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ORIGINAL

Application of Artificial Intelligence in Tree Care in Sub-Saharan Africa

Aplicación de la Inteligencia Artificial en el Cuidado de los Árboles en el África Subsahariana

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ABSTRACT

Artificial intelligence (AI) has emerged as a transformative tool in various industries, including environmental conservation and tree care. In Sub-Saharan Africa, where deforestation, climate change, and inadequate tree management pose significant challenges, AI presents opportunities for improving tree care practices. This study explores the application of AI technologies in tree monitoring, disease detection, and sustainable management strategies within the region. Utilizing a combination of literature review and case study analysis, the research evaluates AI-driven approaches such as remote sensing, machine learning models, and automated data collection for assessing tree care and forest dynamicos. The findings indicate that AI enhances early disease detection, optimizes resource allocation, and supports decision-making for conservation efforts. However, challenges such as limited technological infrastructure, high implementation costs, and the need for specialized expertise hinder widespread adoption. The study concludes that while AI holds significant potential for revolutionizing tree care in Sub-Saharan Africa, strategic investments in digital infrastructure, policy support, and capacity building are essential for its successful integration into forestry and environmental management practices.

Keywords: Artificial Intelligence; Tree Care; Sub-Saharan Africa; Remote Sensing; Machine Learning; Environmental Conservation.

RESUMEN

La inteligencia artificial (IA) ha surgido como una herramienta transformadora en diversas industrias, incluida la conservación del medio ambiente y el cuidado de los árboles. En el África subsahariana, donde la deforestación, el cambio climático y la gestión inadecuada de los árboles representan desafíos significativos, la IA ofrece oportunidades para mejorar las prácticas de cuidado forestal. Este estudio explora la aplicación de tecnologías de IA en la monitorización de árboles, la detección de enfermedades y las estrategias de gestión sostenible en la región. A través de una combinación de revisión bibliográfica y análisis de estudios de caso, la investigación evalúa enfoques impulsados por IA, como la teledetección, los modelos de aprendizaje automático y la recopilación automatizada de datos para evaluar la salud de los árboles y la dinámica forestal. Los resultados indican que la IA mejora la detección temprana de enfermedades, optimiza la asignación de recursos y respalda la toma de decisiones en los esfuerzos de conservación. Sin embargo, desafíos como la infraestructura tecnológica limitada, los altos costos de implementación y la necesidad de experiencia especializada dificultan su adopción generalizada. El estudio concluye que, si bien la IA tiene un gran potencial para revolucionar el cuidado de los árboles en el África subsahariana, se requieren inversiones estratégicas en infraestructura digital, apoyo normativo y desarrollo de capacidades para su integración efectiva en la gestión forestal y ambiental.

Palabras clave: Inteligencia artificial; Cuidado de Árboles; África Subsahariana; Teledetección; Aprendizaje Automático; Conservación Ambiental.

INTRODUCTION

Artificial Intelligence (AI) is rapidly transforming various sectors worldwide, including agriculture. In Africa, AI integration is expanding across agriculture, forestry, and wildlife conservation.[1,2,3,4] However, tree care in Sub-Saharan Africa remains an underexplored field, despite its critical role in environmental sustainability and food security. AI offers promising solutions to pressing issues such as wealth inequality and resource management, making research and implementation in tree care essential.

Africa boasts diverse tree populations, spanning forests, grasslands, and urban areas. Trees provide vital ecosystem services, including food supply, soil conservation, and carbon sequestration. Amid rising global temperatures, urban tree care is increasingly crucial for improving air and water quality, mitigating heat, and enhancing urban resilience. AI-driven technologies—such as smart applications, drones, and satellite monitoring—can predict and prevent tree health deterioration before it impacts infrastructure and the environment.[4,5,6,7,8,9,10]

The push for AI adoption in Africa is gaining momentum, with research initiatives focused on responsible AI deployment. A comprehensive R&D roadmap has been proposed, starting with agriculture, to bridge knowledge gaps and address challenges in AI-driven agricultural solutions. Studies show that AI integration in agriculture could significantly enhance food security and environmental sustainability. However, concerns remain about AI's potential to marginalize vulnerable populations, particularly smallholder farmers, due to disparities in digital literacy, financial access, and governance.[11,12,13]

