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Agricultural Education, Research and Extension in Gujarat:

Towards Technological Pathways for Sustainable Development

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Abstract

Agricultural activities involve the production of crops and animal husbandry for commercial or sustenance purposes. In recent decades, the exponential rise in population has decreased the availability of arable land or rendered it stagnant. This has necessitated greater efficiency in terms of technology development and application of cutting-edge technologies in farm practices for cultivating crops. India has a tropical environment with plentiful sun energy all year long, making it a good place to grow crops year-round. Through river projects and smaller irrigation projects, there is a significant opportunity to improve irrigation potential. Moreover, India benefits from an abundance of available labor. Numerous advances have been made in the hydrological, mechanical, chemical, genetic, and technical elements of agriculture. Governments are expected to spend more on agricultural technological development and attract young talent in agricultural universities in different areas of agricultural research and specialization. Also, planning, devising appropriate programmes and the implementation of need-based agriculture needs to be prioritized in the changing climatic conditions. In this regard, the present paper outlines some technological pathways for sustainable agricultural development in the context of agricultural education, research and extension related issues and practices in Gujarat. Agricultural production is significantly influenced by environmental conditions in Gujarat. This relationship between farming and climate change necessitates innovative farm technologies and the need for skilled agri-professionals to improve crop production. Agricultural colleges and universities in Gujarat have been engaged in research on various issues, including declining groundwater supplies and issues related to salinity in soil and water and have developed new

technologies to address these challenges. This also necessitates the emergence of a critical mass of researchers, equipped with know-how related to innovative farm technologies in the agricultural institutions in the state.

Keywords

Gujarat Agricultural Universities, Agricultural Education, Agricultural technologies.

Introduction

Agricultural education institutions have played a vital role in fostering economic growth and have definitely ushered a turning point in terms of the pursuit of sustainability and food security. Agricultural education and research need adequate nurturing to harness the sector's unrealized potential for sustainable development (Maiti & Chattopadhyay 1988), (Makwana 2022). In addition, there is also concern regarding the sector's capacity to meet rising food demands in the coming decades (Singh 1982). A feasible strategy has been to improve food provision by raising agricultural production and enlarging the variety of agricultural land use (Singh 2012), (Tamboli 2013). However, this strategy cannot be applied uniformly everywhere. Moreover, the technology and expertise currently available will not be adequate for countries like India to produce all the food required in the future (Thokchom 2012). This necessitates the expansion of agricultural education, research and extension in India, besides the enhancement of investments in the agricultural sector, in order to increase agricultural output per unit of land.

Methodology

The present paper is based on relevant secondary sources as well as an empirical study carried out during the period 2018-2022, where interviews were conducted with 10 scientists and around 34 undergraduate and post graduate students located in different streams in four agricultural universities in Gujarat. These universities included Anand Agricultural University, Navsari Agricultural University, Junagadh Agricultural University and Sardarkrushinagar Dantiwada Agricultural University. The student respondents were chosen from the above-mentioned agricultural universities of Gujarat using random sampling technique. Purposive sampling was used to identify the scientists for the study. The objectives of the study were also shared clearly with the respondents. Queries pertaining to the significant developments in agricultural research and education, ongoing and emerging challenges in teaching, research and extension programmes in the context of Gujarat and policy issues relating to sustainable agricultural practices were posed to the respondents in order to carry out the data analysis for the study.

Agricultural Education and Research in India: A Brief Overview

In India, agricultural education has witnessed a slow yet considerably steady development and expansion throughout the decades (John 1987). Before Independence, the emergence of the Imperial Agricultural Research Institute (IARI) at Pusa, was significant in terms of recognizing the need for agricultural education and research. After independence, the organization's name was changed to Indian Agricultural Research Institute (IARI) (Gopalchari 1984), (ICAR 1968), (Maiti & Chattopadhyay 1988). The Indian Agricultural Research Institute relocated to Delhi in 1936. Wheat varieties developed by IARI have been credited with helping India achieve its 'green revolution' (Reddy 1999), (FAO 2022), (KVK 2022). The development of scientific disciplines pertaining to agriculture was the fundamental program of IARI in the 1950s and this served as the foundation for its growth. We find that agricultural education and research in India continued to flourish steadily in the decades following Independence (Ahlawat 2022), (De 1997), (ICAR 1968).

