Sustainable Agricultural Mechanization in Africa

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Club of Bologna

Study Group : Sustainable Agricultural Mechanization in Africa

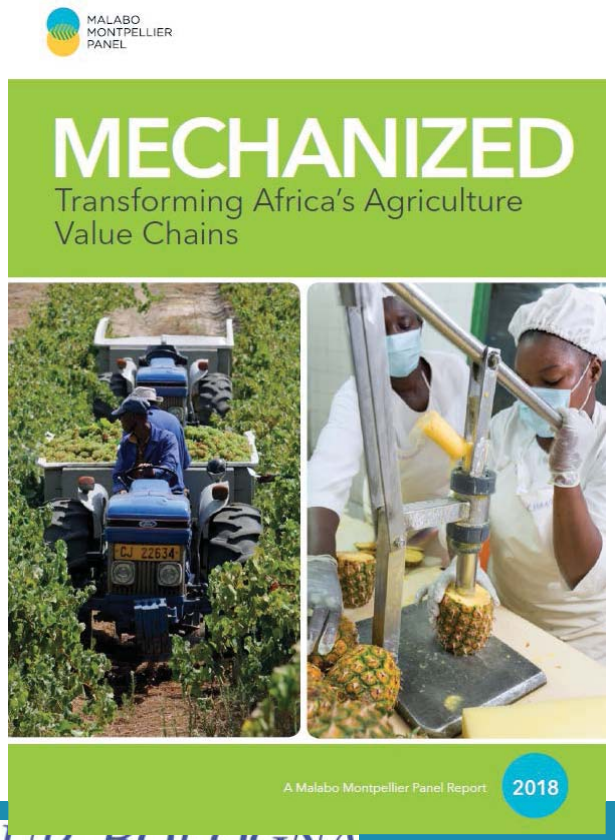
CLUB OF BOLOGNA

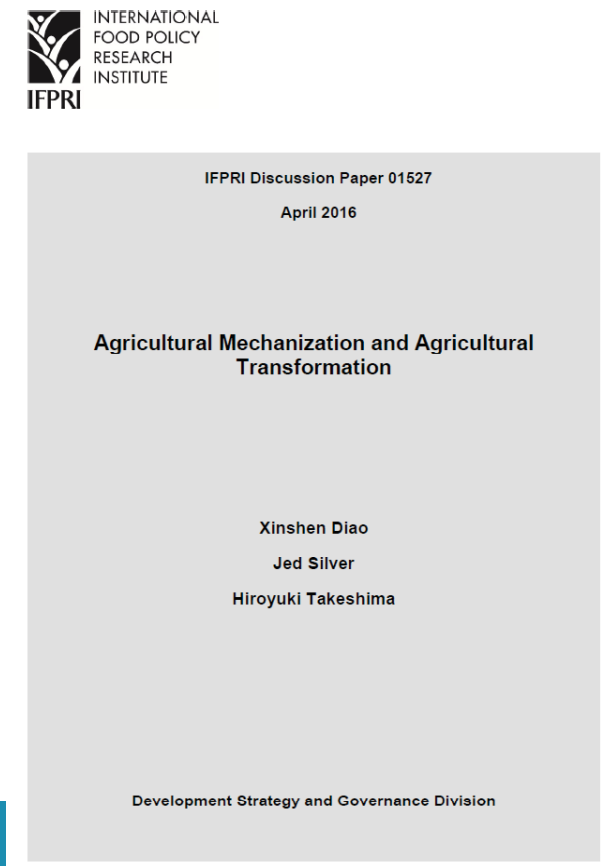
KU LEUVEN

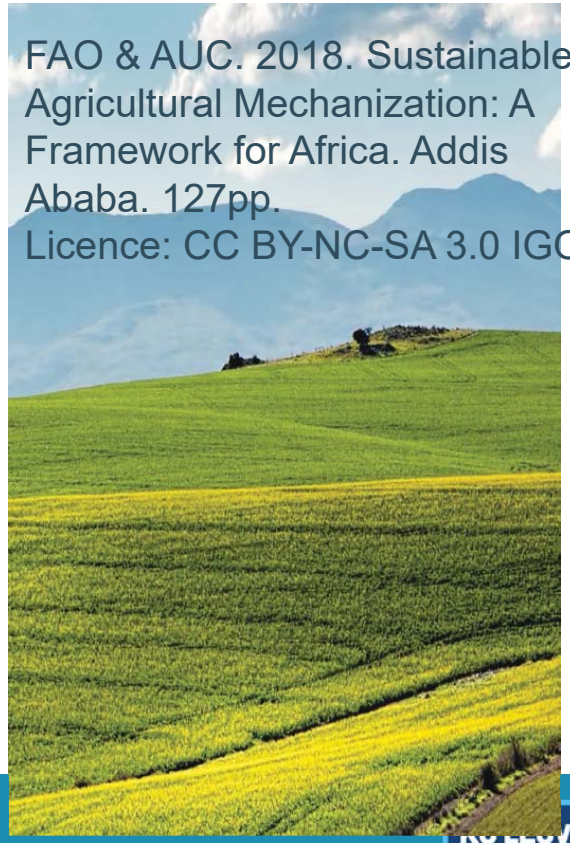
“farm mechanization” – is an essential agricultural input in sub-Saharan Africa (SSA) with the potential to transform the lives and economies of millions of rural families (FAO)