This study introduces an AI- and IoT-based tree care system tailored for urban forestry in Sub-Saharan Africa. The system leverages key performance indicators (KPIs) such as ruggedness, cost-effectiveness, and user adoption. Developed at the Technical University of Munich, the IoT framework comprises low-cost sensors that monitor air pollution, soil moisture, and tree health. Data is transmitted via a Long-Range Wide Area Network (LoRaWAN) to a global server for analysis. AI models—including the Hierarchical Tree Risk Assessment (HTRA) system and YOLO V4 Convolutional Neural Network—enable automated tree crown analysis and risk assessment.[14]

Despite AI's potential, its deployment in Africa presents challenges, including infrastructure limitations, governance issues, and public awareness gaps. Scientific research on AI applications in Africa remains limited, underscoring the need for more empirical studies. AI also carries unintended social justice implications, such as reinforcing economic disparities or restricting access to technological advancements. Autonomous agricultural robotics and digital agriculture, for example, rely on IT infrastructure that is still underdeveloped in many African regions.[15]

While AI holds promise for addressing Africa's socioeconomic and environmental challenges, its implementation must be equitable and inclusive. Responsible AI deployment requires targeted policies, investment in digital literacy, and collaboration between governments, institutions, and local communities. A balanced approach can ensure AI-driven innovations benefit all, rather than exacerbating existing inequalities.

METHOD

Literature Screening

This study conducted a systematic literature review following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A comprehensive search was performed across five major academic databases: Google Scholar, Web of Science, Scopus, ScienceDirect, and ProQuest. The search, conducted on October 1, 2016, employed the following keywords: “tree care” OR “tree maintenance” OR “tree health” AND “cost” AND “benefit” OR “ecosystem service.”

Inclusion criteria for selected studies were as follows: (1) original research articles published in peer-reviewed English-language scientific journals and (2) studies that quantitatively assessed both the benefits and costs of tree care using any measurement approach. To ensure methodological rigour, non-peer-reviewed sources, books, and grey literature were excluded. However, review articles were considered if they contained original research findings. Additionally, reference lists from review articles were examined to identify further relevant studies. The PRISMA flowchart summarising the search process and screening workflow is presented in figure 1. The final dataset comprised 34 original research papers published between 1992 and 2025.

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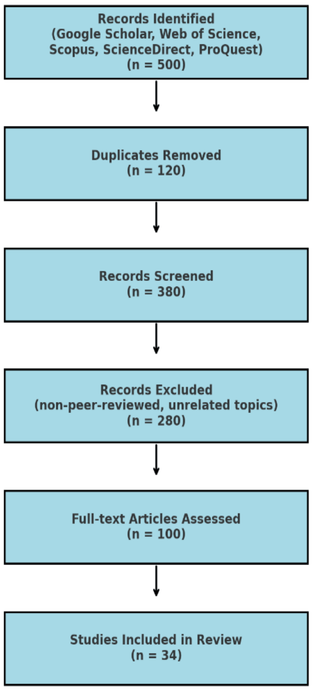

Figure 1. PRISMA flowchart summarizing the literature screening process

Data Compilation and Analysis

Data extraction from the 34 selected studies focused on the following key variables: (1) citation details, (2) spatiotemporal scope, (3) study location, (4) climate classification, (5) tree typology, (6) number of trees assessed, (7) importance of tree care, (8) valuation methods and assessment scenarios, (9) quantified benefits and costs, and (10) tree growth and mortality rates.

RESULTS

AI Applications in Agriculture and Forestry

The idea that trees in need of care do not require hungry mouths to feed has long made tree care, as it relates to markets, a nonstarter for most African people, especially beyond the farmers of South Africa, Zimbabwe, or Swaziland, where such trade practices seem common. AI implications in agriculture have received much attention, especially in the developed world for what they offer in food production, processing, storage and logistics. However, little has been said about their application in forestry with relevance to exacerbating expanding desertification challenges in Africa.[1,2,3,4,5,6,7] It may be the case that most desertification in Africa occurs outside sub-Saharan Africa, with Egypt, Sudan, and the Horn of Africa being foremost concerned. But, as time progresses, current desertification and primary farmlands shift by nearly one percent of all African rural/agricultural land each year and, by 2045, most of South Africa's best farmland lies within the Tropic of Capricorn, the nation's most agriculturally productive regions are mostly centred on the Tropic of Capricorn.