In the study carried out by (Kumar, 2018) states that in the post-irrigation era, salinity-sodicity issues acquired significance as a result of the failure of farmers to obtain the expected high yields (IARI 1977), (Hiran & Singh 1990), (IARI 1977). Due to the decline in profitability of farming, the land would be eventually abandoned by farmers. For the purpose of assisting the Indian Council of Agricultural Research in creating a national water management program, the Indian government formed an Indo-American team (Doorenbos & Fruitt 1977), (IARI 1977), (ICAR 1996). During the Fourth Plan period, the Central Soil Salinity Research Institute emerged as a response to their suggestions. The institute conducted interdisciplinary research on salinity/alkalinity control and adequate irrigation in various agro-ecological zones of the region (Israelson & Hansen 1962), (Rao 1983), (Sankaran & Mudaliar 1997).

At present, the Indian Council of Agricultural Research (ICAR) is an independent agency funded by the Ministry of Agriculture and Farmers' Welfare and operating under the auspices of the Department of Agricultural Research and Education (DARE) (Rao 1983),(JAU 2022). The Council is the main organization responsible for organizing, directing, and supervising all agricultural-related research and education activities nationwide, including those related to horticulture, fisheries, and animal sciences (CPRI 2021), (NAHEP 2022). With its research and technology advancements, the ICAR has certainly played a leading role in bringing about the Green Revolution and bringing about advancements in Indian agriculture (GoI 2022), (The Hindu 2013).

With regard to developments in agriculture, we also need to take account of significant global events (GBP 2022), (Soam & Raghuwanshi 2022). At the end of World War II in 1945, there was a shift in the objectives and concerns shaping agriculture and rural development. During this period, malnutrition was experienced on a serious scale all over the world, prompting industrialized nations to make concerted efforts to boost food production (The Hindu 2013), (Singh 1999). In order to intensify

production, the use of chemical inputs (fertilizers and biocides) also rose as a result of the increasing importance of technological innovation in agricultural research and development (R&D). The production of important crops increased significantly, labor productivity rose and the need for agricultural labor in rural societies witnessed a sharp decrease (Singh 1999), (NAU 2022).

There was also concern over how new agricultural technologies would affect the environment was the major concern in the studies carried out by (Kumar, 2022). Studies conducted later showed that nutrient surpluses had detrimental impacts on soil, vegetation and groundwater. Over time, agricultural research began to emphasize on integrated production systems, to ensure the commercial feasibility of agricultural lands while mitigating the adverse environmental impacts caused by farming practices (JAU 2022), (GoI 2022). Gradually, in response to environmental concerns, lawmakers enacted laws to limit inputs. Concern regarding the availability of food increased during the 1950s and 1960s. The majority of nations have witnessed rapid population expansion as a result of better healthcare infrastructure, which has significantly increased the demand for food. Increased wheat production is largely attributable to expenditures in agricultural research, which facilitated Green Revolution (ICAR 2022), (Singh & Nair 2012), (SDAU 2022). It was based on the change in agricultural practices and the reliance on "high-yielding" crop varieties (wheat, rice, and maize) that performed well to exogenous interventions, in particular (nitrogen) fertilizer, irrigation water and crop protection chemicals. This resulted in a significant increase in crop production. Food production increased considerably, structural famine fears were alleviated, and food prices could be kept at manageable levels as a result of policy actions that made external inputs economically viable to farmers. This was especially true in more prosperous parts of the developing world (Sathe 2015), (GoI 2022).