- *International and coordinated national strategies*
- *International projects,*
- *National initiatives*
  - *Research and development*
  - *Training*
  - *Financial support*
- *NGO’s and (private) foundations*
- *Local communities*
- *Individual entrepreneurs*

Mechanization policy statements







FAO & AUC. 2018. Sustainable Agricultural Mechanization: A Framework for Africa. Addis Ababa. 127pp.
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Sustainable Agricultural Mechanization in Africa: Ten priority elements (FAO & AUC. 2018.)

1. Boosting farm power through appropriate technologies and innovative business models
2. Promoting innovative financing mechanisms for agricultural mechanization
3. Building sustainable systems for manufacture and distribution of agricultural mechanization inputs
4. Sustainable mechanization across agrifood value chains
5. Innovative systems for sustainable technology development and transfer
6. Sustainable transformation of land preparation and crop/animal husbandry practices
7. Social sustainability and the roles of:
   - i) small scale farmers and their organizations;
   - ii) women;
   - iii) youth
8. Human resources development and capacity building for SAMA
9. Need for a long-term vision: policy and strategy issues
10. Creating sustainable institutions for regional cooperation and networking

Mechanizing Africa's agriculture: challenge

- The African continent is littered with wrecks of imported machinery
- Much of the machinery needs to be manufactured locally
- Create job opportunities,
- Keep costs down
- Ensure that equipment is adapted to local conditions
- Maintenance by local technical experts.
- Need for business models that fit African conditions to help scale out feasible mechanization options.

Joseph Rickmanet al., in Realizing Africa's Rice Promise, (eds M.C.S. Wopereis et al.) CAB International 2013.

World Bank Group

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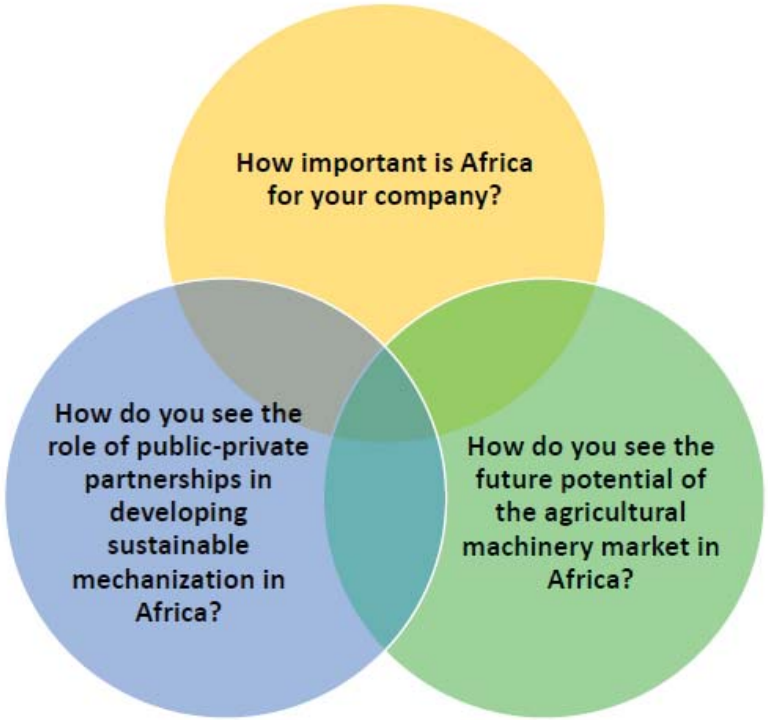
Survey on the importance and future potential of the agricultural machinery market in Africa (lead by CEMA)



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What has improved/worsened in your business dealings with Africa in the past 5 years?

