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An Examination of Agricultural Technology Advancements and their Socioeconomic Effects in the Dehradun and Haridwar Regions

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Abstract: New agricultural technology has had a significant social and economic impact on India's Dehradun and Haridwar areas. Farmers in these locations have observed enhanced efficiency, better resource management, and higher crop yields with the use of modern agricultural practices such as precision farming, drone technology, and internet-of-things monitoring systems. Because of these technological advancements, farmers can now maximize resource allocation, make data-driven decisions, and lessen the risks associated with weather unpredictability and pest infestations. The development of automated procedures and mechanical equipment has also reduced the demand for human labor, increasing productivity while easing the burden on rural laborers. Farmers may now get access to additional markets, negotiate better prices, and improve their livelihoods owing to the integration of digital platforms for market access and financial services. While there has been progress toward a more equitable distribution of benefits, considerable challenges remain, including low levels of digital literacy, high entrance costs, and restricted access to technology. On the other side, modern agricultural equipment is widely employed in Dehradun and Haridwar, indicating that farming is becoming more sustainable and robust.

Keywords: Agricultural, Technology, Socioeconomic, Dehradun and Haridwar regions

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INTRODUCTION

New technology has brought about a sea change in the agriculture industry in India's Dehradun and Haridwar areas. Not only have these innovations changed the way farmers work, but they have also had a significant social and economic effect on the local populations. Precision farming is a game-changing technology in the agricultural industry. The term "precision farming" refers to the practice of optimizing watering, fertilizing, and pest management via the use of modern technology like as GPS, sensors, drones, and more. Precision farming has been especially useful in the mountainous regions of Haridwar and Dehradun because to the uneven and fractured nature of the soil. (Puri, V. K. 2016) Farmers may optimize yields while minimizing input expenditures by appropriately mapping the land's topography and monitoring crop health in real-time. Drip irrigation systems are another important technological development that is changing farming in the area. Water loss and soil erosion are common outcomes of using flood irrigation and other conventional irrigation techniques, particularly on hilly or otherwise uneven terrain. In contrast, drip irrigation reduces water use and ensures soil moisture levels are ideal by delivering water directly to plant roots in a regulated manner. This has a dual benefit of reducing water consumption and increasing crop yield and quality. (Prasad, C. S. 2016).

Greenhouses have allowed farmers in Haridwar and Dehradun to grow high-value crops all year round and

lengthen the growing season. To cultivate plants in an optimal environment, greenhouses allow for the regulation of environmental variables such as temperature, humidity, and light intensity. Thanks to these new avenues for specialization and diversification, farmers may now cultivate high-value cash crops like tomatoes, bell peppers, and strawberries. These technical developments in agriculture have far-reaching socioeconomic consequences. (Mahajan, S. 2015) One positive development is that agricultural incomes and productivity have gone up significantly as a result of improved crop quality and higher yields. Precision farming and efficient irrigation allow farmers to make more money and live better lives by producing more with less water. A move towards commercial farming and agribusiness operations has occurred in the region as a result of the use of new technology. More and more farms are becoming mechanized and larger ones are springing up as a result of farmers' adoption of modern agricultural methods, which allow them to take advantage of economies of scale. As a result, people may now find work in agriculture in a variety of supplementary roles, including primary production, agri-processing, logistics, and marketing. (Shappand, F. W. 2017)

Brief overview of Dehradun and Haridwar region

The scenic regions of Dehradun and Haridwar in the northern Indian state of Uttarakhand are located at the base of the magnificent Himalayas. These two areas draw visitors and believers from all over the globe because to their stunning landscapes, profound cultural history, and religious importance. Haridwar, one of the seven sacred sites in Hinduism and a starting point for the Char Dham pilgrimage circuit, is of great religious importance, while Dehradun, the capital of Uttarakhand, is the regional administrative, educational, and economic center.

