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Needs and Challenges of Smart Agriculture and Entrepreneurship Education – A Case Study by the University of Agricultural Sciences, Dharwad, Karnataka, India

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Abstract. India has a history of more than 100 years of organised teaching, research and development of agriculture, and has grown from few teaching and research institutes at the beginning of 20th century to one of the most productive, vibrant and advanced agricultural systems in the world. Agriculture plays a vital role in the Indian economy and contributes 17.4 per cent to the country's GDP. Government of India has launched several programmes for sustainable development and the state of Karnataka now aspires to be the national hub for smart agriculture. The University of Agricultural Sciences, Dharwad (UASD) has been exploring the possibility of establishing the Centre of Excellence in smart agriculture with the objective of skilling, re-skilling and up-skilling agriculture graduates, and to provide industry-ready man power and to educate farmers through the use of ICT. The university has been a pioneer in imparting quality agriculture education, and has introduced digital technology in several domains. A thrust has been given to areas such as agri-informatics in precision agriculture, conservation agriculture, mechanisation, use of robotics, drone technology, artificial intelligence, machine learning, cloud computing, trade and market intelligence, weather forecast and developing suitable agri-web-portals. The role of agri-business and agricultural entrepreneurship is critical in the overall economy of many developing countries. UASD is implementing a World Bank funded Institution Development Plan (IDP) under National Agriculture Higher Education Project (NAHEP) which has a prime objective of developing entrepreneurship and promoting start-ups. The UASD is utilising digital technology in order to empower students, staff and farmers in future digital agriculture and allied sectors.

Keywords: Smart agriculture, entrepreneurship, start-up, higher education, digital transformation

1 Introduction

India has a history of more than 100 years of organised teaching, research and development of agriculture and has grown from few teaching and research institutes at the

beginning of 20th century to one of the most productive, vibrant and advanced agricultural systems in the world. Starting with only 17 Agricultural, three Veterinary and one Agri. Engineering colleges in 1950, now the country has 63 State Agricultural Universities (SAU), four Deemed Universities (DU), three Central Agricultural Universities (CAU) and four Central Universities with more than 400 constituent colleges, and intake capacity has risen from less than 5,000 to more than 50,000. The Indian Council of Agricultural Research (ICAR) - SAU Model has been quite successful and adopted in many Asian and African countries. The Government has made substantial investment for development of research capacity within the ICAR and SAUs. ICAR has provided leadership, resources and environment for development of a pluralistic system, and also facilitated partnership with international organisations which paid rich dividends in terms of making the country self-sufficient in food production, diversifying production and reducing rural poverty.

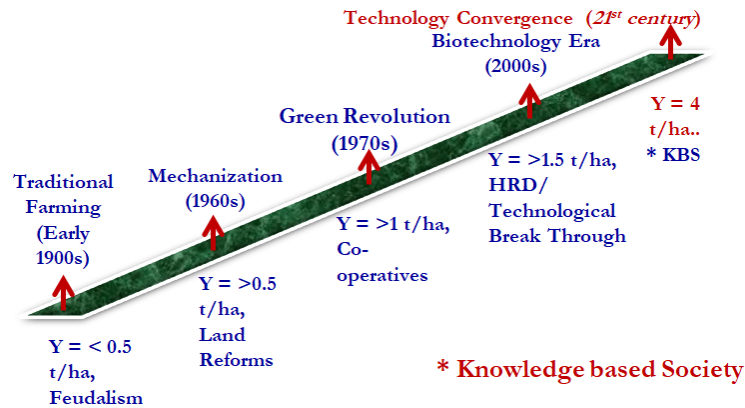


Fig. 1. Distinct Transitions: History of Agriculture.

India has achieved a significant improvement in the productivity of food grains from the level of 0.5 t/ha in 1900 to 4 tones /ha in 2021. This was made possible due to several interventions such as mechanisation in the 1960s, followed by a green revolution (1970s) and biotechnology in 2000 (Fig. 1). The Indian Council of Agricultural Research (ICAR) - SAU Model has been quite successful, and was adopted in many Asian and African countries. The Government has made substantial investment for development of research capacity within the ICAR and SAUs. ICAR has provided leadership, resources and environment for the development of a pluralistic system, and also facilitated partnership with international organisations which paid rich dividends in terms of making the country self-sufficient in food production, diversifying production and reducing rural poverty.