In India, the gradual establishment of agricultural institutions have undoubtedly contributed to the development of teaching, research and extension programs in agriculture across the nation (GoI 2018),(TNAU 2022). In addition to addressing the concerns of rural areas in India, they have gradually centered on agricultural research and development for technology creation and extension activities. The introduction of research programs has been a key component in achieving progress in this domain (IARI 2022). The increase in food production has also assisted the nation in achieving self-sufficiency and meeting the needs of its growing population. Nonetheless, rising levels of poverty, food insecurity, malnutrition and illiteracy still continue to pose a threat to the general population as a whole (NAHEP 2022). Agricultural education and research programs are often criticized for failing to provide farmers and agricultural workers with high-quality equipment that would allow them to increase their yields and incomes and create more jobs (CAZRI 2022), (Gulati 2022).

With reference to agricultural education in India, the Agricultural Education Division of the Indian Council of Agricultural Research is primarily responsible for strengthening and streamlining the higher agricultural education system in order to improve the quality of human resources in the agri-

supply chain and tackle future challenges in the sector (AAU 2022), (CTRI 2022). This necessitates ongoing planning, advancement, coordination, and quality control in India's higher agricultural education. The division works to uphold and improve the standard and applicability of higher agricultural education through collaboration with and efforts from the ICAR-Agricultural Universities (AUs) system, which is made up of State Agricultural Universities (62), Deemed to Be Universities (5), Central Agricultural Universities (2) and Central Universities (4) with faculty in agriculture (SDAU 2022).

Socio-Historical Developments in Agricultural Education and Extension in Gujarat

In Gujarat, the College of Agriculture in Junagadh, began operations in June 1960, with a capacity to admit 100 students. This institution has the distinction of being Gujarat's first government agricultural college. Since its inception till 1967, the college was affiliated to Gujarat University in Ahmedabad (Sathe 2015). The affiliation was then transferred to Saurashtra University in Rajkot, after its inception, in 1968. Later, the college was incorporated into Gujarat Agricultural University in 1972 (JAU 2022). Later, after Gujarat Agricultural University separated in 2004, the campus joined Junagadh Agricultural University on May 1, 2004. Some of its departments include agronomy, animal science, biochemistry, genetics & plant breeding, soil science & agricultural chemistry, agricultural economics, agricultural entomology, agricultural extension, farm engineering, horticulture, plant pathology, agricultural biotechnology and seed science and technology (Gulati 2022).

In 1936, long before the Radhakrishnan Commission proposed the concept of a rural university, Sardar Vallabhbhai Patel, the iron man of India, laid down the basis for a rural education and research institute in Anand for the training of farmers. With the assistance of Dr. K.M. Munshi, the co-author of the Indian Constitution, his vision was realized in 1940 as the Institute of Agriculture, Anand (CAZRI 2022). The Anand Institute of Agriculture (IAA) subsequently rose to prominence and is now considered as the best in the state. In 1947, Sheth Amrutlal Hargovandas donated money in honor of his late son Bansilal Amritlal to construct the first agricultural college under the auspices of the IAA, which was later constituted as Anand Agricultural University in 2004 (The Hindu 2013). Productivity, sustainability and improvement of the socio-economic situation of the farming community are the main goals of all AAU research programs (SDAU 2022). AAU's goals also include distributing Soil Health Cards, making biofuel, cultivating medicinal plants along with traditional crops and processing food products, while animal scientists undertake high-quality research on prevention and therapeutic treatments against infection/infestation, high poultry/livestock productivity and animal nutrition (GoI 2022).

The Navinchandra Mafatlal College of Agriculture, often known as N. M. College of Agriculture, was founded in May 1965 with the objective of enhancing the agricultural community's economic and social standing by providing its students with a quality agricultural education (NAHEP 2022). N M College of

Agriculture was established in 1994 and became a part of Navsari Agricultural University in 2004 when GAU was recognized (SDAU 2022). As of today, N. M. College of Agriculture has been in operation for more than fifty years. Surat, Navsari, Bharuch, Valsad, Narmada, Tapi, and Dang are the seven districts in South Gujarat that are under NAU's authority (NAHEP 2022). Agribusiness management, agriculture, horticulture, forestry, agricultural engineering and agricultural biotechnology are among the faculties provided at NAU, for the mandated crops, including paddy, sugarcane, cotton, sorghum, small millets, mango, banana, sapota, and vegetables (Singh & Nair 2012).