Artificial intelligence (AI) has the potential for addressing major problems, not least food security. For Africa, with a population density above 100 per km2 across most of its nations, desertification is likely, for desertification relates closely to deforestation and widespread soil erosion; to say that all primary woodlands will be cleared or die off come mid-century is not utopian, it may be conservative. A sub-Saharan nation that has lost its primary woodlands and fertility suffers little more materially from them both.[8-15] AI positioning in Africa has, so far, been somewhat one of defence, being more concerned with not creating an AI-regulated AI-leaning environment than with what AI investment and maturation grants it. As viewed in the remainder, AI has the potential for fueling radical transformation in environment space via selective breeding and automatic management extending beyond the present strategy of seed and fertilizer subsidies. Analysis outputs of so-called precision farming consultancy are presently non-existent, and such tools may be largely useless if they were.

Importance of Trees in the Region

The deforestation rate in Sub-Saharan Africa was estimated at 0,77 % p.a. in the period 2005–2010 which is the highest among tropical regions. The region is projected to lose 42 % of its forests and savannahs by 2100 under the business-as-usual global policy scenario.[16,17,18,19,20] The main factors responsible for deforestation are agricultural expansion, forest fires, and logging. However, a larger portion of wide-spread indigenous species could be also reduced in dryland areas. Some tree species with restricted natural occurrences in the region are also under threat. Around one in four African tree species are threatened with extinction.

Keeping trees and establishing new ones, especially in farmlands are expected to increase tree cover in the region. This would have significant impacts on farm productivity through strengthening agroecological functions of trees, and help maintain the region rich in forest genetic resources. Moreover, carbon sequestration through tree planting plays an important role in global mitigation efforts and helps rural farmers to be eligible to access climate finance.[20,21,22,23,25]

Given that the region is expected to suffer severely from climate change, it is necessary to develop an advanced tree care system to promote a wider extent of trees in the countryside. An expert system model based on artificial intelligence (AI) is expected to provide timely and localized information and advice necessary for tree care in the region. AI is the branch of computer science that deals with the ways that computers can more effectively work to mimic human intelligence. Meanwhile, CARE DSS based on AI could avoid false alarms caused by subjective judgement influenced by fear of economic damage and prejudice against particular trees, tree owners or its previous performance. The government of Ethiopia also embarked upon a national green development plan. By 2030, the plan aims to increase national forest development coverage from the current 15 % to 20 %.

Current Tree Care Practices in Sub-Saharan Africa

Sub-Saharan Africa's increasing population will lead to a growing demand for timber and fuelwood, and thus the necessary attention should be paid to quantitative and sustainable management of forests and woodlots. An emerging number of shorter managed intensive rotations (SMIR), such as short rotation coppice (SRC) willows are considered for combining wood production with energy crop demand. The main objective of this research is to identify locations in sub-Saharan Africa, specific for the implementation of SRC systems.[21,22,23,24,25,26,27]

The suitability of Sub-Saharan Africa for SRC systems was checked regarding weather conditions, soil characteristics and water availability. A transient water balance model was utilized to estimate at 5km x 5km resolution the components of the energy crop demand such as the potential evapotranspiration and the actual crop water demand, taking into account the specific characteristics of SRC systems.[2,3,28,29,30,31,32,33]

Current tree care problems in Sub-Saharan Africa were observed within different land use scenarios. Model productivity showed the spatiotemporal transition of agricultural areas to shorter and less sensitive tree rotations in the case of the optimal identified land. Moreover, a sensitivity analysis was conducted for two different climate models and the attendant outcomes showed the change in model productivity in the SRC systems due to a potential change in future climate change scenarios. Sub-Saharan Africa consists of a large number of countries highly heterogeneous in various characteristics, such as climate, soil, geology, vegetation, and economy. Moreover, a diversity of such conditions could also be found encompassed within the territories of individual countries.[34]

At the same time, about two-thirds of the agricultural area of the African continent is under traditional rain-fed agriculture with low levels of agrarian technologies. The holistic consideration of the mentioned points reveals the complexity and variety of the surrounding conditions in the entire African territory. Over the decades, there has been growing concern about the low and decreasing potential of food self-sufficiency on the African continent in conjunction with the increasing population and shrunk arable land as the result of soil degradation.[1,2,3,4,6,7]

Challenges in Tree Care

The list of problems facing the tree-caring industry in sub-Saharan African cities is lengthy. Pest infection and inadequate care and protection are two of the main reasons why trees show signs of decay and fall. Broken or dead branches will naturally detach from a tree, but improper care, environmental conditions, temperature fluctuations, or pests could lead to the same outcome.[1,2,3,4,5,6,7,8] Additionally, poor tree maintenance practices decrease the expected lifespan and use of trees. In general, a tree should provide at least 10 years of service and a lifetime of care, with continued care and work after the first ten years.

