied by humans used for **corn production in the United States**

© Bill Whittaker. Corn harvest with an IHC International combine harvester, Jones County, Iowa, USA.

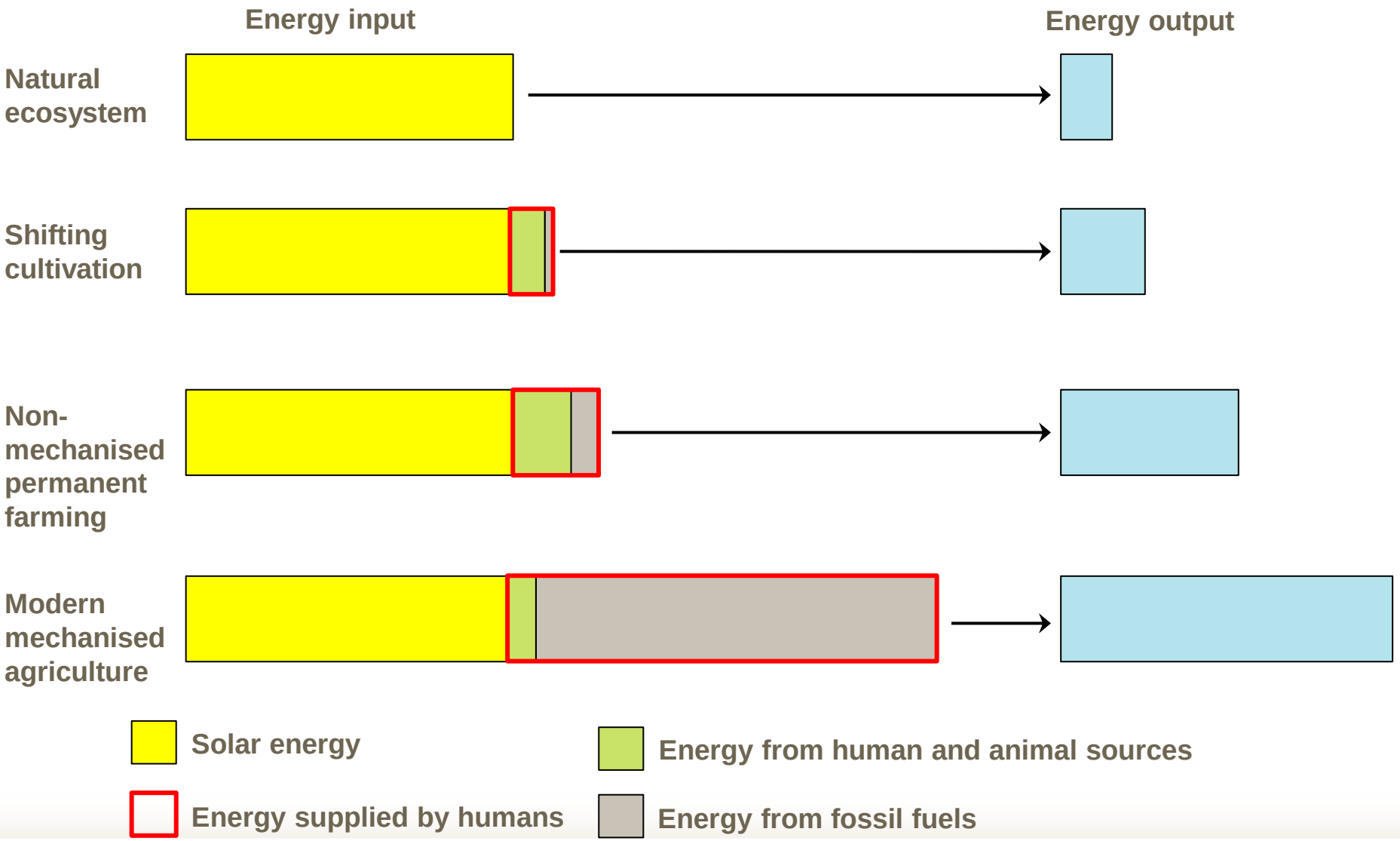


Data (modified) from Pimentel and Wen 1990

Efficiency of energy use

- Amount of energy contained in the harvested biomass compared to the amount of energy supplied by humans required to produce that biomass (energy input)
- An improvement of the energy efficiency could be:
  - decreasing the energy supplied by humans (while having the same output)
  - increasing the energy output (while having the same input)
- Improvements in energy efficiency can lead to ecological and economic win-win situations

