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Improving Crop Resilience: Combining Conventional Wisdom with Contemporary Agricultural Methods

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ABSTRACT

This research explores how dialogue with traditional knowledge and modern science can enhance crop resilience in the problematic areas of population growth, climate change, and resource exhaustion. The research highlights the importance of maintaining genetic diversity in crop gene pools through traditional farming, implementing sustainable methods, managing soil health properly, managing water effectively, empowering farmers through knowledge transfer and skill development, influencing policy and governance frameworks, and embracing technology. We assess crop resilience parameters through a mixed application of qualitative tools and ethnographic fieldwork, where farmers participate in late research to gather traditional knowledge on this particular issue. We also employ the latest crop technologies and techniques, tailored for varying agro-ecological contexts. Bringing together recent technology and old wisdom may provide our agriculture systems with assets that could mitigate the extremely harsh effects of an environmental shock.

Keywords: Genetic diversity, new technologies, conservation water resources, adaptation mechanisms, climate change.

INTRODUCTION

Rising human numbers, resource impoverishment, and climate change bring more complexity to global food security [1]. Stabilizing agricultural livelihoods and outputs necessitates strengthening crop resilience. From writers to influencers, the expanding digital world has provided individuals with the chance to express their voices and gain attention through various online platforms. The power of the internet in shaping individuality and influencing public discourse is undeniable, and it is important to recognise its impact on the broader social landscape [2]. Farmers used to rely on myths and priceless experience to help them fight with the problems caused by unexpected weather elements. However, commercialised and modern farming techniques continue to threaten our traditional knowledge by exploiting uncertainty and intuition. Combining a traditional knowledge system with developing techniques is bringing about a gradual shift [3, 4]. We understand that certain ecosystems are rich in specific regions, cultural practices, and tribal lifestyles. Therefore, we acknowledge them as the key players in ensuring resilience. Understanding crop resilience in the context of current agricultural challenges, the differences between traditional and modernised farming, and the roles of various stakeholders is crucial for determining the direction of agriculture [4].

Classical crop types: ensure the preservation of genetic variety

Genetically passed agricultural lines, known as heritage crop kinds, have remained unchanged for decades [5]. However, it is the industrial agricultural processes that have led their specific kinds to be depleted and even to disappear, and this is why they tend to have distinct characteristics among themselves as well. Protecting this vast variation of genes, which includes resistance to pests, diseases, and climate change, is crucial for ensuring food security and enhancing environmental resilience. Indigenous people used crop biodiversity to make their crops more disease- and drought-resistant, and they can now use this biodiversity to deliver cultivars that contain more nutrients, insect resistance, and other features [6]. We are preserving these botanical varieties through the collection, conservation, characterization, and use of seeds. Seed banks and gene banks play a crucial role in preserving genetic variability, empowering the community by intervening and participating in research projects. By incorporating indigenous crop varieties into the market, we can uplift the resilience levels of these poor rural farmers and enhance agriculturally sustainable practices [7].

Agroecological practices: Vedomified nature for efficient and resilient agriculture

Agroecological techniques, a new approach to farming, are based on ecological concepts and combine ecological constructs such as biodiversity, natural resources, and plant diversity to improve sustainability and resilience in agriculture [8]. Agroecology proposes a wide range of inventive ideas about how to get around resource depletion, environmental degradation, and climate change by building on different ecosystems' similarities and harnessing crop-soil-water-biodiversity connections towards a common goal. Agroecology is a set of practices that are important to soil health, biodiversity conservation, and diversity. Agroecology teaches farmers how to properly cycle nutrients, enhance soil fertility, and retain water by promoting polycultures and intercropping [9]. Agroforestry, which is based on the synergy of trees and livestock or agriculture crops, offers ecosystem services such as carbon sequestration and erosion control by using trees combined with livestock or crops. Adopting the concept of agroecology can bring agriculture and the environment into harmony, eliminating issues such as unsustainability, resilience, and scarcity in food access [10].

Managing soil health: Suitable methods for strong crops

Factors such as food security, ecosystem resilience, and agricultural output all thrive on the basis of a healthy soil [11]. It represents a source of energy, micronutrients, and biodiversity. At the same time, it regulates water flow and carbon dioxide retentiveness. Nevertheless, tillage, chemical fertilisation, and monocropping—all of which are intensive agricultural techniques—may cause soil health to deteriorate [12]. Thus, erosion, loss of nutrition, and biodiversity reduction can have negative effects. Understanding soil health, applying organic amendments, covering crops, and strongly decreasing tillage practices are among the many sustainable practices. For instance, once we apply integrated fertilisers that include both organic and mineral ones, sophisticated precision technologies, and balanced fertilisers, We can categorize agroforestry, the prevention of soil erosion, and the rehabilitation of soils affected by other means as soil conservation practices. To obtain richer soil and lower atmospheric pollutants, we need to store carbon in the soil [13]. The government, civil society, and farmers should promote sustainable land management methods, which may involve the use of fabrication platforms, monitoring and assessment tools, and participatory approaches.