In accordance with Gujarat Act No. 13 of 1969, the Gujarat Agricultural University was established in the state. The government repealed the Gujarat Agricultural University Act of 1969 and enacted the GAUs Act No. 5 of 2004 (Soam & Raghuvanshi 2022). Four separate State Agricultural Universities were established, S.D Agricultural University was established. Banaskantha, Sabarkantha, Mehsana, Patan, Gandhinagar, Kachchh and Aravalli are some of the districts in North Gujarat that fall under S. D. Agricultural University's ambit. SDAU was established to help the agricultural and allied industries. There are eight colleges under the umbrella of S. D. Agricultural University, as well as twenty-eight research stations and three Krishi Vigyan Kendras (NAHEP 2022).

Agro-Economic Conditions in Gujarat

The agro-economy of Gujarat is unique since it is market-oriented and guarantees farmers a reasonable income (John 1987). Gujarat's agriculture and related sectors have outpaced its counterparts in the recent decade with an annualized average growth of 11%, in contrast to the national average of 3% during 2001-02 and 2011-12 (TNAU 2022). During the last decade, the agriculture and related industries grew almost as quickly as the state's highly regarded industrial sector, despite agriculture's declining contribution to the state's production (Gulati 2022). Agriculture contributed 11% to the state's GDP in 2011-12, down from 17% in 2001-02. In comparison to the preceding two decades, during which agricultural growth was prone to fluctuations, the current two decades have seen a more stable expansion of the state's agricultural sector with the efforts of both private and public sectors. Non-food crops like cotton, groundnuts, cumin, fennel, and tobacco make up the majority of the state's agricultural output (FAO 2022).

Innovation and adoption of new technologies are the important pillars for the expansion of agriculture and the growth of the cotton industry, which in turn has increased farmers' incomes and pushed the constraints of producibility (Gopalchari 1984). The commercial seed industry has been at the forefront of developing and advocating the use of Bt-Cotton seeds, while the public sector has been involved in the development and dissemination of high yielding variety (HYV) seeds such as wheat. A total of 113 BT Cotton varieties have been registered by 26 private seed firms in Gujarat (Maiti & Chattopadhyay 1988).

The availability of greater quantities of water is yet another important factor. Gujarat is prone to droughts and just 36% of its gross crop area is covered by irrigation (Chatterjee & Bhattacharya 1986). Excessive water availability from Sardar Sarovar project, increasing expenditures in check-dams and watersheds such as construction of check dams, bori-bunds, and Khet Talavadi (farm ponds), developed by the state in conjunction with NGOs and the private sector, have helped to promote expansion (Ahlawat 2022). A significant improvement includes coordinated efforts to replenish the water table, restrict the use of power for agriculture, and offer large subsidies to farmers utilizing cutting-edge water-saving techniques like drip irrigation (Tamboli & Nene 2013). Reviving crop research systems and launching cutting-edge extension services that provide farmers with access to research and expertise have also contributed significantly to the above-mentioned developments (KVK 2022). An example of cutting-edge extension work is the Krushi Mahotsav initiative. Roughly one lakh government representatives from the chief minister to Taluka level employees from 15 Divisions with 1582 agricultural scientists and a number of other stakeholders, including civil society organizations, elected officials, farmers, and women spend a month in rural areas during April or May show-casing the most cutting-edge technologies to farmers (Sankaran & Mudaliar 1997). Undoubtedly, these developments are the outcome of the tremendous strides made in relation to agriculture education, research and extension related activities in Gujarat (Tamboli & Nene 2012).