Worsened

- Political stability
- Currency exchange
- Import regulations
- Financing potential
- Growing competition locally and from China and India
- Subsidies
- High volatility of commodity prices
- Difficulties to find a strong partner

Improved

- Demand for farm mechanization
- Technical knowledge
- Better understanding of the farmers for quality products
- Understanding of the markets
- Communication and response
- Less corruption
- Distribution network
- More knowledge of how to trade in Africa (north and south)
- Commercial farms

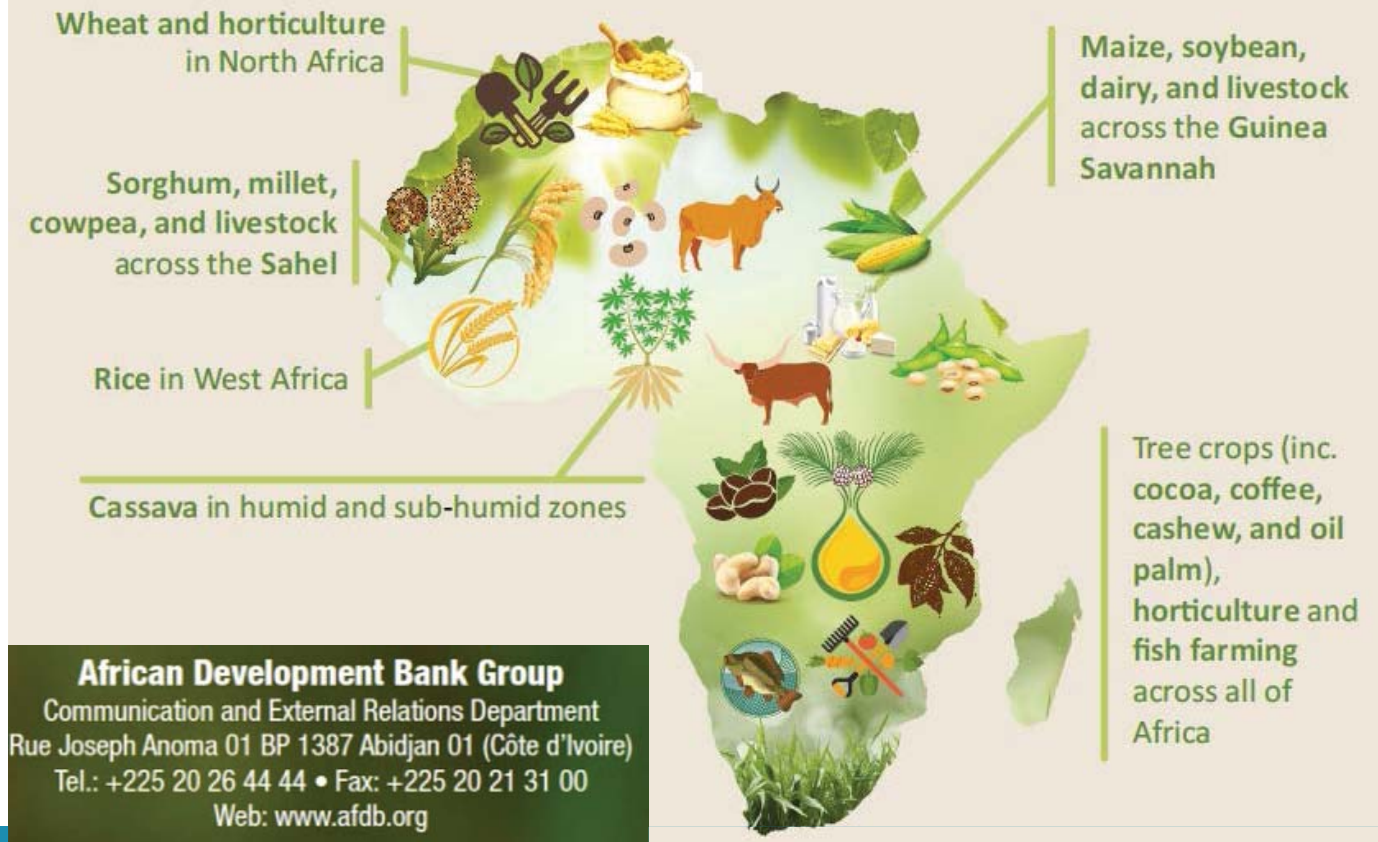
Issues in Agriculture and Food Supply

- World wide technology evolution
- Climate Smart Agriculture
- The (emerging) ICT and mobile communications
- Changing crop production practices
- Food and nutrition concerns
- Breeding adapted crops
- Post-harvest processing

Issues in Agriculture and Food Supply

- Land and farm ownership
- The changing farm size
- Evolving agricultural and related employment in Africa
- Gender issues
- Small and large scale trading
- Abundance of solar energy
  - Irrigation: solar water pumping
  - Electric vehicles and tools?

