

A Conceptual Framework for Technology Adoption towards Sustainability in Agro Based Industry

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Abstract: Agribusiness involves the efficient transformation of agricultural raw materials into final products with proper adoption of technologies providing form utility to the products. Eventually with time agribusiness has become more industrialized, competitive and technological in nature. The main purpose of this paper is to study the adoption of technology for sustaining agro-based industries and identifying the constructs for the development of a conceptual framework. Through extensive literature search the authors first identified diverse constructs like market demand, awareness, cost, social media and others in relation to technology adoption for sustainability of agro-based industry. These constructs were further discussed in details to formulate the conceptual framework for technology adoption. Although limited to technology adoption in agribusiness sector but the originality of this study underpins the proper identification of upcoming or new technologies for adoption in agribusiness thereby making it more sustainable.

Keywords: Agro-based industry, Conceptual framework, Economy, Sustainability, Technology adoption.

I. INTRODUCTION

Agribusiness involves the transformation of agricultural raw materials into final product in an efficient manner with proper adoption of technologies providing form utility to the products. Processing or transformation of agricultural raw materials is very important since most of the agricultural raw materials are perishable in nature and the process of transformation helps to increase the shelf-life of the products making it easier to store, handle and transport. The agro based industry constitutes of paper, beverages, food, clothing, printing, tobacco, textiles and rubber [1]. The growing competition has led to increase in adoption of technologies among farmers and agribusiness sector. It has been found that a large number of agro processing industries are spread across the country for transformation of these products into some final product which provides form utility. India is well known for agro based industries like sugar industry, tea, coffee, gur (jaggery), cashew nuts industries to name a few. These industries have a high demand for the adoption of technologies and their implication [2]. Agribusiness with time has become more industrialized, competitive and technological [3]. In the present era, the agribusiness supply chain comprising of producer, processing industry, wholesaler, distributor and retailers are linked with some technology infrastructure in one or the other way. Internet has been found as the most cost effective means for connecting the agribusiness supply chain [4]. Literature clearly shows that technology adoption plays an important role in developing a sustainable agro based industry. The authors in the present paper attempts to undertake the following objectives: (i) To study the adoption of technology for sustaining

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agro-based industry; (ii) to develop a conceptual framework for technology adoption for sustainable agro based industry from extensive literature review; and (iii) to discuss the constructs in the framework.

Agribusiness and Technology Adoption

Agribusiness industry covers wide range of products and services extending from bulk products to consumer goods [5]. Main Agro based industries spread across the states of India are cotton textile, woollen, sugar, tea, coffee and sugar. According to the Department of Agriculture and Corporation, India is the largest producer of millet, dry bean, chick pea, cumin, ginger, turmeric, chilli pepper, banana, mango, papaya, milk and pulses and second largest producer of wheat, onion, garlic, cabbage, sugarcane, cauliflower, brinjal, potato, broccoli, pepper, cotton, jute, silk, rice, fruits and vegetables. 70% of the total GDP comes either from agriculture or from agro based industry [6]. In order to cease the perishability of agricultural products they are processed into different by-product's by agro-based industries. Such industries make the agricultural products easier for storage, handling and transportation increasing the shelf life of the product. In the transformation of the raw material to final products, significant amount of waste and energy is generated which can be reduced, recycled recovered or reutilized in suitable form. Being an agriculture country and with continuous increase in the agriculture production, India has solid foundation of agro based and agro processing industries. Agro-processing includes all those activities and technologies that are essential and carried out for handling agricultural products and to provide form utility to the agriculture products. Processing of agricultural products has two main functions- one is to make food more digestible and other to stock food in times when it is not readily available. These are divided into two segments namely primary processed products and value added processed food. The primary processed food constitutes tea, coffee, spices, salt, rice, fruits and vegetables, processed marine products, beverages and chocolate, while the value added processed food include processed dairy products like ghee, cheese and butter. Over the years the agro processing industries have grown significantly due to increase in demand of processed food. This not only generated employment and enhanced the socio-economic status of people but it also led to new concepts like packaging, grading, sorting and labelling in this sector. Innovations in technology have been increasing day to day which has led the agribusiness practices grow in an efficient manner. The adoption of technology is influenced by several factors like their adoption, awareness, attitude, location factors and knowledge [2]. Information and communication technology, biotechnology and nanotechnology are the important aspects of technologies in industries. Nanotechnology being relatively new technology was first explored in the agriculture sector in 21st century.

