

Agriculture 4.0: agricultural robotics and automated equipment for sustainable crop production

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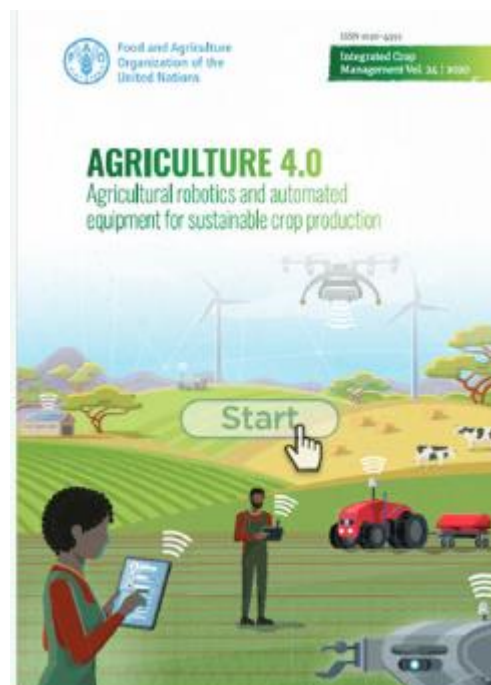
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The Agriculture 4.0 of the title refers to the emerging paradigm of digitalisation, automation and artificial intelligence (AI) used in agricultural production. It integrates a suite of innovations including precision farming, the Internet of Things (IoT) and big data. Mechanisation is a key factor in the transformation from subsistence to market- oriented agriculture, and data-driven agriculture, with the help of robotics and AI, is the basis for future sustainability. This booklet aims to present new technological developments relating to automation and precision agriculture which may have relevance to smallholder farming systems in the future. The way in which information is managed is illustrated by showing how crop sensors can gather data that is captured and processed by specific software and AI. Intervention options are provided and the farmer decides how to act, either directly or via automated equipment. Agricultural robotics can combine all the stages in one platform, or specialise in some of them. This is the current vision for highly developed agriculture – smallholder farms in developing countries will need to acquire the necessary knowledge and skills.

In Agriculture 4.0, drones and other sensing platforms can provide information on a crop's development, soil parameters, fertiliser requirements, the presence of pests and diseases, and the development of weed populations. Input use can then be optimised. Agricultural robots (or 'agrobots') are mobile, autonomous, decision- making, mechatronic devices that accomplish crop production operations under human supervision, but without direct human labour. This technology is fledgling; the first commercially available agrobots are used for weed management, pest and disease monitoring, and harvesting berries and vegetables. Potential applications are many and varied.

The drivers of adoption are currently economic and environmental. There is generally a lack of labour available, especially for fruit harvesting, and agrobots can bridge this gap. Input use (pesticides, herbicides and fertilisers) is more efficient and so reduced when applied by agrobots. Agrobots are also much lighter than conventional tractors and so reduce soil compaction – and their restriction to defined tracks via Global Positioning System (GPS) control will reduce soil damage even further. Challenges to adoption include: the ownership and management of digital data; knowledge, capability and capacity; adaptation of farming systems; purchase price; information technology (IT) infrastructure; and technical maintenance and servicing.

With regard to the perspectives for the application of robotics in developing countries, the agricultural applications will include the creation of direct seeders and weed control options integrated with the development of conservation agriculture (CA) production practices. Reduction of drudgery by automated weeders and water-carrying carts supplied by service providers is another possibility. Agribusiness options will likely be around the potential for leasing and hiring the technologies. This will be of interest to youthful entrepreneurs in rural mechanisation and partial automation, and will go some way to attracting youth back to the agricultural sector and, perhaps, put a brake on the current rural– urban migration flow. Agrobots in this context should be designed so that parts can be provided by 3D printing technology. A concluding discussion explores the potential contribution of robotics technology to the achievement of the relevant United Nations Sustainable Development Goals (SDGs). This publication provides a useful and timely overview of the principles and practices of the vital elements of Agriculture 4.0 – which is already a reality. The potential for its application in smallholder farming systems in developing countries will take some time to be converted into reality.

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