Priority agricultural commodity value chains and agro-ecological zones



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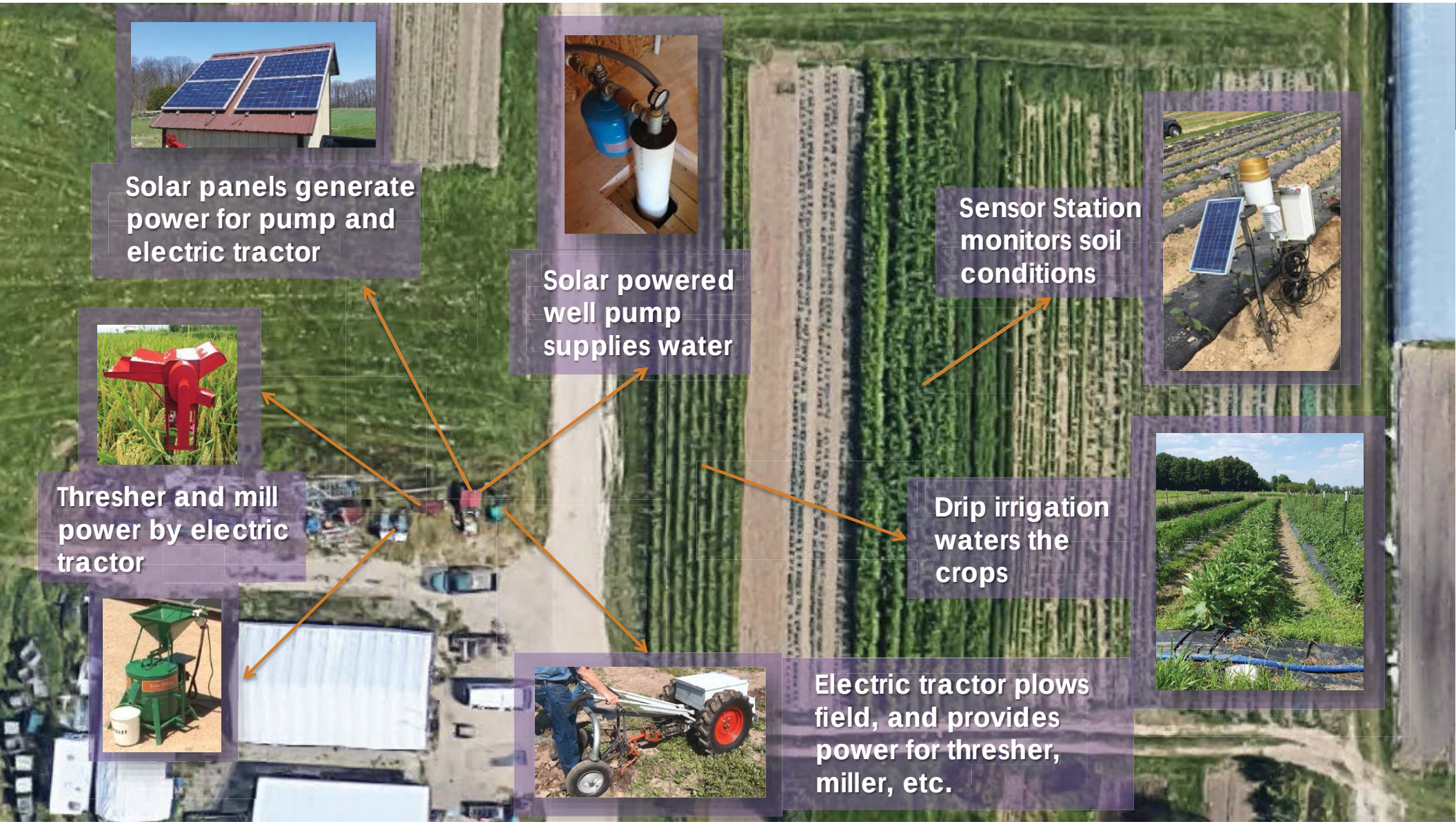
2019

Mechanization of farm activities

- Soil cultivation
- Planting
- Weed control
- Pest and disease control
- Harvest
- Post-harvest handling
- Transport


正英牌播种机
播散丰收希望


Solar panels generate power for pump and electric tractor
Solar powered well pump supplies water
Sensor Station monitors soil conditions
Thresher and mill power by electric tractor
Drip irrigation waters the crops
Electric tractor plows field, and provides power for thresher, miller, etc.

