



Modern Energy Services for Modern Smallholder Agriculture

Agriculture is the engine of sustainable development—and energy is a major driver in this process

The Challenge

Agriculture contributes significantly to the economic and social development of the vast majority of developing countries. Increased agricultural productivity is the primary driver for food security, income generation, development of rural areas and thus global poverty reduction. FAO estimates that an increase of 70 percent in agricultural productivity is required by 2050 to feed the growing world population. This increase must be generated mainly by intensification of current production systems. Greater agricultural productivity requires enormous investments in agricultural production, post-harvest and storage facilities, agro-processing and marketing capacities, as well as improvements in infrastructure and transport. Energy plays a key role at all levels of the agricultural production chain from production, post-harvest and storage and processing to commercialization.



Modern Energy Services for Agriculture

Modern energy services include electricity from the national grid as well as decentralised off-grid technologies, but also the provision of mechanical and thermal energy. Different technologies are powered by different energy sources for agricultural applications. Grid extension to remote and dispersed rural areas is mostly too costly. As costs of rural off-grid technologies decline, they can provide an alternative solution at a lower cost. For off-grid applications, renewable energy technologies can reduce environmental impact and—owing to increasing oil prices—provide lower-cost alternatives to conventional energy technologies. In terms of agricultural applications, **solar photovoltaic (PV)** systems are used for activities that generally require low power input, e.g. PV-driven pumps for irrigation, ventilation for solar drying of fruits and vegetables or solar energy for cooling through absorption, heat or evaporation-driven refrigeration.

Where available, **wind energy** systems represent a reliable and cost-competitive resource for agriculture: powering mechanical or electrical water pumps or for agro-processing activities.

Micro-hydropower provides mechanical and electrical energy for agricultural processing activities demanding higher loads, e.g. milling and pressing.

Biomass energy is based on organic material from agriculture and forestry. It can be used as an energy source for agriculture in the form of electricity and heat, e.g. heat for drying, refrigeration, fermentation or industrial processes, electricity (industrial biogas) to power electric motors, liquid biofuels for transport or to power combustion engines.

Hybrid systems are energy technologies which combine renewable energy (e.g. PV, wind, micro-hydro) with conventional energy (e.g. diesel generator) for decentralised power supply. These systems gain importance as they provide a more reliable and continuous energy supply than is possible with solar, wind, water or diesel alone and thus offer good potential for economic development. However, the financing and maintenance of the systems remain a challenge.

Delivery mechanisms of modern energy services on a fee-for-service basis (e.g. Energy Service Companies [ESCO], leasing and concession models), minimise the risks for smallholders when investing in technologies. They can focus instead on farm management and income generation and pay for services delivered.

Subsequently, for each level in the agricultural production chain, processing and commercialisation, energy demand/technology, energy sources, and the future outlook for energy needs for improving productivity is summarised. Energy for transport is an integral and essential part of all steps of production, from the field to the markets. Transport costs often represent the bulk of marketing costs, depending on fuel prices, access to roads and local infrastructure. Owing to increasing prices for fossil fuels and the need for a safe fuel supply in rural areas, the production of biomass for generating biofuels (bioethanol and biodiesel) is an option for smallholders to contribute to rural transport solutions.



Production

Activities: Land preparation, seeding, fertilisation, weeding, crop protection, irrigation, harvesting/threshing.

Direct energy demand/technologies: mechanical tools (hand tools, animal plough, tiller, mower, hoe, sprayer, sickle), machinery (tractor, tiller, plough, bed planter, harvester, threshing machine), irrigation: motorised pumps (electrical and mechanical).

Energy sources: liquid fuels (fossil and biofuels) for engines (tractors, machinery, pumps), grid electricity for pumps, PV pumps, hybrid systems for pumps (PV/diesel, wind/diesel).

Indirect energy demand: production of fertilisers, pesticides, herbicides, insecticides.

Energy outlook: improving mechanisation, applying energy-efficient organic and conventional cropping systems (e.g. conservation agriculture), producing agricultural energy sources (biofertiliser as by-product of biogas production, oil seeds or commodities for biofuels); irrigation: outscaling irrigation schemes with technically improved solar, wind and (biogas) driven water pump systems.

Post-harvest & Storage

Activities: Packing, dry and cold storing.

Energy demand/technologies: For grain, pulses, oilseeds, roots and tuber crops, good storage and hygiene practice is sufficient: no energy requirements. Cold storage (fruits and vegetables): fans, ventilators, refrigeration.

Energy sources: Grid electricity, electricity generated from a diesel powered compressor, mechanical from a water turbine, Hybrid PV/diesel generator, solar/evaporation.

Energy Outlook: improving storage infrastructure with energy supply (e.g. larger cooling chains), transportation, road networks and communication systems.

Processing

Activities: Drying (fruits, vegetables, spices, tea, coffee, coconut), Cereal milling, Extraction (edible oils, sugar).

Energy demand/technologies: Heat and solar dryer, shaker, grinder, mill, dehusker, sheller, oil presses and expellers.

Energy sources: liquid fuels (liquid propane gas, biomass, vegetable oil), grid electricity, PV, wind/micro hydro and hybrid power systems, diesel engines, electric motors

Energy outlook: upgrading processing technologies, packaging material and machinery.

Commercialisation

Activities: Infrastructure and transportation, information and telecommunication, training, selling.

Energy demand/technologies:

transport cars, pick-up trucks, boats, cell-phones, radio stations, TV, internet, lighting, computer equipment, fax, etc.

Energy sources: liquid fuels (fossil and biofuels) for transport, electricity generated from hybrid systems, PV-powered cell-phones and satellite phone kiosks, solar home systems (SHS) for lighting, solar lantern.

Energy outlook: use of vegetable oils as fuel for transport vehicles, extend energy-efficient bulk transport, improve access to ICT technologies including internet.

Agricultural Energy Outlook

In reducing energy poverty in relation to the food security and economic development of rural areas, agriculture plays a core role as an energy user and producer (through bio-energy). For intensification of agricultural production systems, there is increased energy demand—expected to be covered by different sources, preferably from renewable and low carbon energy sources. Thus, biomass energy strategies for developing countries are gaining in importance for heat and decentralised electricity generation, including self-contained energy cycles of renewable biomass resources, such as the technology—still underestimated in many developing countries—of anaerobic digestion to produce biogas for power generation.

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