Fallen trees in public areas can cause structural damage to buildings and vehicles and can lead to injury or even death. Fallen trees in other locations often create traffic congestion. There are numerous reports each month of accidents caused by fallen trees. Ergo, the problem is high and in need of a solution.[20,21] The overhead costs of tree care are substantial. The cost of cutting down a dying tree is estimated to be between $500 and $1000 and the actual costs may range beyond this estimate as per additional labour, equipment, complexity, permits, transportation, wood chip removal, tree stump grinding, and the disposal or relocation of the wood.

It would be advantageous to all, to extend the life of the tree beyond such a term and thus, lower overhead costs. In recent years there has been a merging of a slow growth in publicly accessible tree inventories for urban trees, and a growing trend in research. Much of the research in this sector has focused on pest infection modeling and automated detection technology. It is hypothesized that a predictive model based on the change in temperature over daily, weekly, seasonal, and yearly intervals could accurately forecast the symbols for trees like the R-value used in urban sound analysis modeling.[33,34,35,36,37,38,39,40]

Opportunities and Benefits of AI in Tree Care

1. Introduction and Current State of Tree Care In recent years, growing attention has been given to the potential of artificial intelligence (AI) to provide solutions to issues that are affecting the care of trees. AI-related innovations are providing smarter solutions for managing tree care processes and linking stakeholders across different value chains and beyond. In this regard, AI has the potential to improve sustainable tree care practices and related value chains worldwide. Despite the various technical and regulatory challenges that stakeholders face in the expansion and adoption of AI in tree care, many government-led and private initiatives are being implemented in Sub-Saharan countries to realize some benefits of AI in the care of trees.[41]

2. The Need for Sustainable Tree Care Practices in Sub-Saharan Countries As worldwide cities expand, there is growing evidence of the socio-economic and environmental benefits of trees, such as their ability to reduce the urban heat island effect. Hence, the importance of trees in urban areas is increasing both in developed and developing countries. Tree care in urban regions can be very effective when it is precisely planned and done knowledgeably. However, this is not usually the case, particularly in the context of developing countries. For instance, a study on the socio-economics of urban tree care in Addis Ababa city of Ethiopia showed that the urban tree care budget for the five-year plan prepared till 2015 was inadequate and unrealistic. Consequently, this situation made the intended tree care activities barely commence, let alone be completed.[42]

Enhanced Efficiency and Precision

Artificial intelligence (AI) is the major technology of the 21st century. AI focuses on creating intelligent machines that can not only function similarly to humans but also make a machine capable of making precise decisions based on underlying conditions. Many scientists define AI as a study similar to natural intelligence exhibited by humans and animals (Neranjan Thilakarathne et al., 2022). In more recent work AI is defined as the computational intelligence that includes machines capable of learning, understanding, responding and acting in a complex situation. Nowadays due to its wide application in daily life as a friendly virtual assistant, it is playing a significant role in research and industry.

One of the current fields where AI is effectively playing an important role is agriculture, especially in those areas where decisions should be made timely. AI is a key pillar of precision farming; therefore, it is playing a pivotal role in agricultural field applications. Currently, a large amount of big data is being generated per day in the agriculture sector, including geolocation-based information from sensors mounted on Internet of Things (IoT) devices and data from Unmanned Aerial Vehicles (UAVs). Using these sensors and vehicles results in millions of data points in a single day.

On a national scale, this amounts to approximately 6 TB of data in a single year. Due to the vast volume of prohibited data, it is standard practice to store information in a cloud where AI can be deployed to extract useful results from the information stored on the cloud. This analysis makes informed decisions and enhances the yield of trees and crops, resulting in the necessary food demands and food security.[20-24] The data collected from such devices include the prediction of crop yield, and natural weather conditions, as well as prediction of disastrous situations such as droughts, etc.