ICAR is the nodal agency for Research and Development and the Agriculture Minister of Government of India is the President. The Director General and Secretary DARE (Directorate of Agricultural Research and Education) is the executive head. It

has seven divisions, namely natural resource management, crop science, horticulture science, animal science, fisheries science, agriculture education, agricultural engineering and agricultural extension. It has research centers on different crops located in different agro climatic zones of India.

National Agriculture Research Education System (NARS) is one of the largest in the World. In addition to universities and colleges, it has 101 ICAR institutes, 79 All India coordinated research projects (AICRP) and 721 Krishi Vignan Kendras (Farm Science centers) (Fig. 2). The widely spread and specific NARS system established strong linkage with research, extension and the education systems in India. AICRP and KVK are part of State Agriculture Universities, ICAR closely linked with all State Agricultural Universities (SAU).



Fig. 2. National Agriculture Research Education System.

Several new initiatives have been introduced in the education system in India that includes, implementation of fifth Deans Committee Recommendations with a focus on Experiential Learning and student READY (Rural Entrepreneurship Awareness and Development Yojana) programmes, apart from including several new courses in emerging areas of Science and Technology. This has brought a major qualitative and quantitative impact in the teaching and learning process.

Some consider entrepreneurship as a very specific occupation, related to Schumpeter's creative as a key driver of economic growth and job creation [2]. This is also the most common reason [3] why researchers and experts promote entrepreneurship education. Lingelbach [4] suggested that, "Yet, entrepreneurship in developing countries is arguably the least studied significant economic and social phenomenon in the world today."

Higher education in India is well established, and caters to the needs of a growing population. Some of the facts about higher education in India include, 993 Universities, and under these universities there are 39,931 colleges affiliated to them. In addition, there are 10,725 standalone institutions. Total enrolment of students in higher education is 37.4 million (19.2 million male & 18.2 million female), out of which 79.8% study in

undergraduate degree programmes (maximum in B.A., B.Sc., B.Com.). There are only 0.5% (1,69,710) in doctoral programmes (PhD) mostly in science, followed by engineering and technology.

2 Key Challenges and Policies for Higher Agricultural Education

There are needs to balance elements in the higher agricultural education, that includes balancing tradition and change, building universities as innovation hubs, improving leadership in universities – learning lessons of strategic management from the best in business, and the role of online learning in reforming India’s education system.

The present strategy is to align the agricultural education system in tune with the National Education Policy (NEP) – 2020 of Govt. of India [1]. The national education policy 2020 is distinct and broad-based and gives choices to the students to pursue their interest, and to excel in the area of their interest apart from giving a thrust to skill acquisition. The NEP 2020 vision is to enhance the Gross Enrolment Ratio (GER) of higher education to reach at least 50% by 2035. The present GER is 26.8 % as compared to USA (86.7%), Germany (65.5%), and China (39.4%).

NEP 2020 includes many features listed below:

- 1) It emphasises large, multidisciplinary universities and colleges.
- 2) Liberal and flexible undergraduate programmes.
- 3) Faculty and institutional autonomy.
- 4) National Research Foundation.
- 5) Better regulatory system.
- 6) Expansion and improvement of new architecture, research universities, teaching.
- 7) Universities and colleges; degree by granting powers to them.
- 8) Overall changes from school level to faculty upgradation.

Several policy initiatives are taken in enhancing industry-academia linkage, Alumni network, dual degree programmes, and specialised courses for entrepreneurship, skill and personality development. The visibility of Indian universities is enhanced through attracting international students mainly from African and Asian countries. To enhance faculty competence, both ICAR and State Governments are encouraging training programmes both at national and international level in cutting-edge technologies. UASD is in the forefront in establishing entrepreneurial and start up eco systems. Important ones are listed below:

- 1) Encouraging startup culture through funding from RKVY-RAFTAAR of the Government of India, ICAR-NAHEP of the World Bank.
- 2) Biotechnology Industry Research Assistance Council (BIRAC) of the Department of Biotechnology, the Government of India.
- 3) Karnataka Innovation and Technology Society (KITS) from the Government of Karnataka.

With the implementation of new policies, there is likely to be enhancement in Gross Enrollment Ratio (GER) in higher education, which eventually may lead to India becoming a USD 5 trillion economy by 2025. apart from sustaining Gross Domestic Product (GDP) growth rate.