Establishing Design Parameters for the Multi-function Traction Prototype

- Must be able to emulate a pair of oxen or be able to generate enough draft to pull a subsoiler 9 in. deep in heavy soil at a comfortable walking speed.
- Should have about 4-6 hours of stored energy while completing field operations. Batteries should be chargeable using solar PV panels
- Should not require any specialized part. All parts should be off-the shelf or easily fabricated in a modestly equipped machine shop.
- Hitching system should allow for implements to be easily changed
- The prototype should be instrumented to measure draft force, energy consumption

Design Specifications

- Electric drive motor: 1800 rpm; 2 hp @ 24VDC and 70 amps
- Dimensions
  - Wheel track width: 32 in
  - Overall length: 100 in including control handles and a riding sulky
  - Overall width: 40 in; overall height: 32 in
- Weight: 825 lb
  - Front axle: 750 lb
  - Rear axle: 75 lb
- Drive train
  - Driver motor pulley = 3 in; Driven pulley = 9.5 in
  - Gear box ratio = 26:1
- Tires: Carlisle Farm Special 30 in dia; Rims: 8X16

Agricultural Mechanization for Small Holder Farmers in sub-Sahara Africa. 2018, Ajit Srivastava, et al., Department of Biosystems and Agricultural Engineering, Michigan State University

courtesy of MeBioS

Discussion: Field Performance

- Battery Capacity: 200 Amp-hr at 24 volts it is 4.8 kW-h
- Power consumed: 60 w-h on average per 100 m run
- Average speed per run: 2.3 km/h
- Distance per charge: 3 hours
- Field capacity at 0.8 m width: 0.2 ha/hr or 0.6 ha/charge
- Assuming a 75% field efficiency one can till about 0.4 ha per charge pulling a chisel plow at 22 cm depth in relatively undisturbed clay soil.

Solar power for tillage

- Average daily power production of 16 panels (300Wp) is estimated at approximately 20kWh
- 2 batteries per set (together 24V) : 4.8 kWh
- This means that 4 battery sets can be fully charged per day
- At 0.4 ha/charge then 3 sets would be enough to work ~1 ha/day
- Leaves capacity for irrigation, lamps,….
- Installation costs of solar panels: 16 *200€ + controller: 4500€
- Battery cost: 200€/(set of 2)

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

SOLAR DRIP IRRIGATION SYSTEM

Pump, Solar Panels & Well

Model:	PS200 HR 07
Flow Rate:	1.2 Cubic m/h
Voltage:	24-48 DC
Manometer:	0-30m
Efficiency:	61%
Solar panels:	135W – two
Well depth:	7 m
Well dia:	1.2 m

LORENTZ

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The U.S. Government's Global Hunger & Food Security Initiative

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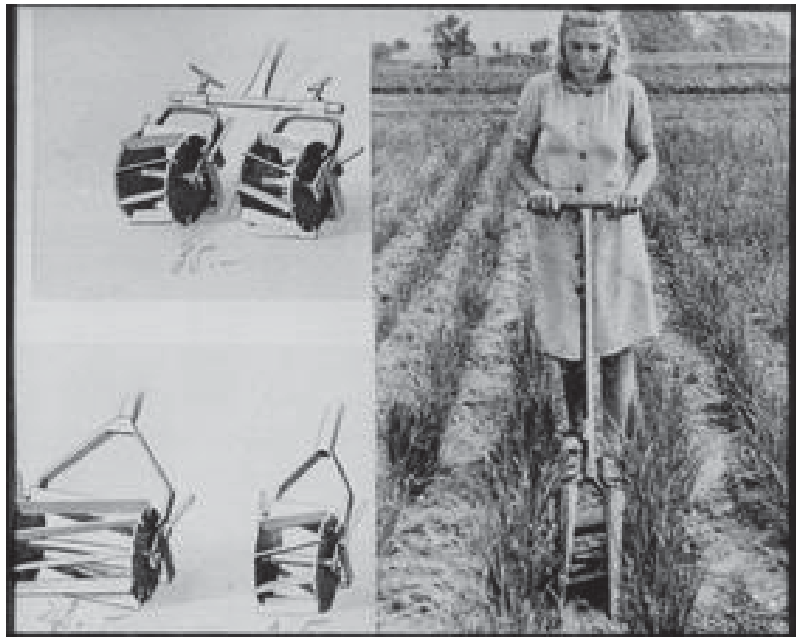
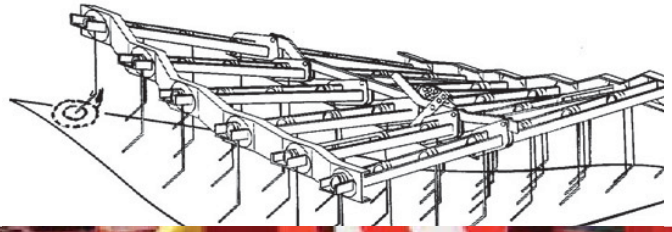
Mechanical weed control

