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### **Smarter Agriculture: The Push for Sustainability in India**

India, home to over 1.3 billion people, relies heavily on agriculture, with nearly 70% of its rural population depending on it for their livelihoods. Agriculture is central to the economy and deeply embedded in the country's social and cultural fabric at the same time. However, this vital sector is facing escalating challenges due to decades of unsustainable practices. The combined impact of soil degradation, groundwater depletion, and increasingly erratic climate patterns has placed immense stress on India's food systems. For a country that must feed a growing population while sustaining the livelihoods of millions of smallholder farmers, the transition to sustainable agriculture is no longer optional, it is essential. By adopting practices such as no-till farming, crop rotation, and integrated pest management, India can move toward a system that produces more but also conserves the natural resources on which future generations depend.

In rural India, a typical family often consists of three or more generations living together, frequently in a joint family system. These households generally own small plots of land, averaging around 1.08 hectares and practice subsistence farming, growing food primarily for their own consumption and selling any surplus in local markets. The most commonly cultivated crops include rice, wheat, and pulses, along with seasonal vegetables. Dairy products often supplement their diets, as many families rear livestock for both milk and additional income. Access to basic services such as healthcare, education, and banking remains limited in many rural areas, especially in tribal and remote regions. Gender disparities persist in rural agricultural communities as well, with women accounting for approximately 33% of the agricultural labor force but frequently lacking land ownership rights or access to agricultural training.

While urban Indian families typically rely on purchased food and are distanced from direct food production, many maintain strong familial ties to villages. Even in metropolitan cities like Delhi or Mumbai, it is common for urban residents to visit extended family in rural areas during festivals or harvesting seasons. These connections reinforce the central role agriculture still plays in Indian identity, regardless of geographic or economic shifts. Nonetheless, the rising cost of food, changing diets, and nutritional imbalances among both rural and urban populations show the urgent need for a more sustainable, equitable agricultural system.

Agricultural practices in India vary widely by region, climate, and crop. In Punjab and Haryana, the legacy of the Green Revolution is strongly visible in the dominance of rice and wheat monocultures supported by chemical fertilizers and tube well irrigation. While this has increased food production in the short term, it has led to long-term problems such as soil nutrient depletion, salinization, and dangerously low groundwater tables. In contrast, arid states like Rajasthan rely on hardy crops such as millet, sorghum, and pulses, which require less water and are better suited to their ecosystems. In the southern states of Tamil Nadu and Karnataka, mixed cropping and horticulture are common, while the northeastern states often employ shifting cultivation methods. Across much of the country, livestock farming remains a crucial livelihood, particularly dairy farming, which provides both nutrition and income to smallholder farmers. Despite regional adaptations, Indian agriculture overall remains highly vulnerable to unpredictable monsoons, increasingly frequent droughts and floods, and the long-term consequences of unsustainable land use.

The problems faced by Indian agriculture today are rooted in decades of policies that emphasized short-term productivity over long-term sustainability. The Green Revolution of the 1960s introduced high-yield seed varieties and chemical inputs that helped India become self-sufficient in food grains, but it also created a system heavily dependent on synthetic fertilizers, pesticides, and irrigation. These inputs have degraded soil health by stripping away organic matter and reducing microbial diversity. Continuous tillage and monoculture farming have further accelerated soil erosion and made farmlands less fertile over time. According to government surveys, nearly 30% of India's land is now affected by land degradation, much of it in agricultural regions.

Water scarcity is another severe and growing issue. Agriculture consumes more than 80% of India's freshwater, and much of this comes from over-extracted groundwater. The widespread use of tube wells, especially in northern India, has led to dangerously declining water tables. In Punjab, groundwater levels are falling by nearly a meter every year, threatening future agricultural viability. Even in states that receive abundant rainfall, inefficient irrigation techniques and lack of water storage infrastructure mean that much of this resource is wasted or lost to runoff.

Climate change has further destabilized an already stressed agricultural system. Rising temperatures, erratic rainfall, and increasing frequency of extreme weather events such as droughts, unseasonal hailstorms, and flash floods disrupt planting and harvesting cycles. These events can devastate yields, especially for smallholder farmers who often lack crop insurance or financial savings. In recent years, states like Maharashtra, Andhra Pradesh, and Karnataka have reported high numbers of farmer suicides, with financial distress linked to crop failure cited as a major contributing factor. These tragedies are a grim reminder of how environmental stressors, when combined with economic insecurity, can have devastating human consequences.