Opara (2004) observed that sustainable economic developments of agro based industries are dependent upon the technologies and their innovations [7]. This has led to installation of several machineries and equipment like processing, high pressure, pulsed light, biological preservation, dehydration, freeze drying, Micro wave drying, Chilling, Freezing, Chromatography, Emulsification, Extrusion, Gelation, Frying, Nano technology, Biotechnology, Gene bank, Grain

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gene, Ark db, Hap map project and Microbial advance database. New technologies have led to an efficient and new pattern of flow of resources and energy in an industry making it sustainable [8]. In the recent past, implications of these technologies have made a drastic improvement in agro based sector thereby making agriculture sector a better one [9]. It is known that there are three alternative means of technology adoption in agribusiness sector namely, transfers of technology, participatory action research and lastly industry led technologies [10]. The transfer of technology comprises of the technologies developed by the researchers and adopted by the farmers. Industry led technology development is a modified form of the transfer of technology which is driven by people with resources. This form of technology adoption comprises of technical knowledge and services. Participatory action research contributes to different types of knowledge and skills involved in the process of technology implementation. It also leads to simplify the complex technologies enabling sustainability in agriculture. Former Indian Prime Minister Atal Bihari Vajpayee in his document ‘Technology Vision 2020’ have explored the measures for making the country self-reliant with technology in agriculture and making the country a developing economy”.

Conceptual Framework for Technology Adoption in Agribusiness Sector

With the development science and technology, on one hand the use of technologies have made the overall agriculture processing and produces easier, on the flip side these agro businesses is generating considerable amount of waste by-products and energy that goes unutilised. In order to make the agribusiness sector sustainable there is dire need for these wastes or by-products to convert them into value added products by way of recycling or recovery thereby making the agro based sector truly sustainable [11]. The strategy for optimum technology adoption must be utilized in the agro-based industries for attaining sustainability [12]. The application of technology is driven by several factors like market demand, economies of scale, competition and network flow [13]. Based on the extensive literature following constructs were identified for developing a conceptual framework which leads to technology adoption as shown in Fig. 1.

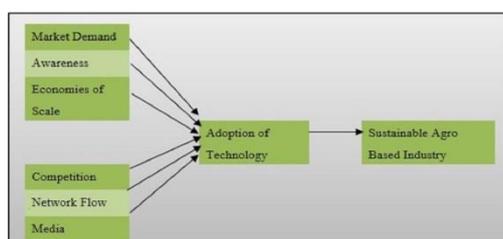


Fig. 1. A conceptual framework for adoption of technologies for a sustainable agro based underlying in the literature review.

Market demand: The rise in demand of the products in the market leads to increase the supplying tendency [14,15]. This requires an efficient implementation of technology for fulfilling the market demand as there is immense demand

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for agro based industrial products in the market. Cotton, sugar, tea, coffee, silk, jute, paper and other industries are well known in India for their products. The population of the country is dependent on agro based industry for basic as well as other needs. The market demand for the agro based products are at a boom in the present era.

Awareness: This is an important driver for sustainability. It is very essential for the industries to be aware about the efficient technologies that should be used within the industry. Awareness about the technologies will only lead to availability, accessibility and acceptability of the technologies which are the 'three A's' commonly known as the energy drivers [16].

Economies of scale: This has to be taken into consideration before the implementation of any technology in order to maximize the output with an optimum use of input. Economies of scale mean to carry out things in efficient manner with high speed and size of the operations so that the output can be maximized within short period of time. Basically, it is an advantage to cost per unit of output [17].

Competition: Competition among local or regional industries and competition in national and international market leads to the adoption of right technology [15]. Because of high degree of awareness, consumers do not compromise with the quality of the products. Therefore, the industries have to fulfil the required needs of the customers at each stage to remain in maturity period of business life cycle. Innovative technologies are thus crucial for sustaining growth in competitive environment [18].

Network: The products in industries flow in a certain network and to happen this in smooth manner, efficient applications of technologies are needed [15]. The flow of network is also known as the flow of transportation of materials from one edge to another for further processing so that the output can be obtained. This is one of the major issues in the industries because the finalization of products requires immense network and linkages. In order to save time, energy and cost, adoption of efficient technologies be implemented [19].

Media: Media has become a very important source of flow of information and communication. Media has helped the farmers to replace the traditional methods with the modern and efficient technology for sustaining their growth [12]. Agro based websites are very helpful to build the chain of useful information. There are a few technologies that are beneficial for both the farmers as well as the agro based industry. Social media explores the use of technology as a tool which leads to enhance their adoption [20]. Barnes and Jacobsen conducted a survey and concluded that about 83% of the industries involved in social media have adopted technologies to enhance the growth of their business [21]. It has been observed that the farmers those listening radio programs adopted modern varieties leading to increase productivity.

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Radio programs, newspapers, television news and social media have increased the adoption of improved agriculture technology [22].