Wikipedia

Rotary hoe



Flexible tines weed control



https://www.hatzenbichler.com/en/original-harrow

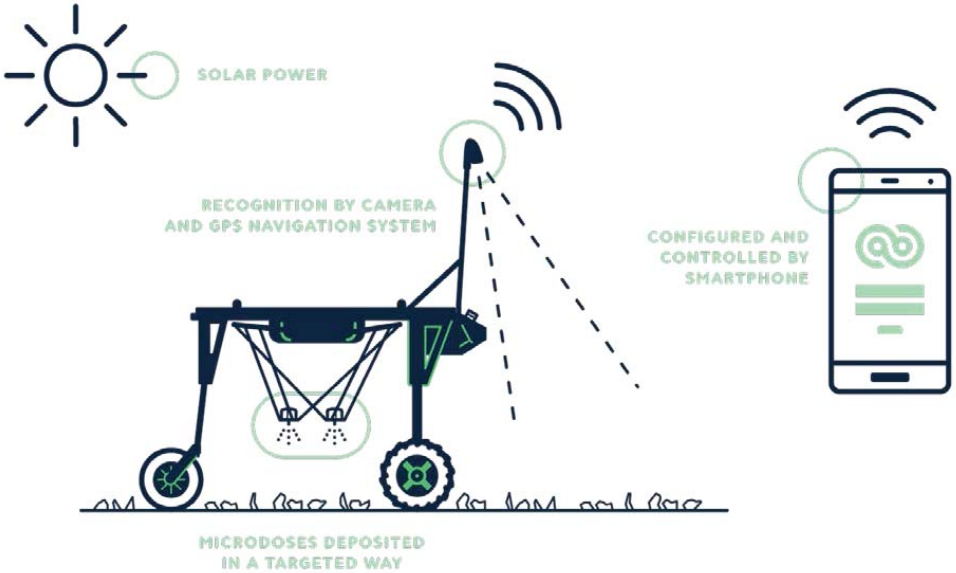
Electric weeders- battery powered

Black+Decker

Naio

Robotic weed control

NAIO- AUTONOMOUS VEGETABLE WEEDING ROBOT - DINO



Ecorobotics

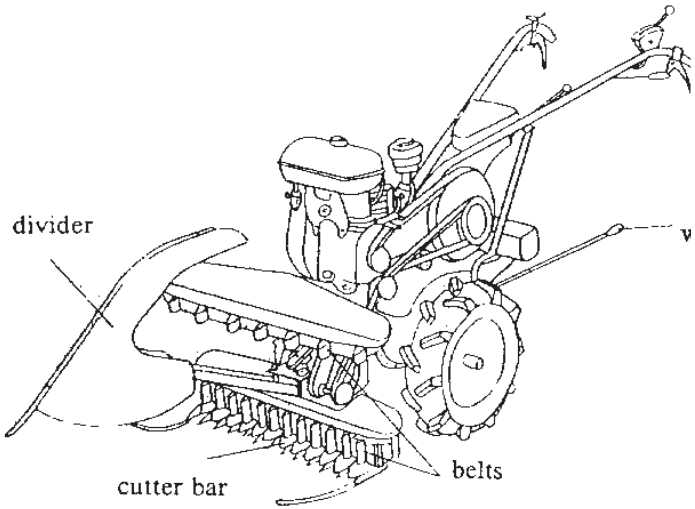
Opportunities for weed control, also in Africa

- Create a new advanced industry with well paid jobs
- Develop low risk models of weed control not dependent on chemical herbicides
- Develop sustainable weed management methods that limit/avoid herbicide resistance
- New weed control tools for arable crops and vegetables, both organic and conventional agriculture
- Have a flexible technology that can take advantage of new technologies as they develop or become accessible to local industry
- Impact on drudgery and labor force activities

