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Biotechnological trends for sustainability

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EDITORIAL

Dated back to over 3 billion years, the history of life on the planet Earth is known and for more than 80% of history, the earth's atmosphere and the supracrustal sections have been undergoing changes, maintenance, and re-circulation for the inception of life. The changes occur in the ecosystem, have always modulated the climate during the Cretaceous period and Late Paleozoic Ice Age. The continuous changes in the earth evinced the drastic changes in the carbon cycle over 400 million years ago which resulted in the colonization of plants in the planet. The changes were also observed in the chemistry of seawater that shifts in the global formation of clay from oceans to lands. Since the climate system has been changed several times, the present ecosystem is at the brink of their ability to fulfill the necessities of the ever-increasing population with challenges including pollution, global hunger, climate change, land degradation social inequalities, and uncontrolled human anthropogenic activities. The tools of biotechnology also help in bioremediating deteriorated soil and water bodies. Biotechnology has various tools and microbes are one of the important tools of the branch. The techniques have been also known to be cost-effective, which also lowers the green products cost. In the agriculture sector, biotechnologically produced sustainable products, that is, biofertilizers and biopesticides help in the crop protection and production without the use of chemical products. In the energy sector, biofuel production is a remarkable invention as fossil fuels are drastically depleting and their usage leads to mass amount of pollution. On the other hand, in industrial sectors biotechnology tools produce biodegradable dyes, medicines, and food products. In present, editorial provides the insight of biotechnology technologies in various sectors including agriculture, environment, food, energy sector, and pharmaceutical industries.

The earth has already lost nearly 40% of the global land and to reach the demands of the population by 2050 will be tripled which is one of the biggest challenge. The on-going urbanization and industrialization in which massive amount of chemicals have been used for the production of various products for their daily requirements in the field of agriculture. However, these activities result in environmental pollution that may recalcitrant and persist in the ecosystem. The modern world needs to shift to eco-friendly approaches and meets sustainable development goals. Biotechnological tools are known to have eco-friendly processes that may help in the production of various sustainable products for several sectors including agriculture, energy, and ecosystem restoration [Figure 1]. The biotechnology-produced products are free from chemicals and it is gaining attention among the population. Biotechnology tools help in the production of biofuels, biofertilizers, biopesticides, biotechnology crops, bioactive compounds, enzymes, and pharmaceutical products.

Agriculture is one of the most important sectors that provide the feed and fodder to the entire population of the earth. Yield is one of the major challenges of the agriculture sector which is achieved by using various agrochemicals, such as fertilizers and pesticides. The utilization of the agrochemicals is observed to have adverse effects on the environment, humans, animals, and other living diversity. The biotechnological tool, that is, microbes as bioinoculants is one of the most appropriate alternatives for increasing the crop yield which may fulfill the demand of the foods. The microbial-based bioinoculants help in crop production and their protection [1].

The yield of the crops is mainly depends upon the availability of plant growth hormones (auxin, cytokinin, and gibberellins), and nutrients