Discussion: Technological Pathways for Sustainable Agricultural Practices

With regard to agricultural education and research, the state government needs to implement effective measures to draw talented students and consequently skilled agro-professionals to the sector. Graduate-level agricultural education is typically not a student's first or favoured choice (Thokchom 2012). In this regard, a scientist, located in the agronomy department of Junagadh Agricultural University commented,

"*After XII, students with a biology background consider several possibilities for their academic career, but BSc (Agriculture) is frequently not on students priority agenda and is not attractive to them (working in the farms with unstable farm income and desire of a good lifestyle). There may be a number of reasons for this, including a lack of knowledge of all the opportunities available to BSc (Agriculture) graduates*."

Another scientist, located in the social science department of Anand Agricultural University, had a similar response.

"This is because people don't know much about the opportunities in the sector. Job opportunities are there not only in government sectors and policymaking agencies, but also in businesses dealing with agricultural inputs, research and education, national banks and government departments".

Moreover, Gujarat has focused mostly on boosting output and emphasizing the monoculture of cash crops. No doubt, the production of cash crops, which resulted in the substantial performance witnessed in the agricultural sector, has been primarily driven by modern, technology-driven agricultural practices and increased irrigation (ICAR 1968). However, protecting the environment and ensuring rapid agricultural expansion in the state can only be achieved through the use of integrated fertilizer management and water-efficient agricultural practices, such as the encouragement of multiple cropping (JAU 2022). In order to achieve resilience against climate change and environmental factors, sustainable technology-based solutions also need to be adopted (SDAU 2022).

Given that groundwater levels have declined in most areas of Gujarat over the past 20 years, efforts must be made to enhance the groundwater regime through recharging initiatives and to stop groundwater mining (CAZRI 2022). Recharge wells and checkdams have been prioritized for the management of rainwater and are examples of technological interventions and practices that have been shown to be helpful in water management. By allowing farmers to plant earlier and depend less on unreliable precipitation, water collection technologies have greatly increased crop yields (Makwana 2022).

Monoculture, heavy cropping and soil-unsuitable crops have also depleted Gujarat's micronutrients and organic matter. Gujarat's soil is still saline, with majority of the coastline regions, including Kutch, North Gujarat and Central Gujarat having saline soil (Soam & Raghuvanshi 2022). Some technological and management advancements that could enhance soil quality include structural soil conservation techniques like soil and stone-bunding and terracing in undulating terrain, agronomic approaches for soil and water conservation and management including minimal tillage, organic and inorganic fertilisers, grass strips and agro-forestry systems (MHRD 2022). However, via capacity-building programmes like *Krushi Mohatsav* in Gujarat, steps to preserve the soil have been implemented. The government also launched the Soil Health Card Program, which educates farmers about soil quality and suggests potential remedial actions. Unless effective soil conservation practices and suitable cropping patterns are adopted, it is unlikely that these programmes would yield sufficient dividends (Makwana 2022).

Promotion of crop cultivation appropriate with soil type, climate and irrigation water availability is necessary for the long-term viability of cropping patterns in Gujarat (The Hindu 2013). Expert comments from agronomists have to be considered while drawing up the list of crops that are best for the different agroclimatic zones, soil composition and water requirements to make agriculture sustainable (ICAR 2022).

Conclusion

An important insight from Gujarat's experience is the importance that government spending on institutions and infrastructure has on agricultural growth (Sankaran & Mudaliar 1997). State policies have no doubt made it easier for domestic private seed enterprises and multinational corporations to operate successfully within the system (IARI 2022). However, other related areas which need improvement include increasing budgetary allocations to the agricultural universities in the state, filling up vacant faculty positions in the universities and ensuring greater autonomy or flexibility for agricultural institutions to prevent bureaucratic delays pertaining to research and extension activities (NAHEP 2022). A strong commitment to boosting enrollment in agricultural education, adoption of technologies, which are relevant to the local context and augmenting the reach and quality of extension activities in remote areas will no doubt lead the state to the path of sustainable development in agriculture (GoI 2022).

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