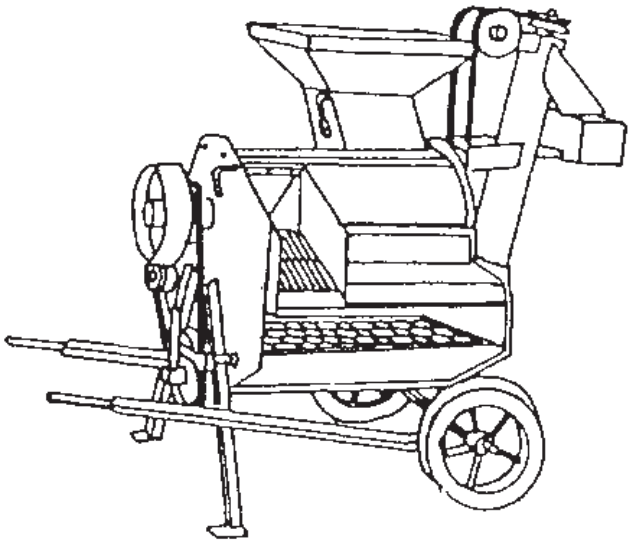
Grain harvesting in Ethiopia: Cutting

Grain harvest in Ethiopia: threshing

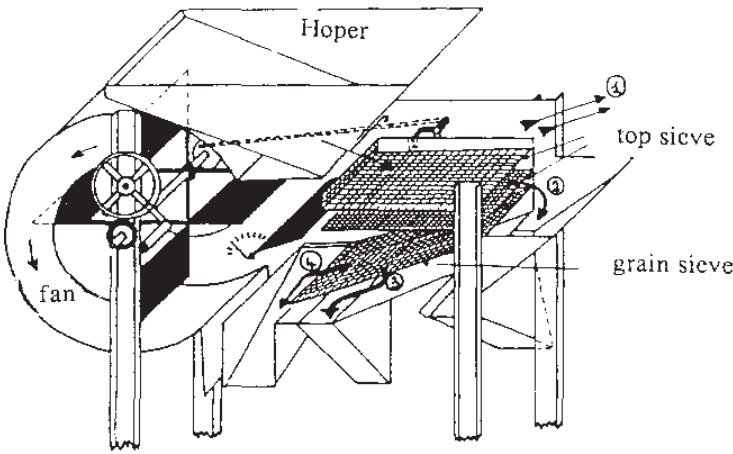
Mechanizing grain harvest



Source: FAO



Source: M. Havard, CIRAD



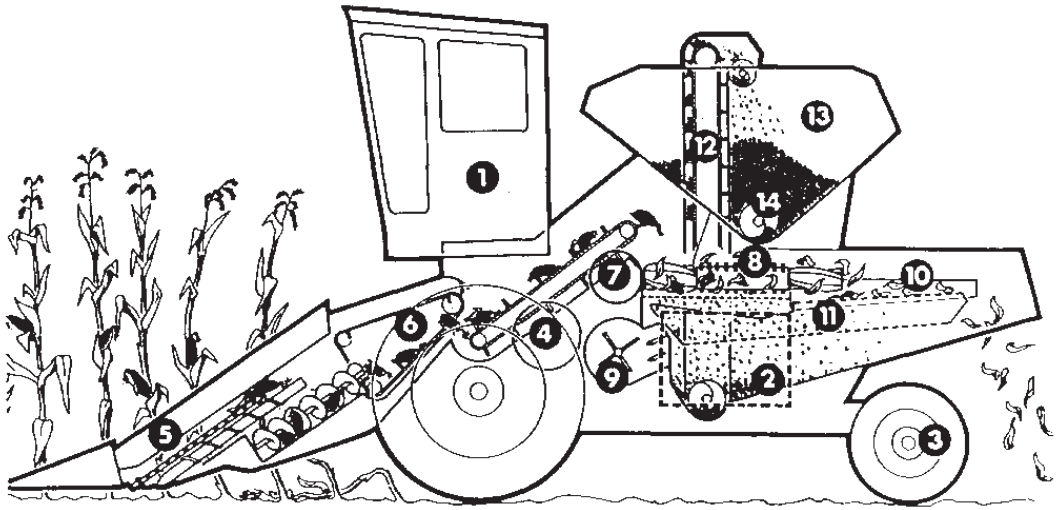
1 light matérial (air exhaust)
2 foreign trashes
3 second quality grain
4 first quality grain

Source: DARRAGON

Engine powered threshing

Combine harvesters

Figure 4.6. Maize sheller.



1 cab
2 engine
3 guide wheels
4 hydraulic speed variator
5 maize header
6 feed conveyor
7 threshing cylinder speed variator
8 threshing cylinder
9 fan
10 cleaning sieve
11 grain auger trough
12 grain elevator
13 hoper
14 unloading auger

Source: CIRAD

Constraints for harvest equipment selection.

- **Technical Constraints**
  - **Available-appropriate technology**
  - **Cropping and Farming Systems**
  - **Cropping Conditions**
    - the moisture content of the grain at harvest time, the maturity of the crop, the type of plant involved and the way it stands in the field
- **Social and Labour Constraints**
  - The skills and experience of farmers,
  - Transfer of activities from women to men
- **Economic Constraints**
  - Ownership or service (Supplied services are generally paid a percentage of the crop: 5 to 10% for threshing and 15 to 20% for combine harvesting)
- **Organization of the Distribution System**
  - Imported machines and parts vs local manufacturing
- **Training Needs**
  - Technical, operational, management…

http://www.fao.org/3/t1838e/T1838E0q.htm#Constraints

Mechanization using small machines for small farms

- Small scale farms experience difficulties to get financing from a bank
  - Even more so in case of women?
- Entrepreneurial people with access to financing can be encouraged to start machinery hire services
  - Or through (partial) donations
- Build a mechanism for commonly use of machines
- Specific rules and payments to be agreed
  - Charge per hour or per surface?
  - When to pay?
  - …
- Cost calculation and estimate potential profit or loss for such an operator