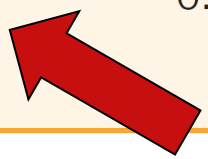
Efficiency of energy use in agroecosystems

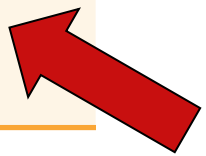


Source: Modified after Gliessman 2014

Comparison of modern and traditional methods for rice and maize production

	Rice production		Maize production	
	Modern (United States)	Traditional (Philippines)	Modern (United States)	Traditional (Mexico)
Energy input (MJ/ha)	64,885	170	30,034	170
Productive yield (kg/ha)	5,800	1,250	5,083	950
Energy input yield (MJ/kg)	11.19	0.14	5.91	0.18
Yield per energy input (kg/MJ)	0.09	7.35	0.17	5.59





Source: Modified after Practical Action (2012)

Energy intensive agricultural practises

Fertilizer use:

- Application of nitrogen fertilizer needs to be continuously increased, since the organic substance is decreasing

Water use:

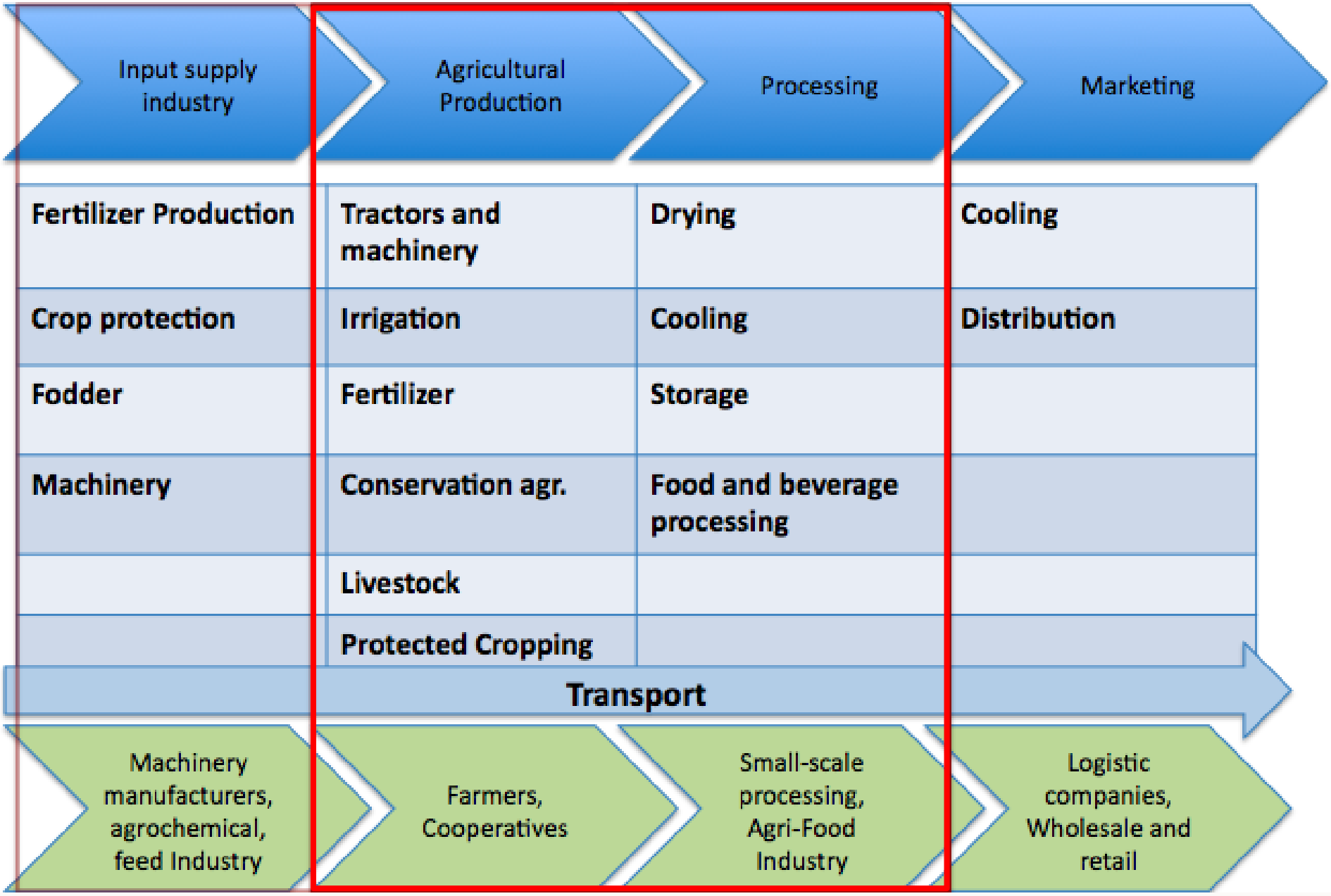
- Water supplies have become polluted
- Excessive pumping of the groundwater led to exhaustion of aquifers

