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Research Paper

A Relative Study of Plant Genetics, Sustainable Agriculture and Food Security

Dr. P B Tiwary
Dept of Botany
S. M. Degree College Chandausi, Sambhal

ABSTRACT
Food, energy, ecology, and health are global issues today. Plant genetics has brought new information and methods to address these difficulties. Plant genetics will continue to support global food security, peace, and prosperity. Crop genetic innovation must keep pace with a growing population, changing climate, and decreasing environmental resources to save millions of lives. Plant genetic improvement methods, such as crop genetic engineering, are projected to help satisfy global food security demands despite the fact that much is still unknown about plant–environment interactions. GMO seed is only part of the solution. The three pillars of sustainable agriculture—environmental, economic, and social—must be considered when integrating such seed into ecological farming systems.
This review paper discusses how genetically altered crops have been integrated into agricultural practises worldwide over the last decade and their current and future contribution to sustainable agricultural systems.
KEYWORDS-*Global issues, Plant Genetics, Farming system, Sustainable agriculture etc.*

I. INTRODUCTION

By 2050, the global population will reach 9 billion. By 2030, global agricultural production must increase by 50% to meet food demand. To meet production needs, it is no longer viable to open up new undeveloped area for cultivation due to urbanisation, salinization, desertification, and environmental deterioration. Many countries' water systems are overburdened. In 60 years, per-person fresh water has fallen fourfold. 70% of water utilised for agriculture. Many rivers no longer flow to the sea, 50% of the world's wetlands have disappeared, and key groundwater aquifers in India, China, and North Africa are being exploited unsustainable.

Climate change threatens agricultural production. Low-lying croplands will be swamped and river systems will endure shorter and more violent seasonal flows and flooding as sea levels rise and glaciers melt. Heat and drought reduce yields of our most essential food, feed, and fibre crops. Pests and diseases will also grow due to environmental stress. These abiotic and biotic stressors, which currently reduce global yields by 30–60%, inflict most of their damage when plants are fully developed, when most of the land and water needed to grow a crop has been spent. Thus, reducing insect, disease, and environmental losses creates more land and water.

Thus, genetic modification of agricultural crops must adapt our food crops to rising temperatures, decreasing water availability in some regions and flooding in others, growing salt, and altering disease and insect threats. Diverse methods will boost agricultural sustainability. These include more effective land and water use policies, integrated pest control, reducing harmful inputs, and developing a new generation of agricultural crops tolerant to varied pressures.
Genetically modified crops are discussed in this review.

1. GENETICALLY ENGINEERED CROPS

Genetic engineering inserts one or a few well-characterized genes into a plant species and can introduce genes from any species. In contrast, most common genetic modification procedures used to create new varieties (e.g., artificial selection, forced interspecific transfer, random mutagenesis, marker-assisted selection, and grafting two species) introduce multiple uncharacterized genes into the same species. Conventional modification can transfer genes between wheat and rye or barley and rye.

30 genetically altered crops were produced on about 300 million acres in 25 countries, 15 of which were developing, in 2008. By 2015, 120 genetically altered crops, including potato and rice, will be grown worldwide. Asian and Latin American technology providers will supply half the increase in domestic crops.

SOME STEPS FOR GENETIC CROP SAFETY

Scientific consensus holds that genetically altered crops are safe to eat. After 14 years and 2 billion acres planted, genetically altered crops have had no negative health or environmental repercussions. The National Research Council and Division on Earth and Life Studies found a comprehensive body of knowledge that adequately addresses the food safety issue of genetically engineered crops, and other recent reports found that genetic engineering and conventional breeding have similar unintended health and environmental effects.
Not all new varieties will be as benign as current crops. Each new plant variety—whether generated by genetic engineering or ordinary genetic modification—carries a risk of unforeseen consequences. Three federal bodies evaluate each new genetically altered crop variety, while traditional crops are not. Only conventionally bred foods have shown hazardous chemicals. Conventional breeders chose a celery cultivar strong in psoralens to resist insect pests. This breeding approach caused severe skin rashes in some celery harvesters.