The development and usage of a Smart Agriculture system based on artificial intelligence and machine learning is changing the agriculture sector by not only improving the crop production, but also making it cost effective. Recognising the importance of artificial intelligence (AI), the National Institution for Transforming India (NITI) Aayog initiated a National Programme on AI, with a view to guiding research and development in new and emerging technologies. Considering the growing acceptance of farmers for the internet and mobile based services, the Indian Council of Agriculture Research (ICAR) made an attempt to provide valuable agro-met information to the users through web portal (Crop Weather Outlook) which provides ‘Value Added Agro-advisory Reports’. University of Agricultural Sciences (UAS) Dharwad has excelled in the area of smart agriculture and entrepreneurship development. The University stands in the 9th rank at national level and first in the state.

3 Agriculture Education and Careers

The role of agricultural education is to provide improved, relevant and effective teaching [5]. Nawaz, [6] referred to the lack of business education in agriculture, and Knudson [7] confirmed that agricultural entrepreneurship is at an early stage of development. Inadequate education and training as well as technological know-how make small businesses less competitive and more vulnerable to the economic downturn [8]. Agricultural education as under-graduation and post-graduation is available to the students in State Agricultural Universities (SAU) as well as Central Universities (CU). The students seeking admission for under-graduation programmes must have studied two years of pre-university course (PUC). There are total of 71 Agricultural Universities in India spread in different states. The respective state conducts a Combined Entrance Test (CET) for the students, and selects the students based on the merit of both their regular exam and the marks obtained in the CET. Universities follow guidelines of the state government with respect to the quota/reservation of seats for different categories such as a Scheduled Caste (SC), Scheduled Tribes (ST) and otherclasses. The Undergraduate course of BSc. Agriculture, Horticulture, Sericulture etc., are for the period of four years. During the last decade, the competition for admission to agricultural courses has increased due to more job opportunities in government and private sectors.

Students join the course with different aspirations and aspire for a job such as an appointment in government organisations, universities, and jobs in banks.

Table 1. Placements of graduates of UAS Dharwad, during 2008 to 2018.

Sl. No	Career Working Field	Number	Percentage
1	Government Jobs	300	37

2	Private	393	49
3	Bank	33	4
4	Entrepreneurs	60	8
5	Farming	20	2

The analysis of the data of the passed-out students from 2008 to 2018 reveal that, 49 % of the students secured job in private sector followed by government jobs (37%), banks (4%). Only 8% choose to become entrepreneurs, and 2% opted for farming (Table 1 and Fig. 3).

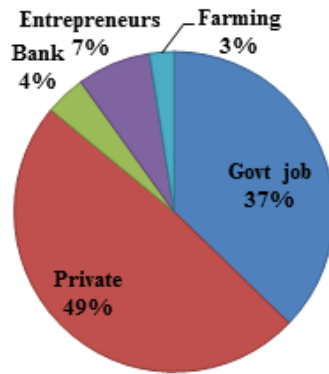


Fig. 3. Placements of graduates of UAS Dharwad during last 10 years.

It clearly indicates that students are more oriented towards the Government or a private job, rather than starting their own enterprise.

4 Smart Agriculture Initiatives at UAS Dharwad

Agriculture plays a vital role in the Indian economy and contributes 17.4 per cent to the country's GDP. The Government of India has launched several programmes for sustainable development and state of Karnataka now aspires to be the national hub for smart agriculture. The University of Agricultural Sciences, Dharwad, has been exploring the possibility of establishing the Centre of Excellence in smart agriculture, with the objectives of skilling, re-skilling and up-skilling agriculture graduates, thus providing industry with ready manpower, to educate farmers through the use of ICT. The university has been a pioneer in imparting quality agriculture education, and has introduced digital technology in several domains. The thrust has been given to agri-informatics in precision agriculture, conservation agriculture, mechanisation, use of robotics, drone technology, artificial intelligence, machine learning, cloud computing, trade and market intelligence, weather forecasting, and developing suitable agri-web-portals.. Efforts have been made in implementing an Academic Management System

(AMS), a Human Resource Management System (HRMS), a Public Finance Management System (PFMS), and other web portals in daily activities of the university. Farmers are educated through university-owned FM radio, sending updated information on weather, outbreak of pest and diseases, and timely management practices through mobile apps and SMS.