Dehradun, located in the Doon Valley, has good weather and soil for agriculture. The region is recognized for its diverse agricultural production, which includes cereal grains, fruits (such mango and lychee), and medicinal plants. Additionally, students from all over the world travel to Dehradun to attend the Doon School, the Forest Research Institute (FRI), and the Indian Military Academy (IMA). The Hindu holy city of Haridwar, located on the banks of the Ganges River, is extremely important in Hinduism. During the Kumbh Mela and other holy holidays, Haridwar attracts millions of visitors who come to wash in the Ganges. Ancient temples, ghats, and ashrams dot the city, providing a sense of calm and quiet. Dehradun and Haridwar have a cultural past that incorporates aspects of Pahari, Kumaoni, and Garhwali traditions. The region's rich cultural tapestry is on full display during the raucous festivities of holidays such as Diwali, Holi, and Navratri. Visitors may also sample the local food of Haridwar and Dehradun, which is known for its aromatic spices and wonderful flavors. (Singh, T. 2019)

The agricultural sector is vital to the economy of the Dehradun and Haridwar area, providing jobs for a large percentage of the locals. Small and marginal farmers have been cultivating their land for sustenance through traditional farming techniques for years. New economic sectors including tourism, education, and manufacturing have emerged as a result of changes in land use patterns brought about by fast urbanization and industrialization. Problems including water shortages, environmental deterioration, and socioeconomic inequality are plaguing the area. Unplanned urbanization strains natural resources and infrastructure, while climate change threatens agricultural output. Furthermore, sustainable development solutions are necessary since many areas of the region still face problems with poverty, unemployment, and lack of access to

healthcare and education. In order to overcome these obstacles and realize the region's full potential, the significance of utilizing technology and innovation is becoming more acknowledged. To promote equitable and sustainable development in Dehradun and Haridwar, initiatives are being implemented, such as implementing new agricultural technology, boosting eco-tourism, and investing in healthcare and education facilities. (Mathur, V. C. 2018)

COMPONENTS OF NEW FARM TECHNOLOGY

Once technological advancements in agriculture get under way, they inevitably cause shifts in agrarian practices as a result of the widespread adoption of new farming techniques. Biochemical and mechanical advances made up modern agriculture technology. Soil conservation, irrigation, mechanization, fertilizers, pesticides, High Yielding Variety (HYV) seeds, and better tools are all part of the technological package that has contributed to enhance agriculture. The new agricultural plan required large, guaranteed-irrigated farms with access to substantial capital, institutional financing, and extension services, notwithstanding a significant rise in productivity. (Ismail, A. S. 2018)

This report evaluates agricultural technology components based on:

(i) Irrigation

In order to use better agricultural technologies, irrigation is a must. To maximize output per acre, irrigation is a useful tool, especially when combined with other inputs. More importantly, improved irrigation is necessary for multiple crops and for obtaining the most efficient use of land and resources. Production per acre is greater in India's irrigated fields compared to the country's dry fields. There have been tremendous gains for India's rural economy as a result of irrigation development. Specifically, it has contributed to a change in cropping pattern toward new and improved crop types, an increase in the need for farm labor, a larger farm acreage, and better land utilization.

(ii) Chemical Fertilizers

The fields of biology and chemistry come together in biochemical technology. Soil fertility is restored and plant diseases are protected by chemical fertilizers, insecticides, weedicides, and herbicides made possible by chemical technology. In the end, biological technology increases production by influencing the plant's physiognomy and genetics. Biochemical technology is neutral in size, uses land sparingly, and absorbs labor. High Yielding Varieties Programme (HYVP) and Intensive Agricultural District Programme (IADP) programs emphasized fertilizers more to make up for the nutritional deficit. From 1.20 million tonnes in 1966–67 to 22.67 million tonnes in 1999–2000, the consumption of fertilizers has expanded significantly.

(iii) High Yielding Variety (HYV) Seeds

Something else related to bio-chemical technology is the growing popularity of HYV seeds. Both the pattern of land-using character and output per unit of land are enhanced by the high yielding variety seeds. Producing high-quality seeds will remain a crucial component of agricultural production strategies, according to planners. Consequently, we will push forward with the plan to produce certified seeds even more forcefully. The utilization of HYV seed as a resource input is one of the new agricultural tactics that

has been widely adopted and is responsible for enhancing output. (Zellner, A. 2015)