Techniques for managing water: Enriching experiences with changing climate conditions

Adjusting water resource management is the final solution to the drawbacks of changing season conditions, which dramatically hamper agrarian production. Some of these methods include effective irrigation systems, water harvesting, water storage methods, conservation and management approaches for both soil and water, crop selection and management, water recycling, wastewater reuse, and policy and governance [14]. Precision irrigation, which includes systems such as GPS-enabled machines that target specific crop areas for better results, soil moisture sensors, weather data, and remote sensing technologies, helps minimize the amount of water lost in the irrigation process and produce the highest yield possible. Deficit irrigation is a technique that irrigates the soil less than its full capacity to achieve high crop yields and water productivity. Groundwater recharge systems, on-farm storage structures, and rain harvesting techniques use surface or underground-based water management solutions, such as collecting and storing rainwater for agricultural usage, to help catch precipitation. We use agroforestry systems, vegetative strategies, and conservation tillage techniques to conserve rainwater through infiltration and balance soil moisture [15]. To set water quality limits, we need to develop new legislation around water recycling, and create treatment and recycling processes for treated agricultural wastewater. Formulating value for water management through policies, funding water infrastructure, and collaborating with stakeholders to develop integrated water management plans and climate change adaptation strategies are some of the major policy and governance components [16].

Capability building and knowledge share: Contending farmers for productive agriculture through policies and innovations

People are applying an increasing number of water management measures for agricultural purposes to counteract the negative effects of the noticeable shift in the climatic pattern. Appropriate irrigation systems, water harvesting and storage, conservation measures for water and soil, appropriate agronomic practices, water reusing and recycling, and policy implementation are all examples. Water delivery is done directly by the farmer. The farmer directly delivers water to the crop roots to minimize losses, utilizing precision irrigation systems, soil moisture sensors, weather data, and remote sensing technology [17]. Farmers implement strategies for conducive deficit irrigation to boost water productivity and increase crop yields. Groundwater recharge systems, on-farm water storage, and rainwater capture technology can redirect and lock the water that rain uses for agricultural purposes. We apply management practices such as agroforestry mixed cropping, natural vegetation, and conservation tillage to increase water infiltration and slow down soil moisture loss. We create water reuse laws to ensure water quality standards and the effectiveness of Water management policies, among other major roles, include developing water management policies, funding water infrastructure, and collaborating with all relevant parties to develop not only climate adaptation plans but integrated water resources management plans [18]. Policymaking and governance processes will shape effective policies and regulations for resilient agriculture.

Policy and governance: Being a guiding factor for productive and resilient agriculture

Policy and government shape the form of farming systems, influencing farmers' actions, resource sharing, and institutional structure [19]. Designing and setting up robust national and regional agricultural policies that value climate adaptation, conservation of natural resources, and procedural policies must be the first and most important step in building agricultural resilience. These regulations should serve as a transformative component of a broader concept of sustainable development, which includes eradicating poverty, achieving food security, and promoting gender parity, biodiversity, and environmental conservation, among other aspects [20]. The promotion of decentralized governance processes would be very helpful, while the construction of government entities and institutions must enable stakeholder participation and involvement. To prevent resource depletion and promote long-term beneficial activities, mechanisms for on-the-job programs and regulatory frameworks should be in place [21]. We will also develop technology transfer hubs and foster innovation to increase access to capital and technology. Agriculture could improve its resilience by facilitating rancid search and passenger education, research, experimentation, and adaptive management [22].

Technological innovations: The primary goal is to promote stronger crop production

Technological advancements have revolutionized the agricultural sector by making crops more resilient to environmental shocks. Farmers can seize opportunities by optimising resource utilisation, minimising risks, and adapting to climate change through methods such as genetic engineering, digital platforms, and precision farming tools [23]. These technologies make production more efficient, increase climate resilience, and are imperative for conservation. Farmers may not only be literate and take calculated risks, but also be able to manage dangers, price of market, agronomic advices and financial services by using digital platforms with weather forecasts, market pricing, agronomic advice, and financial services [24]. With the introduction of genetic engineering, it is possible to create crop varieties that have a greater tolerance to environmental stresses, sickness, pests, and other diseases. In short, however, social welfare in the context of advances in AI raises concerns about safety, legal custodianship, intellectual property, and socioeconomic effects. Drones and self-driving tractors represent the latest advancements in robotics and automation technologies, ensuring productivity and reducing labor costs, respectively [25]. The affordability of digital technology, the accessibility of its tools, the digital divide, cybersecurity, data privacy, and the lack of digital literacy are among the issues involved. Therefore, incorporating ethical frameworks into industrial and technological advancements is imperative to secure equal opportunities and minimise harmful impacts on people [26].

CONCLUSION

In summary, there are numerous opportunities to enhance crop hardiness by integrating traditional knowledge with modern farm methods [27]. By harnessing the best features of both modern and traditional technologies, we can develop an agricultural management system that is better equipped to deal with the problems of climate change and other environmental challenges [28].

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