Pesticides use:

- kill populations of beneficial insects and microorganisms
- causing health problems for farmers and farmworkers
- Pests and diseases have developed resistance to the extensive use of pesticides especially in monocultures

Renewable energy options along the value chain

Examples of energy use within agricultural value chains



Energy is key for agricultural productivity

1. Energy for transport (fossil fuels or biofuels)
   - Needed for many services within the supply chain
   - Access to markets is a major incentive for farmers to increase production in order to increase income
2. Energy for production, processing and commercialization is provided in different forms
   - In many rural areas, connecting to the national grid is economically or logistically unfeasible
   - Decentralized power production with renewable energy systems and hybrid systems (combination renewable/fossil) proves more
     - ✓ reliable
     - ✓ environmentally friendly
     - ✓ cost-effective than fossil fuel systems alone

Overview of renewable energy technologies I

Energy source	Conversion to	Most applied technologies and applications
Solar energy	Heat, mechanical energy, electricity	• Photovoltaic (PV) driven pumps for irrigation, • Crops, fruits, spices drying, ice making and cold storage (through absorption or heat driven refrigeration)
Wind energy	Mechanical energy, electricity	• Direct use: grinder, mills, mechanical water pumps • Electrical water pumps
Microhydro power (water)	Mechanical energy, electricity	• Direct use: mill, grinder, • Electrical motor for processing

Overview of renewable energy technologies II

Energy source	Conversion to	Most applied technologies and applications
Biomass energy	Heat, electricity, liquid biofuels, biogas	• Dryer (fruits, herbs, spices) • Fermenter (tea) • Combustion motor or electric motor (fuels like ethanol and biodiesel for transportation) • Anaerobic digester: biogas for lighting, cooking and heating and industrial biogas for decentralised electricity.
Hybrid power systems	Combine fossil fuel-fired generators with wind or solar electrical power	• Wind/PV Hybrid • Wind/Diesel Hybrids Used in the food processing sector (grinding of corn, wheat and millet, and milling of grain-hulling paddy).