Despite the seriousness of these challenges, India is seeing growing momentum in the movement toward sustainable agriculture. Many farmers, scientists, and policymakers are recognizing that a fundamental shift is necessary to protect both productivity and the environment. No-till farming is being promoted in states like Haryana, where farmers are encouraged to use seed drills that sow crops without plowing the field, preserving soil moisture and reducing erosion. Crop rotation and intercropping are also gaining ground, helping to replenish soil nutrients naturally and reduce pest outbreaks. These methods stand in contrast to monocropping, which increases vulnerability to pests and diseases while exhausting soil nutrients.

Integrated pest management, which relies on biological controls, crop rotation, and targeted chemical use only when necessary, is being promoted by both government and non-governmental organizations. Farmers are trained to identify natural predators and resistant crop varieties, reducing the need for blanket pesticide use. Agroforestry, the practice of integrating trees with crops, is being adopted in parts of Madhya Pradesh and Odisha, improving biodiversity, reducing wind erosion, and offering additional income sources through timber and fruit. In water-scarce regions such as Rajasthan and Gujarat, farmers are shifting to drip irrigation and rainwater harvesting methods, which dramatically reduce water use while maintaining or even improving yields.

Government programs like the National Mission for Sustainable Agriculture (NMSA), part of India's broader climate change strategy, aim to support sustainable practices through training, demonstration farms, and financial support. State-level initiatives are also playing an important role. For instance, Telangana's Rythu Bandhu scheme provides direct financial aid to farmers for each cropping season, encouraging investment in more sustainable inputs. In Madhya Pradesh, soil health mapping initiatives are helping farmers make more informed decisions about fertilizer use and crop selection based on detailed nutrient profiles of their land.

Technology has also begun to play a transformative role. Digital platforms such as Kisan Suvidha and IFFCO Kisan provide real-time weather updates, crop advisory services, and price information to millions of farmers via mobile phones. Startups like DeHaat and CropIn are using satellite data and artificial intelligence to offer precision farming solutions, helping farmers monitor crop health and manage inputs more efficiently. These tools empower even small-scale farmers to make data-driven decisions, increasing their resilience in the face of climate uncertainty.

At the grassroots level, organizations such as BAIF Development Research Foundation and Digital Green are helping spread sustainable methods through community-based models. Peer-to-peer video training, for example, allows farmers to learn from others in their region who have already adopted techniques such as composting, integrated nutrient management, or organic farming. Farmer Producer Organizations (FPOs) also offer a powerful model for collective action, allowing smallholders to pool resources, access markets more effectively, and share knowledge.

While these many solutions have merit, one approach stands out as a priority for long-term transformation: youth engagement and agricultural entrepreneurship. Rural youth are increasingly leaving villages in search of urban employment because farming is seen as low-status and unprofitable. If this trend continues, India risks not only a shortage of farmers but also a widening rural-urban divide. Programs that encourage young people to see agriculture as a dignified, innovative career path are essential. This could involve fellowships that connect young people with sustainable farms, mentorship programs where older farmers share traditional knowledge, and training in agritech tools that allow youth to experiment with new techniques. Cultural considerations must also be factored in: for example, joint family structures could make youth engagement more effective if entire households are included in training, while addressing gender disparities ensures that young women are equally empowered to participate. By reframing farming as an entrepreneurial, respected, and sustainable profession, India can secure its next generation of agricultural leaders.

Other reforms such as expanding extension services, redirecting subsidies, reforming water policy, and improving insurance remain vital, but they will be far more effective if young farmers are willing and empowered to adopt them. Youth are uniquely positioned to integrate traditional practices with modern technologies, bridging generational divides and building resilience.

Sustainable agriculture in India is not just about environmental conservation; it is fundamentally about food sovereignty, social justice, and rural prosperity. The challenges facing Indian agriculture are severe, but they are not insurmountable. The knowledge and tools already exist: what is required now is the commitment to scale them up equitably and urgently. By prioritizing youth engagement alongside ecological farming techniques, modern tools, and community empowerment, India has the potential to lead the world in sustainable agriculture. The future of Indian farming lies not in repeating the past but in cultivating resilience, balance, and care—for the land, for the farmers, and for the generations yet to come.

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