(iv) Plant Protection

Plant protection methods might prevent the potential decrease in agricultural productivity. The use of pesticides and other plant protection chemicals does not directly boost output, but it does reduce crop failure and raise harvest yields. However, pests and chiseases are more common in the new seed type. In 1949, the importation of Dichlorodiphency Trichloroethane (DDT) and Benzene Hexachloride (BHC) marked a significant breakthrough in plant protection. In comparison to industrialized nations, India's pesticide use is negligible, with the exception of some states such as Andhra Pradesh, Punjab, Haryana, and Uttar Pradesh, where usage is rather substantial. (Chow, G. C. 2020)

NEW FARM TECHNOLOGY AND MECHANISATION IN AGRICULTURE

Mechanization is using tractors and related machinery on a much larger scale. This includes farrow tillers and thresher harvesters, among others. Chemical fertilizers and other agricultural nutrients are applied in higher quantities as part of modern guaranteed irrigation methods. When we talk about mechanizing farming, we're referring to practices like using herbicides, weed killers, and High Yielding Variety (HYV) seeds to ensure a harvest. Increased crop yields are a remarkable result of the modernization of agriculture brought about by the adoption of new agricultural inputs and technologies. Green Revolution 6 has far-reaching consequences for the problem of taxing agricultural revenues and the power structure at different levels. All districts chosen under the Intensive Agricultural District Programme (IADP) plan were required to adopt technical changes in the High Yielding Varieties Programme (HYVP) in 1966. Higher agricultural productivity by repeated cropping was the focus of the plan. According to the Planning Commission, the HYVP was now a "crucial component" of their plan for agricultural growth. The new agricultural strategy's most intriguing aspect was the renewed support it gave to scientific agriculture and research and extension programs. The new plan calls for a technological leap forward in India by implementing measures such as using more of the recommended amount of fertilizer, expanding the use of pesticides to protect crops from insect damage, and introducing new and HYV improved seeds. The agricultural output of our nation saw remarkable transformations as a result of this technical advancement. It was the quick introduction of hybrid hybrid varieties of rice and wheat, which had multiplying impacts on other crops, that gave rise to the term "Green Revolution" to characterize the increase in food grain output observed from 1966–67. (Martin, B. R. 2015)

The use of new agricultural strategy technologies from the mid-sixties has contributed to the revolutionization of agriculture in India. Some examples of agricultural technology advancements include pesticides, irrigation, mechanization, better tools, soil conservation, and similar practices. Increased agricultural output is a direct outcome of the effective implementation of these new plan components. Some of the variables that will determine whether or not the aforementioned elements of the new agricultural strategy are implemented include irrigation, farm size, available cash, institutional financing, and extension services.

Two broad types of contemporary agricultural technology:

(i) Mechanical technology and

(ii) Bio-chemical technology.

i. Mechanical technology: Production tools, whether mobile or fixed, are the focus of mechanical technology. As a rule, this is capital demanding yet scalable, which means it reduces costs. More fixed capital is needed for it. (Borude, S. G. 2015)

ii. Bio-chemical technology: The fields of biology and chemistry come together in bio-chemical technology. To restore the soil's fertility and shield plants from pests and illnesses, chemical technology has produced fertilizers, insecticides, weed killers, herbicides, and similar products. Improved crop yields are the end result of biological technology's manipulation of plant genes and physiology. Biochemical technology is neutral in size, saves land, and absorbs labor.

Timely field agricultural operations result in multiple cropping in a single year, which means that mechanical technology, although capital costly, may actually save land and absorb labor. The use of pesticides and weedicides makes it feasible for biotechnology, which now requires a lot of human labor, to potentially reduce that need. Nevertheless, technological advancements in mechanization have traditionally been the most important driver in reducing labor costs, while biological improvements have been the most important factor in reducing land costs. Mechanization in agriculture refers to the use of various implements and machines in various agricultural processes, including but not limited to: cultivating land, producing crops, harvesting, preparing crops for storage, storing crops, and processing crops on-site. There are three primary power sources: mechanical, animal, and human. Agricultural mechanization refers to the study of ways to provide farmers with efficient and effective tools, implements, and machines through their production, distribution, repair, maintenance, management, and use. (Mubarak Ali. 2016)