In view of the COVID-19 pandemic during 2020, on line classes and on-line examinations have become regular phenomena. To facilitate the students in better learning, all the course contents are digitised and uploaded on the university website. The proposed Centre of Excellence in Smart Agriculture will have training modules for agriculture informatics, simulations, agriculture equipment design and modifications, machine learning and imaging. It is also proposed to create the digital assets, develop Virtual Learning (VR) ready contents, and develop 3-D contents on advanced/smart agri-technologies. which will provide a wonderful learning experience not only for the students, but also for the farmers.

An agri-war-room called Raith Chetan (farmers' helpline) has been established to help the farmers not only by educating them, on-line, on cultivation practices but also on marketing of the produce like the e-National Agriculture Market (e-NAM) by which several thousand farmers have benefited during the lockdown period. GIS technology has been profusely utilised in soil resource mapping, nutrient mapping, land suitability evaluation for different crops, crop coverage, identifying water-logged and saline areas, watershed characterisation and planning, land and land capability classification. UAS, Dharwad has taken initiatives in the setting up of a GIS lab and remote sensing facilities through which early warnings and forecasting of weather, pest and disease incidence and crop coverage are being monitored.

Facilities are also created for an Automatic Smart Irrigation Decision Support System (SIDSS) to educate the farmers in effective water management. Watershed delineation, mapping soil resources, land capability and crop suitability, identification of water logged and saline prone areas, flood-mapping, land use and land cover, nutrient mapping for precision agriculture are being done at UAS, Dharwad. Algorithms are being developed for disease-forecasting, nutrient management, precision water management and sensor-based irrigation scheduling in association with Indian Institute of Technology (IIT), Dharwad and Fourth Paradigm Institute, Bengaluru.

Farmers are being trained to use the National Agriculture Market (e-NAM), an online trading platform for agricultural commodities set up by the Government of India. The market linkage is a must for agriculture, and to realise these, models on price forecasting for different commodities are developed by the University. Efforts are being made to develop drones for the spraying of chemicals and also to monitor crop health status. Efforts are also being made in establishing a Centre of Excellence in Smart Agriculture with a view to skill, reskill and upskill agriculture graduates, providing industry-ready manpower and information to educate farmers in smart agricultural technologies at UAS, Dharwad.

5 Entrepreneurship Development Initiatives at UAS Dharwad

5.1 Course on Entrepreneurship Development in Undergraduate (UG)

The fifth Dean's Committee of Indian Council of Agricultural Research (ICAR) has introduced entrepreneurship development related courses as a mandatory course with two credits in all degree programmes. This was one of the important changes brought by the orientation of the education system with the introduction of exclusive courses in Entrepreneurship development, with 2 credit hours for undergraduate students.

The course curriculum includes topics, for example the concept of entrepreneurship, project identification, management, supporting institutions and Government schemes. Students visit different institutes, and entrepreneurship is a part of their practical classes. During the final year, Student READY (Rural Entrepreneurship Awareness and Development Yojana) is offered, which includes placement of students at the grass-roots level unit of the Agriculture Department called by name Raita Samparka Kendra (farmers' contact centre) for eight weeks, to understand the agricultural ecosystem in rural areas and the practices adopted by the farmers.

After eight weeks, they would undergo two weeks of internship in the Agri-Clinic, where they conduct diagnosis of soil / plants followed by five weeks of institutional attachment and two weeks of Industrial attachment. The institutional attachment includes placement in Krishi Vignana Kendra (KVK), Agricultural Research Stations (ARS), horticulture or seed farm and processing plants.

Thus, the programme of 20 credit hours provides an opportunity to learn in the field, and develop feasible enterprises, and the programme is called student READY. During the second semester, students undergo experiential learning modules in five different subject-matter areas (Fig. 4).