Cost Reduction and Resource Optimization

New approaches for tree care moulds are being developed and implemented in Sub-Sahara Africa. Combining localization systems, drones, telemetric data, built-in cameras, and LiDAR technology increases the potential for a new market in assisting tree care, which will greatly help trees to adapt faster to the hotter and dryer conditions that were already placed on that part of the world. One of the potential growths in drone capability could be viewed in the field of automated tree pruning procedures. Additionally, the risk of pests and diseases boom with the dryer and hotter weather, resulting in most of the local knowledge essential in coping with diminished local tree wealth.[37,28,39,40,41]

That knowledge is fading due to the ageing of the population of farmers and a new generation that has adapted to the digital era. The methods that drone and LiDAR technologies can give a new life to the knowledge and tradition of adapting to tree care. Hence new tools are needed to make these practices administrable again and new ways for the farming community to learn about them. [20,21] Here a benefit pops up in the first possible link between a developed, and a developing market. While the first one lacks trees, all of the machinery is operable at full potential, some of the newcomers in the developing one can be quite low-cost regarding local potential income.

There is growing interest in the application of artificial intelligence in agriculture. The recent introduction and development of low-cost sensors and robots in agricultural applications have enabled their use by small farmers. Today, there are documented cases where the introduction of an autonomous vehicle has led to lower pesticide and fertilizer consumption. Furthermore, cooperation among experts, researchers from different areas, NGOs and local authorities is essential if lasting changes are to be carried out. NGOs, local authorities and experts must make farmers fully aware of the correlation between bad habits, such as the illegal clearing of trees, and climate change.[27]

The effect of bush dynamics and deforestation should act as a trigger for producers to engage in more sustainable practices. However, their age and the lack of alternative economic income in this part of the world will also make them vulnerable to it. Recent recommendations that hold back the legal forestry cluster first-time offenders to prevent them from committing the same offence again can deepen the low-income financial gap, making it even harder to correct the bad habits. On a scale such as this, the entire territory of Africa can become stigmatized and blocked from further growth. Such a scenario requires a drastic behaviour change by farmers and the entire local administration.[29]

Thus, people in Mozambique have defined a new tree-planting strategy that also includes creating a new protected area. On the other hand, an IT approach can play a major role by introducing instruments of control, continuous monitoring and forecasting to help farmers produce more with a reduced environmental impact. As a means of more than just business as usual, it is important to provide political decision-makers with the best information and tools to fight and control climate change on a larger scale.[20-23]

Challenges and Limitations

AI has the potential to develop by orders of magnitude the capacities of farmers to raise productivity and adapt to climate change, in ways which were unimaginable even a decade ago. That being said, it is widely recognised that AI could also marginalise the poor and disadvantaged, contributing to further deepening of the digital divide. This profound social concern was recently underscored by the President of the United Nations General Assembly.[20,21] These contemplations and informed concerns are items of a consensus effort to frame a research agenda designed to act as a steward for mitigating the profound challenges and responses to AI in the context of countries in sub-Saharan Africa. [24-27]

Initial targeting of the potential application of AI was made on the agricultural sector in sub-Saharan Africa, due to its centrality to many of the pressing difficulties on the continent, such as food security and environmental justice.

Any application of AI in this sector would seem to say something relevant to the concept of ‘tree care’, a concept purposely defined broadly here to encompass any kind of activities related to crop and livestock production. Broadly framed, the term ‘tree care’ could be taken simultaneously as covering efforts to generate a complete transformation of the state of African agriculture into a high-tech venture dominated by quantum farming, genetic engineering, agrobots, and other automatons, as well as covering an Africa dominated by small-holding and agroecological farms, which eschew any kind of industrial farming and biotechnology.[25]

Data Accessibility and Quality

Impediments in sub-Saharan Africa (SSA) constrain the application of artificial intelligence (AI) in tree care. Adaptations through which these impediments could be overcome are proposed, including increasing the availability of financial resources for extension services, reorganizing the extension services, providing digital equipment to district extension services, and expanding the training available to teach the application of AI to integrated pest management for urban trees.

Artificial intelligence (AI) could play an important role in managing urban trees. Considerable research and various practical solutions have been directed toward the application of AI in agriculture in sub-Saharan Africa. These applications include site-specific input rate-and-timing agronomic practices for simulation models, AI systems for optimizing input rates of N before sowing, applications of AI and bioinformatics in crop breeding and the prediction of pests and diseases in crops, and analyses of the perspectives and knowledge of local farmers.