Examples renewable energy technologies

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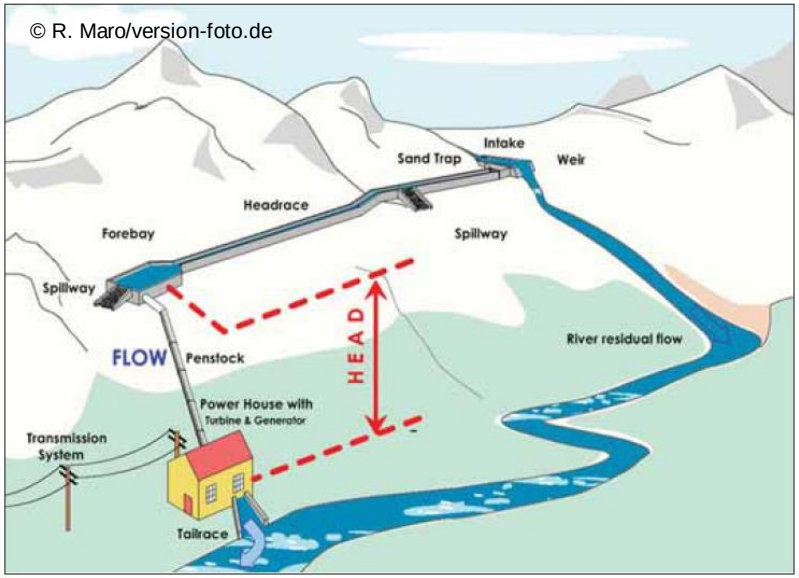
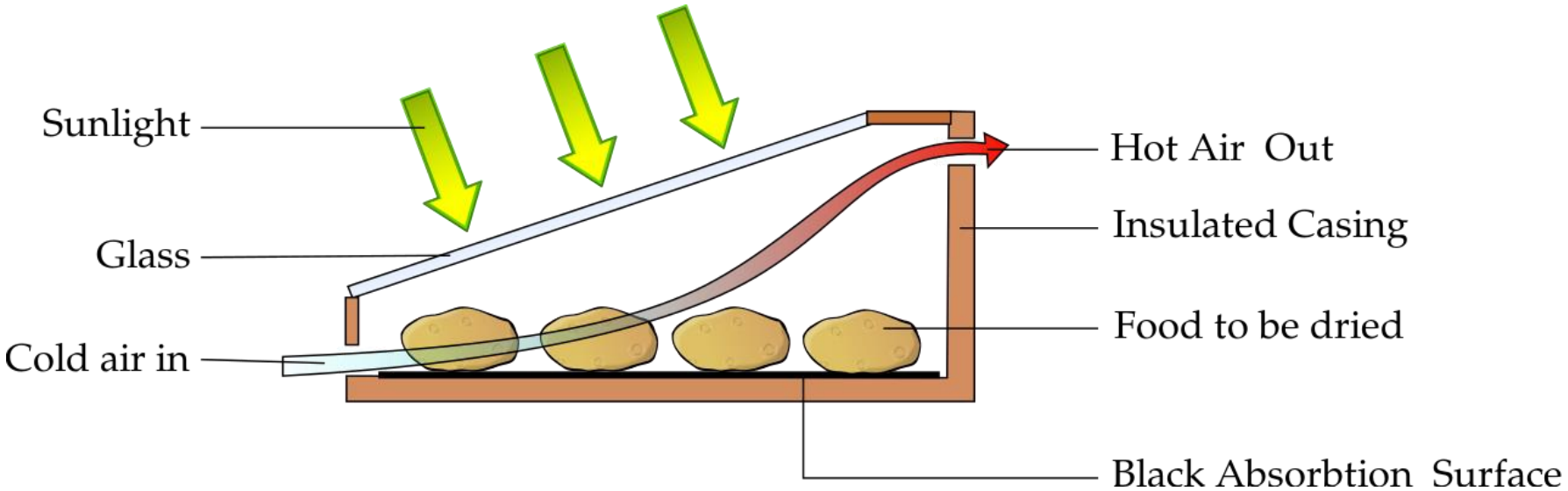