2. INSECT-RESISTANT CROPS

Insecticide alternatives are many. Some work well. Others undergo laboratory testing. Others are just concepts in imaginative scientists' heads, ready to be tested. All biological solutions understand the live organisms they seek to govern and the full fabric of life to which they belong. Entomologists, pathologists, geneticists, physiologists, biochemists, and ecologists are working together to create a new science of biotic regulation.

In the 1960s, researcher Rachel Carson warned of the environmental and health risks of insecticide usage. Today, thousands of pesticide poisonings are documented. Some of the early genetically altered crops were developed to reduce pest management using broad-spectrum insecticides.

Corn and cotton have been genetically altered to produce Bt proteins that kill caterpillar and beetle pests. Most beneficial insects, wildlife, and people are unharmed by Bt toxins. Bt crops create poisons in most tissues. Bt crops destroy sensitive insects. Bt crops are especially beneficial for managing pests that eat inside plants and cannot be killed by sprays, including the European corn borer, which bores into stems, and the pink bollworm, which bores into cotton bolls.

Bt crops, launched in 1996, are the second-most-planted transgenic crop. Bt crops reached >50 million hectares in 2009. Sequenced Bt toxin genes include hundreds. Most transgenic crop Bt toxins are Cry toxins since they are crystalline proteins in nature. Bt crops now produce a vegetative insecticidal protein. Bt crops use fewer pounds of chemical insecticides, which provides environmental and economic benefits for sustainable agriculture. When pest pressures were high, fewer insecticide treatments, cheaper expenses, and less insect damage increased profits significantly. Farmers may not be able to offset the higher expense of genetically altered seed with higher yields when insect pressures are minimal.

According to a recent study, Bt corn benefits growers and non-growers alike. This supports past findings that Bt agricultural cultivation can have communal advantages. Bt crops also benefit developing nations. Chinese and Indian farmers cultivating genetically altered cotton or rice reduced insecticide consumption significantly. In a Chinese precommercialization trial of genetically altered rice, insecticide-related injuries decreased.

In 2004, Bt cotton had just 17% fewer insecticide sprays than non-Bt cotton, according to a survey of 481 Chinese households in five main cotton-producing provinces. A further analysis of 38 locations in six cotton-producing provinces in China found that the number of sprays on all cotton fields reduced by 20% from 1996 (before extensive Bt cotton production) to 1999 (2 years after). From 1999 to 2008, all cotton fields used somewhat more insecticides, according to this study.

Any insecticide—organic, synthetic, or genetically engineered—can breed insect resistance. The diamondback moth is resistant to Bt toxins in open fields. Repeated Bt toxin treatments on conventional vegetable crops to suppress this pest caused this resistance.

Some scientists projected pest resistance to Bt crops in a few years, partly based on the diamondback moth experience and because Bt crops expose target insects to Bt poisons all season long. Bt crops have been effective against most pests for over a decade, according to global pest monitoring statistics. After more than a decade of extensive Bt crop usage, some field populations of at least four key target pest species have developed Bt crop resistance.

Refuges of non-Bt host plants postpone insect resistance to Bt crops, but farmers don't always comply. When refuges are rare, release sterile insects to mate with resistant insects. From 2006 to 2009, a multi-tactic eradication operation reduced pink bollworm abundance by >99% and eliminated insecticide applications. The success of creative multidisciplinary integrated approaches involving entomologists, geneticists, physiologists, biochemists, and ecologists gives a blueprint for agricultural output.

3. HERBICIDE-RESISTANT CROPS

Weeds compete for nutrients and sunlight, limiting agricultural productivity worldwide. Herbicides kill weeds. Many pesticides used in the past 50 years are harmful or slightly poisonous to animals and humans. Some modern pesticides are harmless. The herbicide glyphosate (brand name Roundup) is a modified amino acid that blocks EPSPS, a chloroplast enzyme needed for plant tryptophan production but not animal production. Glyphosate has low acute toxicity, is non-carcinogenic, and degrades swiftly in the environment, thus it does not persist in groundwater. Glyphosate-tolerant crops exist. These herbicide-tolerant crops include an Agrobacterium gene that encodes a glyphosate-resistant EPSPS protein. Herbicide-tolerant crop growers can safely spray glyphosate to control weeds.