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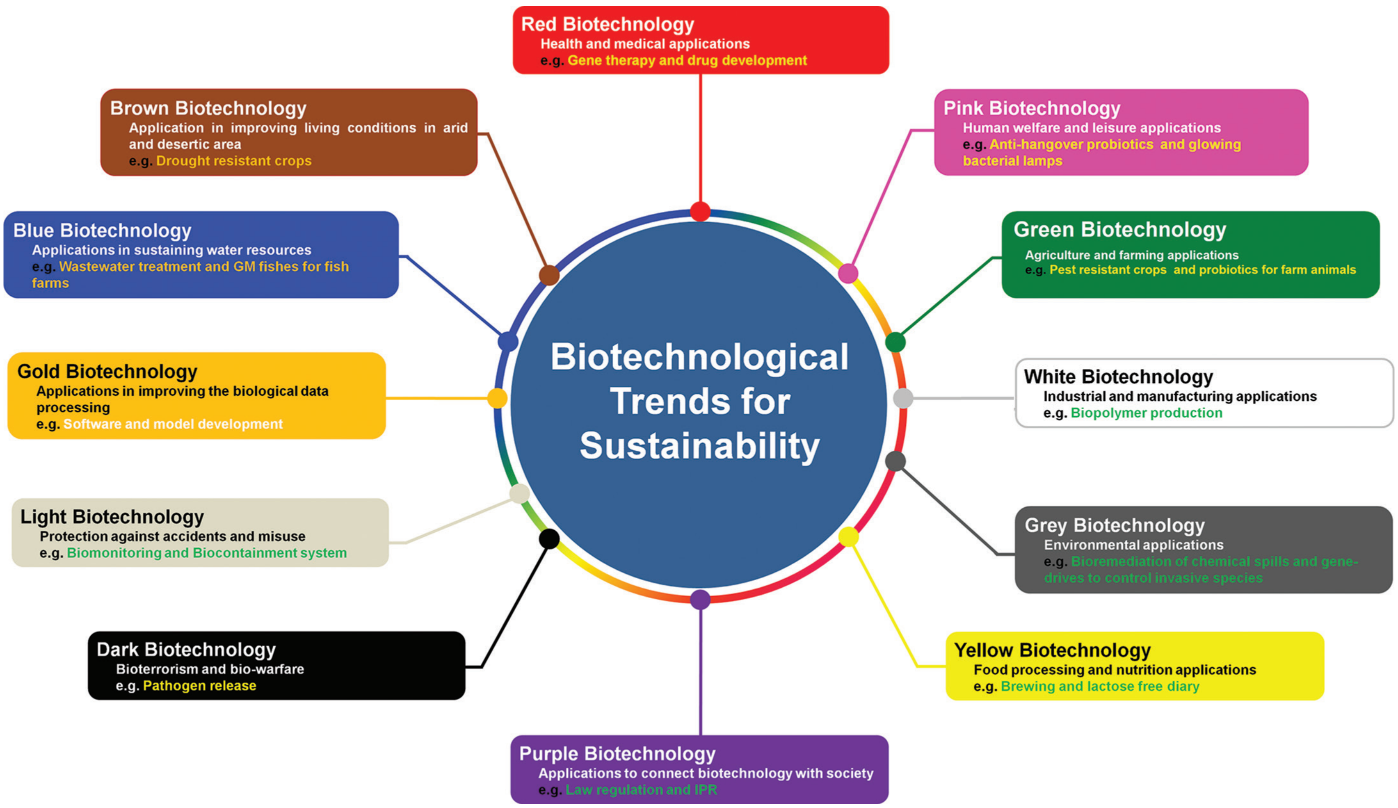

Figure 1: Biotechnological trends for sustainability.

(phosphorus, nitrogen, potassium, zinc, and iron). The present status of soil has very limited or no amount of soluble nutrients that can be absorbed by the plants for their use. The plant growth promotion and yield of the crops mainly depend upon the utilization of deleterious chemicals. The use of bioinoculants developed through biotechnological technology is a sustainable approach. Bioinoculants enhance the plant growth through natural mechanisms such as nitrogen fixation, nutrients solubilization (phosphorus, potassium, and zinc), production of siderophores that chelated the iron in the soil. Apart from solubilizing, fixing, and chelating the nutrients from the soil, microbes produce plant growth regulators including auxin, cytokinin, and gibberellins, which help in promoting the plant's growth [2]. These listed mechanisms have known to be reported by the various mechanisms that help the growth promotion of the plants. In a report, endophytic bacteria *Acinetobacter soli*, and *Bacillus thuringiensis* from root nodules *Erythrina brucei* were reported for solubilizing phosphorus, and producing indole-3-acetic acid. The inoculation of these strains in wheat is reported for enhancing the shoot length and plant growth [3]. In another report, *Pseudomonas migulae*, *Pseudomonas poae*, and *Pseudomonas extremaustralis* from apple were reported for fixing nitrogen, and solubilizing phosphorus and potassium. The inoculation of these strains in apple seedlings was reported for enhancing biomass and content of N, P, and K in apple plant leaves [4].

Plants yield have been majorly affected by various biotic and abiotic factors. Insects, nematodes, and pathogenic microbes (bacteria, fungi, and viruses) are the various biotic factors that infect plants and cause several diseases, and this resulted into a drastic decline of the crop yield. On the other hand, environmental factors, such as drought, salinity, acidic, alkaline, low/high temperature, heavy metals, and water logging conditions are the various abiotic stresses, which lower plant growth and productivity. Microbes alleviate both stresses by mechanisms including the production of antibiotics, hydrogen cyanide, hydrolytic enzymes, secondary metabolites, 1-aminocyclopropane-1-carboxylate (ACC)-deaminase activity, induction of systemic acquired resistance, non-volatile and volatile organic compounds [5,6]. Several microbes have been reported for exhibiting mechanisms that helps in the alleviation of biotic and abiotic stress that result in the growth promotion of plants. In a report, rhizobacterial isolate *Bacillus subtilis* from potato field was reported for producing exopolysaccharides, hydrolytic enzymes, siderophores, and ACC deaminase production. The strain was reported for alleviating the stress caused by salt, heat, heavy metals drought, and *Rhizoctonia solani* [7]. In another investigation, *Ralstonia solanacearum* growth was inhibited by the tomato-associated bacteria *Bacillus cereus* by inducing host resistance [8].