SMEs possessing knowledge of AI may struggle to establish themselves in SSA rural areas, where few examples exist and the financing is not forthcoming. In the urban areas of large cities, where there are already skilled workers and technical equipment, the potential for the application of AI might extend from the more routine aspects, such as the trimming of roadside trees and removing the weeds around them, to more sophisticated tasks, such as protecting the trees from pests and diseases.

Infrastructure and Connectivity Issues

The infrastructure and connectivity issues as well as the energy consumption concerns are linked to Tree Care issues in Sub-Saharan Africa. Tree Care is dependent on a good infrastructure system to transport equipment and personnel to the area requiring treatment. In many instances, the road networks are rudimentary at best and the closest that one can come to a tree on the map may be as much as fifty meters away in reality.[20,21]

Then the remaining distance can be a rugged steep climb further hampered by a “jungle” made up of savannah thorn trees with characteristically long thorns; undergrowth averaged 1,5 m high and plenty of opportunistic parasites like poison ivy and plants with stinging spines. Secondly, the care of many trees in urban or sub-urban environments is carried out in undesirable locations. This can be areas with potential overhead powerline hazards, within or close to army or police installations or other low tolerance or controlled access areas. The common factor of all these environments is the total lack of quality choices concerning tree care. There may well be one contracted tree care entity or the tree care responsibility gets passed from contractor to contractor during the life of the trees.

African problems are often exacerbated by large distances that have to be covered for access to remoteness. This can be in the middle of a national park itself many hundreds of kilometers away from a useful road link or a tree on a mountaintop. The burgeoning population growth does bring up that as the density of people increases, they live closer to the trees. This is of huge importance as people can act as "sensors" by spotting various adverse tree phenomena such as dieback, stress, pests diseases etc.[1,3,7]

The downside is that the face of the earth where trees and natural habitats have been will lose out to the regenerative force of this exploding population. One only has to look at satellite imaging of the African continent to see how some of the most arable land in the world is being lost to informal township sprawl. Africa itself lags in everything communications which will make the proposed scenario impossible on a large scale shortly. The content of most African internet pages is also underdeveloped, in other words, most of it is not useful visionary ideas that can be expanded upon or used as a base for development.

This is partially linked to the local language and writing infrastructure and partially because things like the entertainment industry and large-scale agriculture are globally controlled rendering it impossible for a newcomer to enter. With Africa being so woefully behind in infrastructure it was probably wise to forget about the mobile web scenario. About this, the microdata challenges only allow for proposals in six broad themes, none of which directly address infrastructure or the application of artificial intelligence (AI). This brings to mind an interesting discussion when four years ago it was difficult to put in a subsidy proposal for economically poor or "no data" people due to the requirement of justification through the amount of money spent promoting the service.[8]

Case Studies and Examples

In 2019, a dream to see Africa rise and harness responsible Artificial Intelligence (AI) for the betterment of life led us to publish a paper on the research and development (R&D) of AI which would guide Africa on to journey towards responsible AI technologies. After the agriculture paper, a second one was worked on to help refine the findings of the initial ones to better focus on responsible AI R&D in the respective problem sectors and thus better guide the stakeholder's seeking guidance on this vital issue and support on the course of planning and implementing responsible AI interventions.[20,21]

Africa's struggles to build a safer, fairer, and more prosperous world presents a compelling opportunity to build capacities and lay the foundations for robust, future-proof AI technologies across sectors. AI has vast potential to engage, educate empower and enable for substantive and sustainable change. As a powerful visionary technology, AI can and must be harnessed to support the most vulnerable and work for the achievement of sustainable development goals. It will take concerted efforts from all sectors to ensure AI truly better serves humanity. The pressing challenges of food insecurity, climate change and environmental degradation, which often exacerbate social unrest as well as labour rights violations, are a continuum. Food insecurity is one of the greatest existential threats facing humankind.