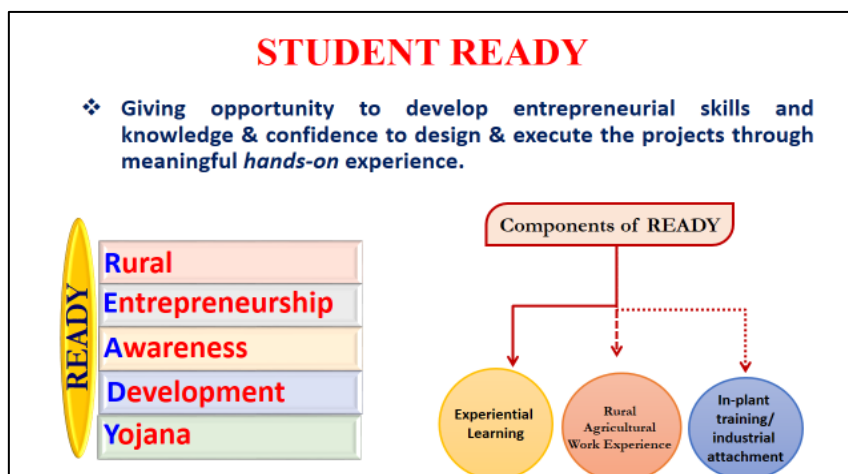


Fig. 4. Curriculum transition with the thrust on hands-on experience and entrepreneurship.

5.2 EDP and Ideation (Ideathon) Workshops

The role of agri-business and agricultural entrepreneurship is critical in the overall economy of many developing countries. Agri-business represents perhaps half of the Gross Domestic Product (GDP) in many countries and over 2.5 billion people in these countries depend on agriculture for their survival [9].

UASD is implementing the World Bank funded Institution Development Plan (IDP) under National Agriculture Higher Education Project (NAHEP) which has a prime objective of developing entrepreneurship and promoting start-ups. Under the project, six EDP programmes covering 1688 students have been conducted during 2019-21.

Table 2. EDP conducted under NAHEP-IDP during 2020-21.

Particulars	Training or Workshop	Percentage
Total programmes	6	-
Total participants	1,688	-
SC and ST participants	292	17
SC and ST Girls	122	7
General Girls	644	38

It was observed that the participation of girls was on a par with boys, and care was taken to ensure participation of special category students namely schedule caste and schedule tribes (Table 2 and Fig. 5). In addition, sixteen webinars on opportunities in entrepreneurship development was conducted and benefitted 2,593 students.

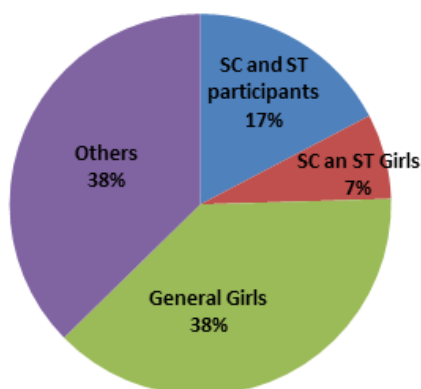


Fig. 5. Representation of different category participants in Ideathon workshop.

Another project called RAFTAAR (Remunerative Approaches for Agriculture and Allied Sector Rejuvenation) promotes Agribusiness incubator. It has promoted over 20 startups in agriculture and allied areas. A Section 8 Company, ASTRA (Association for Startup and Technology Refinement in Agriculture) has been established to support entrepreneurship and start-ups by students. Efforts are being made to establish close linkage with industries, as well as alumni entrepreneurs, to strengthen the endeavor of entrepreneurship development in agriculture.

5.3 Incubation Centre

Under the flagship programme of Karnataka Innovation and Technology Society (KITS), Department of Information Technology (IT), Biotechnology (BT) and Science and Technology (ST), Government of Karnataka, the incubation centre with common instrumentation facility was established at the University of Agricultural Sciences, Dharwad for promoting the innovation in agriculture and biotechnology, with a grant of 60 million rupees (approximately 716,000 Euro). Since the inception of the project, several workshops/conferences were organised to develop skill enhancement.

The state government's novel initiative, New Agriculture Incubation Network (NAIN), was established under the Karnataka Start-up Policy for 2015-20 by the Department of Information Technology, Bio-Technology, Science and Technology to encourage students, research scholars and alumni to share their ideas, to solve chosen local problems, and to validate, refine and nurture ideas, provide an ecosystem to convert ideas into proofs of concept, and convert them into minimum viable products/services, and encourage and lead the teams towards setting up a business enterprise.

6 Conclusion

The University of Agricultural Sciences, Dharwad has been exploring the possibility of establishing the Centre of Excellence in smart agriculture with the objectives of skilling, re-skilling and up-skilling agriculture graduates, thus providing industry-ready manpower, educating farmers through the use of ICT. The UAS Dharwad has been a pioneer in imparting quality agriculture education, and has introduced digital technology in several domains in order to digitally empower students, staff and farmers for digitally-enabled future agriculture, and allied sectors.

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