Typical example of a diversion type run-of-river hydropower plant

© Th. Klewar

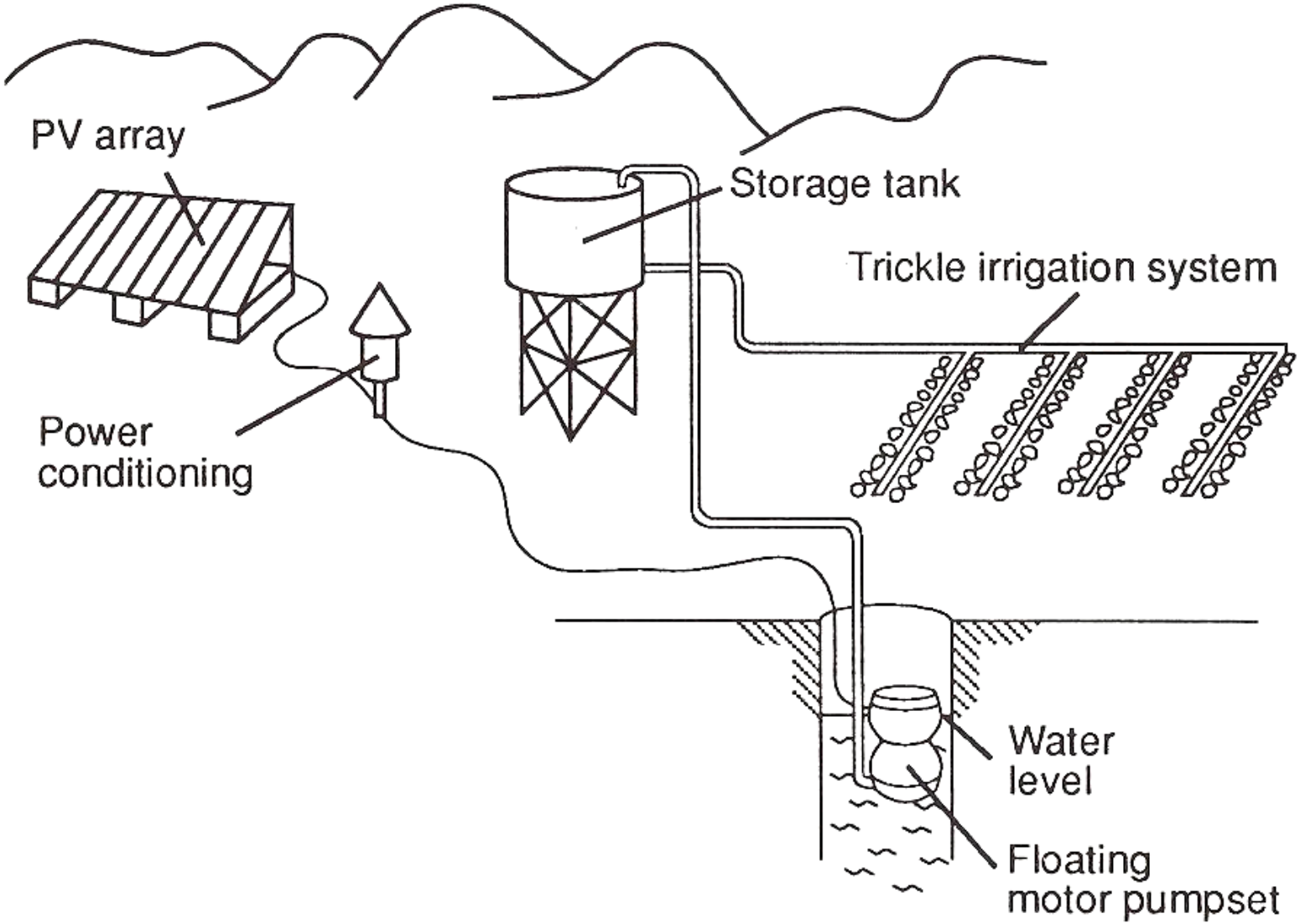
Source:
https://energypedia.info/index.php?title=File:Good_and_bad_of_mini_hydro_power_vol.1.pdf&page=1

A scheme of a Direct Solar Dryer



Source: A.K.Karthikeyan; online: http://commons.wikimedia.org/wiki/File%3ADirect_Solar_dryer.svg

A scheme of a Solar Irrigation System



Source: Practical Action (2010)

Keywords

- Energy flows in ecosystems
- Fossil and renewable energies
- Sustainable use of energy
- New agricultural technologies

Wrap up

- Non sustainable agriculture today is using more energy to produce, process, transport, and market food than the food itself contains
- Most of this invested energy comes from sources with a finite supply
- Fossil fuels will not always be available in abundant supply and relatively cheap in monetary terms
- If the strategy for meeting the food demands of the growing population of the world continues to depend on these sources
    - the consequences will continue to undermine the ecological foundations of agriculture
    - increase economic risk
    - cause social problems

Thank you!

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On behalf of

Federal Ministry for Economic Cooperation and Development

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