Different Forms of Machinery Ownership and Use

- Individual ownership
  - Small-scale (subsistence)farms that have their own animals
  - Individual ownership of tractors and machinery large/medium scale farms
  - Ownership by women is very limited
- Collective ownership
  - CUMA
- Service delivery enterprises
  - Hello Tractor
  - TroTro Tractor
  - Center for Mechanized Services (CEMA) by the Syngenta Foundation

- FAO and CIMMYT publication: ‘Hire Services as a Business Enterprise’

Private initiatives and PPI's

- AGCO Agriculture Foundation (September 2018)?
  - supporting farmer education initiatives as well as access to mechanization and agricultural projects
  - AGCO Future Farm in Africa (Zambia)
- Syngenta Foundation

Technology in Research Centres/ Universities

- Upgrade the training of engineers and technicians in Africa
  - augmented reality and virtual reality.
  - CAD
- ICT and agriculture.
- Business plan development
- Entrepreneurship
- Women in Engineering
- Vocational training in machinery maintenance
  - In collaboration with industry
  - Internships
  - Make it attractive for women
- Value of the “AgTecCollection in mediaTUM”

Spin-out of Research Centres/ Universities

- ResilientAfrica Network (RAN) funded by USAID is a partnership of 20 African universities in 13 countries.
- Regional Universities Forum for Capacity Building in Agriculture (RUFORUM, www.ruforum.org): African Young Entrepreneurs Competition Series
  - MUWOGO: innovatively extend the shelf life of fresh cassava roots
  - *Fruiti-Cycle* is an electric motorized tricycle that uses solar power and manual peddling; refrigerated storage unit which uses evaporative cooling

Breeding Entrepreneurs in Mechanization?

- Detect the entrepreneurs with exciting ideas
- Help to develop the technology
- Make a business plan
- Financial support
- Networking support
- If failed, encourage another try

Entrepreneurs in Agricultural Mechanization

- **ICT entrepreneurs**
  - Mobile phones as enabling technology
  - Accelerating e-agriculture through *AgriHack Talent* initiative of the Technical Centre for Agricultural and Rural Cooperation (CTA)
  - Weather forecast for better managed agricultural operations, including pest control and fertilizer application
- **Scaling up of innovations and new technology**
- **The 'uberization' of agricultural equipment.**

The African agri-tech space is booming, with the number of startups operating in the market growing 110 per cent over the past two years, and over US$19 million invested into the sector in that period.

http://disrupt-africa.com/agrinnovating-for-africa-2018/

“Feed Africa”: the African Development Bank

Boosting Africa’s agricultural productivity through technology

The Bank has been harnessing the potential of technology to boost Africa’s agricultural value chains.

The rapid pace of growth in the use of drones, automated tractors, artificial intelligence, robotics and blockchains are transforming agriculture. Smart farming and technological innovation is boosting productivity, but more education, connectivity and funding is required.

“The Bank will continue to develop its focus on promoting new technologies and modern farming techniques. For instance, our Technologies for African Agriculture Transformation (TAAT) framework aims to expand access to agricultural yield-enhancing technologies, including high-yielding and bio-fortified staple crops. TAAT aims to reach 40 million farmers with improved food technologies by 2025.”

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Millennials ‘Make Farming Sexy’ in Africa, Where Tilling the Soil Once Meant Shame

Young workers taking a break from farming. Though about 60 percent of Africa’s population is under 24, the average farmer’s age is 60.
CreditNana Kofi Acquah for The New York Times

“How can we have all this land, good weather, a lot of water bodies, but we still are importing onions?” Mr. Ansah-Amprofi said.
Nana Kofi Acquah for The New York Times

Suggestions

- Specialization for certain crops (CEMA for rice…)
  - New machinery challenges detected?
- The sun shines every day
- Disruptive technology attractive to young people
  - Portable weeding machinery using backpack batteries?
  - Electric vehicles with batteries powered by solar energy
  - Service providers managed by woman, for weeding
  - ICT in conjunction with reliable and well established machinery.
- Drawings and construction guidelines of older equipment ???????
- Upgrade the training of engineers and technicians in Africa
- Scaling up of proven novel technologies

Inventing a better wheel?

- Agricultural machinery adapted to local needs-
  - Starting with available tools and documentation?
  - Local creativity

- Agricultural mechanization also changes (local) agriculture

- New requirements and novel technology to be incorporated in machinery

- Entrepreneurs discover agriculture as exciting activity

Is this so?

- ‘Small scale farms should either scale up or get out, or they are trapped in poverty’

Thank You