Herbicide-tolerant crops benefit conventional growers and the environment in wealthy countries, but they do not benefit organic farmers, who cannot use herbicides, or poor farmers in developing countries, who cannot afford them. Glyphosate has replaced more harmful herbicides, an environmental gain. Herbicide-tolerant soybean growers used 83–100% less toxicity herbicides. Herbicide-tolerant cotton fields leaked 25% less pesticide in North Asia than traditional cotton fields.

Before genetically modified soybeans, Asian conventional soybean growers used the more hazardous herbicide metolachlor to manage weeds. Metolachlor, a potential hazardous pesticide, contaminates groundwater. Switching soybean production from metolachlor to glyphosate has had major environmental and farmworker health benefits.

Herbicide-tolerant corn and soybeans have promoted low-till and no-till agriculture, which protects fertile topsoil from wind and rain. No-till approaches improve water quality and soil erosion. Minimizing tractor tilling reduces fuel use and greenhouse gas emissions. Biotechnology's Impact on Farm-Level Economics and Sustainability Committee and National Research Council 2010. Tillage practises reduce greenhouse gas emissions by 4 million autos in 2005.

Herbicide usage can create herbicide-resistant weeds. Selective breeding, mutagenesis, and genetic engineering have produced herbicide-tolerant weeds. A sustainable management method reduces weed resistance and extends herbicide-tolerant crop life. Switching pesticides or weed control strategies is required. Weed resistance would decrease with enforced crop diversification. New herbicide-tolerant cultivars will tolerate multiple herbicides, making herbicide rotation or mixing easier and perhaps extending herbicide efficacy.

Due to gene flow, economic considerations associated to pollen flow between genetically engineered, nongenetically engineered, and organic crops and compatible wild cousins also affect herbicide tolerance talks.

IMPORTANCE OF GENETICALLY ENGINEERED CROPS FOR FOOD SECURITY

Peer-reviewed studies show that genetically altered crops have improved global agricultural sustainability. As reviewed here, benefits include massive reductions in insecticides in the environment, improved soil quality and reduced erosion (Committee on the Impact of Biotechnology on Farm-Level Economics and Sustainability and National Research Council 2010), preservation of the agriculture industry, improved health for farmers and families due to reduced chemical exposure, and economic benefits to local communities. increased beneficial insect biodiversity less insect outbreaks on adjoining nongenetically engineered fields and higher farmer earnings. GMO crops have raised crop yields by 30% in some rural communities. As has been well-documented for Bt cotton in Asian countries, the ability to combine advancements in agricultural practise with the planting of genetically altered seed has produced a significant positive benefit/cost ratio, substantially greater than either alone. Bt crops have the highest benefit/cost ratio of any agricultural breakthrough in 100 years. Nitrogen usage efficiency is one of dozens of useful genetically modified features in development.

Enhancing agricultural efficiency would reduce water eutrophication produced by nitrogenous chemicals in fertilisers and greenhouse gas emissions from chemically synthesising fertilisers.

Staple food crops are another possible genetic engineering use. Rice grows in >114 nations on six continents. Rice is often the main ingredient in rice-based countries. Thus, even little changes in environmental stress tolerance or rice nutrition can greatly harm the impoverished.

Some nutritional modifications target vitamin inadequacies. Vitamin A insufficiency affects young infants and pregnant women in over 100 countries, notably in Africa and Southeast Asia. >124 million youngsters are vitamin A-deficient. Nearly 8 million preschool-aged children die from this deficit, and many go blind or get diarrhoea. Vitamin A deficiency is thought to kill 6000 children and young mothers daily. The World Health Organization believes that vitamin A nutritional status could save 1.3–2.5 million late-infancy and preschool-age children each year.

