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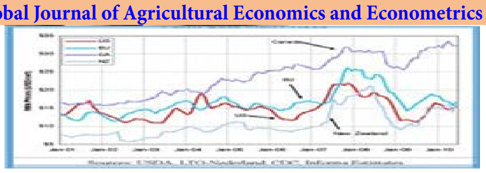

Commentary Article Open Access

ISSN: 2408-5499 Vol. 9 (4). Pp.1-12
August, 2021

Uncertain ground research on soil “ecosystem” services and natural capital: A critical review

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Received 03 August 2021; **Accepted** 17 August 2021; **Published** 24 August 2021

ABSTRACT

The concept of “ecosystem” services of soils has received a lot of attention in the scientific literature and the media in recent years. The monetary valuation of these services is frequently depicted as a fundamental condition for the preservation of the natural capital that soils represent, as required by many countries and international organizations. This emphasis on soil services is set in the context of a broader interest in ecosystem services that began in 1997 and accelerated after 2005. The detailed review of the literature offered in this article reveals that interest in soil multifunctionality dates back to the mid 1960’s, Hundreds of experts around the world were trying, and mostly failing, to figure out how to place real price tags on “nature’s services.” Since then, soil scientists have worked to better understand the numerous activities and services of soils, as well as their possible links to critical soil properties such as biodiversity. They’ve also attempted to make progress on the difficult quantitative issues. However, researchers have shown little interest in monetary valuation, undoubtedly because it is unclear what economic and financial markets would do with prices for soil functions/services, even if we could come up with such numbers, and because there is no guarantee that markets would manage soil resources optimally, based on neoclassical economic theory. Instead of monetary value, the research has focused on decision making processes that do not require the systematic monetization of soil functions/services, among other things. Multi-Criteria Decision Analysis (MCDA) methods easily incorporate deliberative procedures involving a range of stakeholders, whilst Bayesian Belief Networks (BBNs) provide the extra benefit of allowing the effect of parameter uncertainty to be accounted for Participants must be extremely aware of the extreme relevance of soils to many parts of their everyday lives in order to progress in such public debates. We believe that, as long as this criterion is met, the combination of deliberative decision making procedures and a rigorous scientific methodology to quantifying soil functions/services (including uncertainties) is a highly powerful combination.

INTRODUCTION

According to the United Nations, the global population will increase from 7.3 billion today to 9.7 billion by 2050. The world will require far more food, and farmers will be under extreme pressure to meet demand. Agricultural robots help farmers increase output yields in a variety of ways. Drones, autonomous tractors, and robotic arms are all examples of how technology is being used in unique and innovative ways. In agriculture, robots can be used in a variety of ways. The Merlin Robot Milker, Rosphere, Harvest Automation, Orange Harvester, lettuce bot, and weeder are some examples and prototypes of robots. The milk bot is an example of a large scale application of robots in agriculture. Because of its efficiency and lack of need to shift, it is widely used among British dairy farms. According to David Gardner (CEO of the Royal Agricultural Society of England), a robot can do a difficult activity if it is repetitious and the robot is allowed to sit in one spot. Furthermore, robots that perform repeated operations (such as milking) perform to a regular and specific standard. Horticulture is another area where it can be used. Harvest Automation Inc.’s creation of RV100 is one horticulture application. The RV 100 is made for transporting potted plants in a greenhouse or outside. Spacing possibilities, collection, and consolidation are all features of the RV100 when it comes to handling and organising potted plants. High placement accuracy, autonomous outdoor and indoor function, and lower production costs are all advantages of employing RV100 for this operation. Many sectors of agriculture are already being transformed by new technologies, and the agrochemicals industry is no exception. Intelligent and autonomous robots can enable ultra-precision agriculture in this scenario, potentially altering the agrochemicals industry. Bulk commodity chemical providers will be turned into specialised chemical firms as a result of this process, and many will have to reinvent themselves, learning to see data and Artificial Intelligence (AI) as key components of their whole crop protection strategy. Domain and task specific robots meant to execute a single task on a certain crop in a pre-defined domain, and generic platforms built to perform multiple tasks in different domains, are two types of agricultural platforms. Both are likely to have significant roles to play. Because farms have such disparate infrastructure, early robots may only be able to function on a single farm or only to a limited extent across multiple farms. We may see a combination of robots specialised to a specific task and the introduction of multi-purpose robots capable of carrying out a multiplicity of various duties, similar to the myriad use cases seen with modern agricultural vehicles. Most contemporary robotic platforms are not resistant to real world situations such as mud, rain, fog, low and high temperatures, to name a few. Most existing manipulators, for example, are not designed to deal with humidity in glasshouses. The development of rapid prototyping techniques and low cost processors has led to an increase in the usage of 3D printing and “maker” technologies in this sort of Mechatronics and electronics, enhancing the promise of low cost robotic platforms for a number of applications.

Embedded software allows for highly flexible and application specific platforms that may be tailored to a number of functions while using common hardware modules. While such technologies have been widely used in UAVs (Unmanned Aerial Vehicles) and smaller scale robots, there is great room for robotics in Agri-food to expand on a much larger scale. Robustness and reliability, power management (platforms must be able to operate all day, in some cases 24/7, for extended periods), usability (platforms must be able to be used effectively by non-specialists), maintenance (e.g. self-diagnosis), and integration with mobile communications are all issues that must be addressed in order to transition from prototypes to robust commercial platforms. Agricultural robots must travel in dynamic and semi-structured surroundings in this style of locomotion. Aerial vehicles must operate for lengthy periods of time in a variety of weather conditions, while ground robots must navigate over uneven, inhomogeneous, muddy soil. Agrirobots are now built primarily by borrowing technology from other industries (e.g., drones) or as an add on to existing systems. As a result, they might not be entirely optimised for their jobs, or they might still have some of the restrictions of existing platforms.

Manipulators of this type will be required for a variety of activities in future agriculture, including substituting dexterous human labour, lowering prices and improving quality, and completing operations more selectively than present larger machinery such as slaughter harvesters. Soft grippers are being employed for experimental work on selectively picking mushrooms, sweet peppers, tomatoes, raspberries, and strawberries in this direction. Other applications, such as broccoli harvesting, can be done with cutting tools, but the harvested product must be handled and stored with care. Mechanical weeding, precise spraying, and other types of inspection and treatment are examples of this. Manipulators will also be required when food handling applications, such as big automated warehouses, become more automated. Open ended learning, which allows for adaptability to seasonal changes, new emerging diseases and pests, new crop types, and so on, is an open challenge in robotic vision and machine perception for robotic agriculture. The majority of present research focuses on the initial training phase before deploying a robot vision system, rather than the continual adaption of learnt models over time