Earth's water, land, and air are heavily polluted with toxic materials including polycyclic aromatic hydrocarbons, xenobiotics, pesticides, azo dyes, oily sludge, heavy metals, and nitroaromatic compounds. These toxic metals are the result of the different anthropogenic activities of humans, such as industrialization, affectation, and the use of chemical compounds for the production of various daily needs. The toxic compounds could be treated by the mean of biotechnology tools [9]. The microbes can be used for the bioremediation different toxic materials and different species have been reported in various studies. In a report, *Kocuria assamensis* from a soil sample of Himachal Pradesh was reported for degrading the malathion and chlorpyrifos [10]. Heavy metals (chromium) remediation was reported by the bacterial strains *Stenotrophomonas maltophilia* and *Brucella intermedius* [11]. In an investigation, *Bacillus megaterium*, Bacillus Tequilensis, and *Pseudomonas* reidholzensis *from oily sludge were reported for biodegradation of heavy oil* [12]. Brevibacterium sediminis *was reported for bioremediating the pyrene, a* polycyclic aromatic hydrocarbons [13].

The biotechnology tools have a wide range of applications in several industries, such as food and pharmaceuticals. Microbes, the most important biotechnological tools can be used for the sustainable production and processing of the products. The microbes help in the production of amino acids, bio-flavors, vitamins, colorants, pigments, probiotics, enzymes, biotherapeutic agents, antibiotics, and anticancer compounds [14]. In a study, *Sporobolomyces ruberrimus*, a yeast, isolated from Passu Glacier, Hindu Kush, Karakoram, and Himalaya range glacier, Pakistan was also reported for producing amylase [15]. In an investigation, *Streptomyces* spp. from sediment soil was reported for producing red pigment which was having biological activity against antifouling activity [16]. *B. thuringiensis* was reported for producing protease which could be used for enzyme-modified cheese [17]. In another report, *Acetobacter malorum* and *Acetobacter orientalis* was reported for Vitamin B_{12} which was isolated from fermented sourdough [18].

Fossil fuels are the primary energy source from the industrial revolutions and their demand is increasing with every progressive day. Its cost is also increasing drastically and it is estimated that the price may be reached to $95/barrel by 2050. On the other hand, the utilization of fossil fuels releases huge amount of global greenhouse gas (GHG) is a huge problem on the earth. Many of the countries are targeting to meet the net zero emission of GHG. Alternative renewable fuels are an urgent need of the world. Biofuels are known as one of the best sustainable and renewable fuels that could be produced by various microbes [19]. In a report, *Streptomyces fulvissimus* was reported for producing enzymes including amylase, pectinase, cellulases, and xylanase which help in reducing agricultural waste into biofuels [20]. In an investigation, *Rhodotorula diobovata* was reported accumulating lipids, which were found to generate biodiesel using sugar beet molasses as substrate [21]. *Bacillus* strains (*Bacillus atrophaeus*, *Bacillus spizizenii,* and *Bacillus aerophilus*) associated from *Cinnamomum camphora* leaves were reported for biofuel production [22].

In conclusion, biotechnological tools including microbes are in high demand as mankind is becoming dependent on this tools. Biotechnological tools can be used in the agriculture, industries, energy sector, and environmental sector. In the agricultural sector, biotechnological tools (biofertilizers and biopesticides) can be used for crop production and crop protection, whereas, in the environment, microbes help in the bioremediation of various toxic metals such as xenobiotics, polycyclic aromatic compounds, azo dyes, oily sludge, and heavy metals. On the other hand, biotechnology techniques are also useful for the production of biofuels, vitamins, enzymes, amino acids, pigments, and probiotics, which could be used for the production of various industrial products. In recent years, biotechnology and their applications have been uncovered and in the future, many more technologies can be unlocked for sustainable development.

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