With the world's population on track to increase to 9 billion people by 2050, agricultural production must grow by a projected 70 %, even as global warming, water scarcity, and land degradation continue to hit millions of farmers and vulnerable communities. Efforts to establish sustainable food security for all of us must take land and water use into account and concentrate on moves towards environmental justice. Food insecurity will likely decrease the educational, health, and running capacity of African communities as they struggle to make ends meet. Any downfall of biodiversity and ecosystem service will reduce Africa's capacity to conserve sustainable resources and address methods of economic growth.[23]

On the other hand, AI technologies have the potential to revolutionize the entire agricultural sector. There are emerging areas, agricultural robotics and drones, remotely sensed data for agricultural monitoring, predictive analytics and forecasting, and precision agriculture, which are already starting to transform food production systems. No brand line of AI-enabled agribots can prune plants in a greenhouse just as well as humans, with the added benefit of 24/7 workforce availability. And 'plant doctor' AI algorithms are being used for smartphone apps to indicate pests on the spot. Efficient algorithms are increasingly shaping the agricultural IT business, giving rise to a new approach to farming named smart agriculture. On the research front, a few selected examples demonstrate the current landscape of AI innovation in agriculture spanning across; selective breeding, research on plants, automatic plant and farm machinery management, precision farming and monitoring systems.[33,34,35,36,37,38,39,40,41,42]

The available AI-ICT landscape within the agriculture sector is outlined, along with examples of regional and country-based strategies aimed at fostering AI, by focusing upon more encouraging aspects, as well as trying to look at the readiness of African countries from a policy/economy-friendly technological innovation perspective. Along the agricultural value chain, examples from a variety of agricultural sectors show how AI can be harnessed.

From pest management to genetic sequencing, agri-robotics and drones to climate, AI can address a wide range of concerns both in the developed and developing world. The combination of AI applications with other Fourth Industrial Revolution (4IR) technologies is also examined, with innovative clusters in emerging markets due to the potential for these to be a multiplier effect. Some significant opportunities with the potential to augment human capabilities, while also reducing barriers and providing greater access to new markets for African farmers, are considered, finding that a majority of African farmers are likely to adopt AI technology.(39,40,41,42)

Successful AI Implementations in Tree Care

The bulk of the intentional work on providing updated tree care in AI gardening is being carried out in foreign countries. As a result, the corrupt system often favours the available local plants in long-established street and school gardens. AI tree nursing robots built for rich countries are inadequately functional, extremely overpriced relative to losing five or six avenue trees, and require more servicing than poor-country cooperations can usually afford. For these and other reasons, it is often much more practical and numerous to care for avenue trees in the month after the rainy season instead of protecting them with expensive plastic tubes. So, there is a need for some new tactics, perhaps involving artificial intelligence, that forest-oven shade-tree doctoring squads can use to maintain young urban trees without using the current overseas-made gear.(37,38,39)

In recent years, much research and implementation work has focused on automating small-scale skill training by using artificial intelligence and machine learning technologies. As a result, the projects produced generally inexpensive, shock-hardy phones capable of imparting needed skills in a difficult-immersion environment. This food on small-scale urban farming tree doctoring aims instead at the quite different important underlying task of protecting urban tree saplings, involving a complex preprocessing habitat analysis plus reliable hand-off for tree surgery, watering, composting, and staking. However, it appears that there has been no similar work published to date. There are numerous different approaches to illustrations that could be used to establish a precedent in such a novel area, for example, original silvicultural calculations, experimental robot designs, extensions of existing software to new botanic areas, and surveys of current challenges to the young tree-plantation sector.

Analysis and Remarks

There is a general lack of knowledge about trees and their management in urban areas or the vicinity of homes in sub-Saharan Africa. The majority of urban trees are found along roadsides and thus fall under the jurisdiction of urban councils; yet, a lack of awareness of the importance of urban or domestic trees has resulted in several negative consequences, including air pollution, reduced shade, diminished soil fertility and thus food insecurity, drying up of water sources, and damage to structures. Artificial intelligence could be a potential solution to this problem. There is surprisingly little information available on tree or forest management in the vicinity of homes. Estimates of tree planting around homes in Africa range widely but all indicate a significant proportion of rural households do plant trees. However, recent data from Malawi and Zambia show this practice is not as widespread as has been claimed.