NEED FOR NEW TECHNOLOGY IN AGRICULTURE

An integral part of every farm operation is the force behind it, which may be defined as the human hands, agricultural implements, draught animals, tractors, implements, machinery, and equipment. Expenditure on farm power, including labor, draught animals, fuel, and depreciation of machinery, typically surpasses the expenses of other inputs like seeds and agro-chemicals in nearly every agricultural production system. The underutilization of farm power, low productivity of labor, or scarcity of labor negatively impacts agricultural output and food security in several developing nations. There is a growing consensus that agricultural labor productivity has to be enhanced. Irrigation pump sets are an obvious example of a situation requiring machinery. To better acknowledge the significance of manual labor and hand tools, draught animals and mechanical power, as well as other concerns connected to the labor shortage, like cropping and farming systems, it would be more appropriate to refer to agricultural mechanization as farm power or labor productivity enhancing technology rather than agricultural mechanization. (Grover, D. K. 2018)

Agricultural implements and machinery are necessary to solve environmental issues in farming; for instance, pesticide use and soil tillage both deal with health concerns. Similarly, processing on-farm and reducing post-harvest loss also need the use of machinery. The importance of agricultural mechanization in combating poverty, hunger, and environmental and health issues has therefore been acknowledged.

Unfortunately, many people have a very limited understanding of what mechanization is and how it works, which prevents them from appreciating its true purpose: increasing the efficiency of both land and labor. Agricultural mechanization plans should really be subsumed under agricultural technology plans, which in turn should be a component of a larger plan for agricultural growth. The three main goals of automation in this setting are as follows:

i. Increase in labour productivity

When people are able to work fewer hours or in other industries, or when they can cultivate more land with the same amount of labor, a typical event is the introduction of machines to replace human labor ("labour-saving"). (Bui-Lau, A. 2019)

ii. Increase in land productivity

More output from the same amount of land is the goal of mechanization in this case. A supplementary input, machinery is necessary to increase land productivity, for instance by installing pump sets or by reducing turnaround times to increase cropping intensity. It is desirable to prevent net displacement or replacement of workers in a labor surplus economy.

iii. Decrease in cost of production

Farm mechanization has the potential to reduce production costs or compensate for increases in the expenses of labor or draught animals. (Junankar, P. N. 2019)

IMPORTANCE OF MECHANISATION

Mechanization is the planned use of inputs by means of agricultural machinery and equipment, such as prime movers, power-driven machines, and hand tools and bullock-drawn equipment, to carry out the many tasks involved in crop production. By reducing the amount of manual labor required for different agricultural tasks and increasing efficiency in the use of inputs, mechanization allows farmers to make better use of their resources.

- Indian farmers have always relied on the strength of both humans and animals. These sources aren't perfect, and they haven't been successful in producing many crops. Many farmers believe that growing more than one crop at a time is the most efficient use of limited farmland.
- The availability of draught animals as offspring of domesticated milking animals ensures their continued usage as a primary source of operational power. Except for human strength, these draught animals will remain the primary means of propulsion in hilly areas and on smaller farms. But these creatures are becoming less common. The utilization of draught animals has decreased due to the rise of mechanical power in farming. (Flinn, J. C. 2017)
- Mechanization allows for efficient use of different inputs and timely field operations. Indian farmers have effectively mechanized tilling, planting, watering, protecting plants, and threshing.
- Timeliness is of the essence for farmers that engage in dry land agriculture since they labor in environments with unpredictable weather. Tilling and ploughing must be done quickly, within strict time constraints, and this cannot be accomplished just by relying on animal or human strength. If farming is to

be modernized, machinery must be used.

- When breaking down the whole cost, human work is by far the biggest component. Any rise in the wage, no matter how little, would have a significant effect on agricultural economy. Consequently, farmers are likely to be very sensitive to salary increases, which might be a major factor in the trend towards mechanization and other technologies that save labor.

TECHNOLOGICAL CHANGE IN INDIAN AGRICULTURE

When a nation is impoverished, it stays poor. A number of contemporary ideas in economics have this view. This sentence contains a nuanced meaning that is not immediately apparent due to its unusual word choice.

Using the methods given by science and technology is essential for every nation hoping to become wealthy, regardless of how abundant its natural resources may be. Crucial to the manufacturing process are scientific breakthroughs, technical innovations, and inventions. All it takes to boost a product's chances of selling in a price- and quality-sensitive market is the application of cutting-edge technology. In the absence of affordable technology, a developing nation will continue to lag behind. Enlistment can only be accomplished by purchasing or obtaining the necessary technologies. (Singh, S. R. K. 2015)

The influence of technical progress is pervasive across all industries. There is absolutely no exception in Indian agriculture. The agricultural sector has seen remarkable transformations in the period after independence, characterized by development and advancement. Most notably, the use of machinery to augment and even replace human or animal labor in farming has emerged as a significant development.