The World Health Organization recommends breastfeeding, vitamin A supplementation, and vitamin A-rich diets and food fortification to treat vitamin A deficiency. In response to this difficulty, Rockefeller Foundation-supported scientists tried to fortify rice plants with more carotenoids, vitamin A precursors. They genetically engineered rice to produce carotenoids, the yellow pigment in daffodils, and two bacterial genes. "Golden Rice" was the genetically altered golden, carotenoid-rich rice plants.

Golden Rice-2 has 50–60% of the adult vitamin A RDA in one cup. Golden Rice could alleviate vitamin A deficiency and save thousands of lives, according to other studies. Golden Rice may be most beneficial to low-income people for a fraction of the expense of existing supplementation programmes. If projections are correct, this low-tech, sustainable, publicly sponsored, people-centered endeavour will complement other options, such as home gardens with vitamin A-rich carrots and pumpkins.

Nutritionally enhanced rice is like vitamin D-enriched milk, but the procedure is different. Vitamin A fortification of rice is similar to adding iodine to salt, which greatly reduces baby iodine deficit. Iodine deficiency, the biggest preventable cause of mental retardation, affects 2 billion people worldwide.

Environmentally tolerant genetically altered crops are also expected to benefit society. Such crops are projected to improve local food security, especially for farmers in impoverished nations that have limited access to markets and now depend on others for essential commodities.

Over the past decade, three-quarters of severe droughts have happened in Africa. Genetically altered drought-tolerant corn, Africa's staple crop, is expected to boost poor farmers' yields. Drought-tolerant corn will benefit most non-irrigated agriculture and management systems. Drought-tolerance technologies may assist various agricultural crops in developed and developing nations.

Plant diseases and environmental pressures jeopardise global agricultural productivity. Stem rust threatens wheat, which produces 20% of the world's calories. Wind-borne fungus spores propagate the ailment swiftly. Stem rust has caused severe famines throughout history.

II. CONCLUSIONS

Farmers have used genetically modified seed to boost yield for centuries. High-yielding crop types developed in recent decades allowed the US, China, and India to produce the same quantity of food on two to four times less land. Without yield increases, maintaining per capita food consumption by 2050 will require nearly tripling the world's farmland area. Raising global yields to North Asian levels might save a lot of land. High-yielding cultivars will be essential to sustainable agriculture since agricultural systems release a lot of greenhouse gases, and higher yields reduce carbon emissions dramatically.

Thus, raising global yields without harming the environment is a major task. Recent food security assessments emphasise the benefits of sharing agronomic and food science technology with those who lack it. These results also emphasise the necessity to study food crop genetic diversity and create novel genetic methods to improve ecological farming.

Even with novel farming practises, genetically enhanced seed cannot solve all agricultural challenges. Seed can only go so far in most agricultural systems, whether conventional, organic, or otherwise. Ecological farming approaches for seed cultivation, technical advancements, and government policy reforms are also needed.

In many countries, such programmes strengthen local educational, technical, and research capacity, food processing, storage, and agribusiness capabilities, as well as rural transportation, water, and communications infrastructure. To ensure food availability for all, trade, subsidy, intellectual property, and regulatory obstacles that hinder trade and technology must be addressed. Ecological farming employing genetically altered seed will become increasingly crucial in sustainable agriculture, despite the intricacy of many of these interrelated concerns.

AUTHOR'S REMARK

So, in this review article, the author gave worldwide data of crops that are genetically modified for the need of sustainable agriculture alongwith food security . Author review the various studies that has been done for the sake of world in agricultural industries. There is a shining future for genetical modified crops as GMO seeds etc. All the review summarises as genetically altered crops can assist sustain food production when used with best management approaches. The method is popular worldwide since farmers, the environment, and consumers benefit greatly. Utilizing the best agricultural technologies, including genetically altered seed, in ecological farming will lead to sustainable agriculture.

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