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Editorial

Integrated Crop Management in Sustainable Agriculture

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Integrated crop management (ICM) aims to balance economic, environmental, and social factors in crop production. The ICM involves different crop management practices and technologies to increase crop yields, reduce environmental damage, and sustain crop production. The ICM is a whole-systems approach based on knowledge and stresses the importance of understanding local ecosystems and changing management practices to be better suited to these ecosystems.

The rapid increase in global population has resulted in the construction of new residential colonies on fertile agricultural lands, resulting in a major decrease in the area devoted to crop production. In addition, abrupt changes in regional and global climates are resulting in various biotic and abiotic stresses, which make agricultural production more challenging. This situation requires sustainable agricultural production on the available cultivated lands. Several management options are employed to sustain crop production, including the creation of climate-resilient genotypes, integrated soil and crop management, etc. The ICM combines several eco-friendly practices to sustain agricultural production. These practices include seed priming [1], the application of organic and inorganic amendments [2–4], the use of plant growth promoting bacteria [1], the application of macro- and micronutrients [2,4], biofortification, the use of biopesticides [5], the use of high-yielding genotypes [6], alternative cropping systems [7–9], the conservation of natural enemies [10], etc. The use of these management measures improves soil health and crop yield. Nevertheless, the environment, soil type and fertility, and crop type have a significant impact on the advantages of ICM. Reduced soil quality, which favors insect pest infestation and lowers farm earnings, is a result of monocropping or the adoption of the same crop rotation strategy. Combining exhausting and restorative crops in crop rotation, intercropping, and relay cropping improved soil health, crop nutrition, crop yield, and net returns. Hence, the advantages of integrated crop management should not be evaluated only on the short-term yield response, but rather on a long-term basis. This Special Issue, entitled "Integrated Crop Management in Sustainable Agriculture," focuses on the impacts of ICM practices on soil health, crop productivity, and a reduction in the impacts of expected climate changes on crop production in a sustainable manner.

Implementing diverse crop rotations helps maintain soil fertility, reduce pest and disease pressures, and minimize the risk of monoculture-related issues [7,9]. Monitoring soil nutrient levels and applying fertilizers in a targeted, efficient manner ensures optimal crop nutrition while minimizing nutrient leaching and environmental contamination [2–4]. Selecting and breeding crop varieties with desirable traits, such as disease resistance [11] and drought tolerance, can improve overall crop performance and resilience [6].

The inclusion of high-yielding crops in existing cropping systems can increase profitability; however, it cannot affect the overall productivity of other crops grown in the system. For example, the inclusion of Bt cotton (*Gossypium hirsutum* L.) genotypes in Pakistan's cotton–wheat (*Triticum aestivum* L.) cropping system modified nutrient availability,

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while the productivity of winter crops following cotton remained unchanged. Nevertheless, the economic analysis revealed that the Bt cotton–wheat cropping system was more profitable than the conventional non-Bt cotton–wheat cropping system practiced in the country [7]. Hence, the use of high-yielding crops or crop varieties in the existing cropping systems can improve farm profits. Similarly, the inclusion of a leguminous crop, i.e., mungbean (*Vigna radiata* L.) in barley (*Hordeum vulgare* L.)-based cropping systems, improved soil health to a significant extent. Furthermore, including an allelopathic crop, i.e., sorghum (*Sorghum bicolor* L.), in the cropping systems lowered weed infestation in the barley crop [9]. Hence, improved crop rotations exert notable positive impacts on crop productivity and weed infestation. Furthermore, legume species significantly altered soil microorganisms and nitrogen cycling. Common beans (*Phaseolus vulgaris* L.) grown with chicken dung biochar resulted in a diversified prokaryotic community compared to other legume species [8].

Nutrient management is another strategy employed to improve crop production in diverse environments. The combined application of phosphorus and potassium improved sorghum's fodder yield and quality [2]. The application of nutrients recommended by the nutrient expert model and leaf color chart significantly increased the yield and net economic returns of various rice (*Oryza sativa* L.) genotypes. Therefore, these strategies could be used to improve rice productivity and nutrient use efficiency [4]. Biochar can increase crop yield and soil health when applied at an appropriate dose. The combined application of manure and biochar considerably improved the chemical properties of manure, plant biomass, and soil chemical parameters. Hence, manure characteristics, soil health, and plant biomass can be improved through the application of a high biochar dose along with manure [3].

Plant growth-promoting rhizobacteria are widely used to sustain crop productivity in stressful and benign environments. Furthermore, priming seeds before sowing with different compounds also improves crop productivity and quality. Seed priming with boron and seed inoculation with boron-tolerant bacteria improved dry matter accumulation, yield, and economic returns of chickpea (*Cicer arietinum* L.) sown in arid and semi-arid environments. Furthermore, foliar application of boron improved grain B concentration. Hence, different application methods can be used to achieve the desired results [1].

Genotypes play a significant role in sustainable agriculture. The selection of genotypes with higher yields and economic returns helps to attain higher profits. The genotypes can be selected through large-scale adaptability trials and the best-performing can be recommended for cultivation. The exotic genotypes can be recommended for cultivation after thorough testing [6]. Nevertheless, recommended genotypes require an optimum growing environment, and sowing density is one of the most important factors affecting growth and productivity. Optimizing sowing density in stressful and benign environments is a helpful approach to improving crop yield and productivity [12].

Growing environmental concerns necessitate the development of environmentally friendly pest management options. Plant-based pesticides are being developed to manage different pests in field crops. Encapsulation using synthetic zeolite, natural zeolite, and gelatin created an eco-friendly biopesticide from clove bud essential oil that could be used as a biopesticide to manage disease and pest infestation [5]. Similarly, preserving natural enemies through the safe use of pesticides could also lower their adverse impacts on the environment. Timely use of insecticides with low impacts on non-target organisms can preserve natural enemies [10].

Disease prediction models can predict the onset of disease and recommend suitable management strategies. The onset of the potato leaf roll virus was predicted by stepwise regression with a high degree of success. Furthermore, foliar application of salicylic acid in combination with acetamiprid proved the most effective treatment against the disease's incidence and its vector [11].

The use of any of these ICM strategies could be helpful in sustaining crop production. Several other strategies not reported here, i.e., nanoparticles, plant extracts, precision models, and climate-resilient genotypes, could also be used to improve crop productivity. We hope that studies related to these aspects will be published in the future.

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