Agriculture employs two-thirds of the Indian workforce and is crucial to the country's economy. Agricultural expansion is critical to the country's development. The expression "our land is our future" is quite appropriate in this context. We must pay heed and act now, since there is an urgent need to greatly enhance food grain production. It is critical and cannot be stressed. The basic goal is to feed more people per hectare of land. The agricultural movement must have this as its primary purpose and theme. Farm mechanization, the use of high-quality seeds, higher doses of fertilizer and plant protection agents, assured irrigation, and access to funding have all contributed to the present increase in food grain output. Agricultural mechanization refers to a wide variety of methods aimed at raising productivity via the use of improved inputs and technology. (Yolopoulos, P. A 2018)

ADOPTION OF PRECISION AGRICULTURE TECHNOLOGIES

New precision agriculture instruments have given farmers in the Dehradun and Haridwar area cutting-edge ways to maximize crop yields with little input and impact on the environment. With the use of cutting-edge technology like GPS, sensors, drones, and data analytics, precision agriculture—also called smart farming —manages field variability in crops, soil, and environmental factors with pinpoint accuracy. The chapter delves into the socio-economic effects of the region's widespread use of precision agricultural technology. The utilization of Global Positioning System (GPS) technology is an essential part of precision agriculture. Precise planting, watering, and harvesting are made possible by GPS, which allows farmers to precisely map their fields and monitor the whereabouts of machinery. Farmers may save a ton of money on fuel,

time, and labor by using GPS navigation devices to cover more ground in the field with less downtime. Increased efficiency and production have resulted from the widespread use of this technique by farmers in the Dehradun and Haridwar region. Precision agricultural approaches rely heavily on the integration of sensor technology. For example, farmers may use soil sensors to track soil moisture, nutrient content, pH, and temperature in real-time. This helps them plan irrigation schedules, fertilizer applications, and overall soil management. The same holds true for crop health assessments, insect infestation detection, and nutrient deficiency detection; these sensors may be used both from above and below ground to enable targeted interventions and reduce crop losses. The region's farmers have been able to improve crop quality, optimize resource allocation, and reduce risks related to environmental unpredictability thanks to the implementation of sensor technology. (Manoharan, B. 2017)

Drones are a new and useful tool for precision farmers, allowing them to survey vast agricultural areas with pinpoint accuracy and in record time. Drones, with their high-resolution cameras, thermal imaging capabilities, and multispectral sensors, may take precise pictures of fields and surrounding terrain, revealing important information on crop health, growth trends, and pest threats. Aside from surveillance, drones may be utilized for precise spraying, which allows for the tailored administration of fertilizers, insecticides, and herbicides according to the unique needs of crops. Drones have drastically altered agricultural management in the Dehradun and Haridwar area, allowing for faster problem detection and resolution at a lower cost and with less negative effects on the environment. Precision agriculture has never been more effective than it is now, thanks to data analytics and decision support technologies. Farmers may optimize inputs, acquire insights into crop performance, and make data-driven choices to maximize yields and profitability by integrating data from diverse sources including weather predictions, soil samples, crop sensors, and satellite images. By analyzing massive databases, sophisticated algorithms and predictive models can spot patterns, outliers, and trends; this paves the way for preventative management and less risk. In order to boost profits in a highly competitive agricultural market, farmers in the area have turned to data-driven solutions to help them become more efficient with their resources, cut down on input costs, and boost productivity. (Muthamil Selvan, M. 2016)

CONCLUSION

In the Dehradun and Haridwar areas, new technology integration in agriculture is driving economic and social growth and promoting long-term viability. Not only do these advances help farmers make a living, but they also make rural communities stronger by increasing production, making better use of resources, and opening up new markets. Equal access to these instruments, proper training and assistance for farmers, and the resolution of infrastructure difficulties are all critical for technology-driven agriculture to reach its full potential. The area can create a more sustainable, equitable, and lucrative agriculture economy by working together and investing strategically in technology.

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