Tree species selected for planting around homes in Africa generally fall into one of six income-generating categories. Decisions on tree planting are not always made only by the household head since children and women can play very active roles, but the household head appears to have the dominant say. Urban trees play an important role in constituting the domestic 'woodlot' for urban households in the dry tropics. Typically the majority of trees in the vicinity of homes are domestic or community trees and relatively few are state-owned or well-maintained urban trees. Dry tropic urban residents, who tend to be of lower socio-economic status, are reliant on community trees. Trees on land near homes tend to be cared for more intensively than those on commons and hence designation of official community or urban tree areas may help improve tree maintenance.(20,21)

Emerging technologies and innovations, including innovative finance, digital data, artificial intelligence and Internet of Things applications, are rapidly changing various sectors in society, including agriculture. AI-powered innovations have the potential to revolutionize agriculture in resource-scarce environments. They help users solve multiple challenges, including disease diagnosis in plants and spotting pest infection, forecasting weather for better farming and supporting plant breeding with well-trained models. However, the use of AI and big data in agriculture requires a holistic approach, because current complexities and interdependencies have far-reaching concerns beyond the capacity to solve problems.(27,28,29,30)

One of the concerns is increasing monopolies on data, seeds and pesticides, worsened by the huge dependency on agro-chemicals when transforming seeds into crops. The application of AI and big data in agriculture could further intensify these monopolies. Monopolized pre-trained seed models and private data can enable seed companies to earn substantial returns by selling targeted seeds to farmers. Consequently, a coexistence of fully-integrated platforms currently in agriculture and the powerful combination of AI and IoT innovations can help to generate compound fixed capital fundamental for boosting rapid growth of high-quality seeds. In turn, big seed corporations will continue enjoying an almost monopoly over pre-trained models with increasing knowledge stored in data. On the other hand, the most straightforward unsolved challenges define responsible

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approaches for developing and adopting AI-powered innovations in agriculture to avoid bigger asymmetries, as well as ensuring equitable collaborations for small agrarians.[20,21,22,23,24,25]

Research and Development Opportunities

Innovations driven by AI are increasingly becoming mainstream in the field of tree care. Developing countries are now making giant leaps in AI and as a third wave of power, the application of AI has been attracting increasing attention recently. The big difference from the first two waves is that AI can understand the structure or morphology of the tree via images or sounds. Artificial intelligence (AI) can be educated in the qualities of trees, the diagnosis of their ailments, the pestilence and malady incumbencies they may have, and the prognostications on which deterrent line of management might be efficacious.

This branch of science, greatly used in agroforestry practice, is known as Artificial Intelligence in Tree Care. Although digital AI tree care advice may denote the difference between a flowerbed flourishing or fading to a trunk load of leaves, commercial success is however to compound. AI is a big opportunity for granivore countries to avail themselves of in tree care. Computer scientists in Sub-Saharan Africa now have a window of opportunity to detect and respond to this new trend in AI applications.[20,21]

With the dawn of AI in tree care, Sub-Saharan Saharan countries are now coming forth as breadwinners in contriving advanced tree care convolutions. Of late, tree data has been catching on peculiarly in Famine Architecture Malingering (DAM), with countless researches being set afoot into the dissipation and sanctification measures in place to ensure arboriculture longevity. Sub-Saharan Africa, with a Decline or Penury Index (DAI) of 1,7, has a whopping consumption of digital tree data, towering in the triumvirate key axes 86 % higher than the celestial mean. No longer coerced to resort to primitively mechanized tree-care solutions, Sub-Saharan Africa is now proficient in investing in AI solutions for their built-in eco-campus environments. Now, AI algorithms tackling diseases on trees can be straightforwardly customized for an eucalyptus, a cedar, or an olive tree. This redesigning is performed by altering merely gestated visual data previously fed into the AI system.[42]

CONCLUSION

Despite the development of AI and remote sensing methods in urban areas, tree care and maintenance in rural areas are in the initial stage. The development of this method is a challenge for industrialized countries, while tree care may sometimes be better understood in rural areas of developing countries, such as Africa. Sub-Saharan Africa has been the main focus of many line-oriented interventions in the field of goat forest conservation, protection, and development in the past. The implication of this AI technique is in the tree care sector for rural purposes in Sub-Saharan Africa. The process of visual inspection of a tree using the proposed involves the implementation of a mobile application in the rural scenario. The hardware requirements of this method are a mobile phone with an installed mobile application. Further implication, the AI techniques can be trained with other trees growing in Sub-Saharan Africa, that is, there are various tree species in this region.

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