Adoption of technology: With time in agribusiness sector, technologies have been changing, upgraded or improved upon consistently on various sustainability fronts [23]. The key technologies being employed in agro based industries include - thermal processing, aseptic processing, minimal processing technology, enzymatic processing ionizing radiation, ultra high pressure, pulsed light, biological preservation, dehydration, freeze drying, Micro wave drying, Concentration, Hurdle technology, Micro wave heating, Vacuum cooling, Chilling, Freezing, Chromatography, Microencapsulation, Emulsification, Extrusion, Gelation, Frying, Nano technology, Biotechnology, Active packaging, Smart packaging, Modified air force packaging, Cold storage, Robotics, Gene bank, Grain gene, Ark db, Hap map project, Microbial advance database, Genome mapping, Oliv track, Data bank, Intelligent packaging, Machines, Equipments, Management information system, waste management processes and Geographic information system. The use of technology in industries is limited which is the major cause of unsustainability [24].

Sustainability of agro based industry: Sustainability of agro based industry is a well-known term which constitutes of economic, environmental and social parameters. The efficient application of technology and other technologies can be made only if the technology is adopted for sustainability or in other words it is maintaining a balance between the economic, social and environmental perspective. The economic sustainability is defined as the cost benefits and optimization of inputs for maximizing the output or profit. Environment aspect means reduction of greenhouse gases, minimization of carbon dioxide and reduction of pollution. Social aspect pertains to employment and social benefits [25].

II. CONCLUSION

In the 21st century, it is very imperative for agribusinesses to have complete knowledge and support to attain sustainability; however, it has major challenges [26]. The foremost being to identify the right technology that could be best applied for smooth and sustainable operations. In this regard, technology literacy will play a key role in agribusiness sector and would therefore be of high value for marketing managers. Secondly, technology largely influences the productivity and market growth of food industries [27]. In this case, information technology would simplify the overall complexity in tracking the products thus leading to sustainability of the production system. Beckman and Sinha argues that high technology firms recognize that consumer not only go for high value of the products but also for the high service providers [28]. Thus, the development of new technologies leads to adoption processes enhancing the economic growth. Due to the introduction of new technologies, it is very essential to build a timely and implementation strategy for the high technology industry in order to make their practices sustainable [29]. High technology firms when invest in dynamic capability for production, marketing and research development with

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high level of competition leads to have better performance. The technology adoption in agro based industry may lead to sustainability of agro based industry as shown through the conceptual model. The proposed conceptual model has to be empirically validated further for linking technologies for obtaining a sustainable agro based industry.

REFERENCES

- [1] FAO, "The State of Food and Agriculture 1997". FAO Agriculture Series No. 30, Rome, 1997.
- [2] S. Ernst, M. Tucker, "Perceptions and adoption of information technologies: Implications for Ohio's produce industry in the new economy", The Ohio State University, Division of Agricultural, Environmental, and Development Economics, Working Paper Series, 2001.
- [3] E. De Oliveira Wilk, JE. Fensterseifer, "Towards a national agribusiness system: A conceptual framework", International Food and Agribusiness Management Review, Vol.6, no.2, 2003.
- [4] L. Spinosa, A. Klen, R. Rabelo, L. Camarina-Matos, A. Ferreira, "Towards an open platform for Systems", Wageningen Academic Publishers, Wageningen, pp. 245-292, 1999.
- [5] PL. Kennedy, RW. Harrison, NG. Kalaitzandonakes, HC. Peterson, RP. Rindfuss, "Perspectives on evaluating competitiveness in agribusiness industries", Agribusiness, Vol. 13, no.4, pp. 385-392, 1997.
- [6] B. Lonia, "Studies in techno economic aspects of power generation from agriwaste in India", Thapar University Digital Repository, 2006.
- [7] L. Opara, "Emerging technological innovation triad for smart agriculture in the 21st century", 2004.
- [8] D. Giurco, A. Bossilkov, J. Patterson, A. Kazaglis, "Developing industrial water reuse synergies in Port Melbourne: cost effectiveness, barriers and opportunities". Journal of Cleaner Production, Vol. 19, no.8, pp. 867-876, 2011.
- [9] TW. Schultz, "Transforming Traditional Agriculture. Yale University Press, New Haven, CT SCM in the Agribusiness Sector. European Esprit PRODNET II project", American Journal of Agriculture Economics, Vol. 70, no.1, 1964.
- [10] LS. Lev, DG. Acker, "Alternative approaches to technology development and adoption in agriculture", Journal of International Agricultural and Extension Education, Vol.1, no.1, 1994.
- [11] R. Frosch, N. Gallopoulos, "Strategies for manufacturing", Scientific American, Vol.261, pp. 94-102, 1989.
- [12] FA. Abdullah, BA. Samah, "Factors Impinging Farmers' Use of Agriculture Technology", Asian Social Science, Vol. 9, no.3, pp.120, 2013.
- [13] AC. Brent, S. Oelofse, L. Godfrey, "Advancing the concepts of industrial ecology in South African institutions: science policy", South African Journal of Science, Vol. 104, no.1-2, pp.9-12, 2008.
- [14] Jacobs, Kees, "2016: the future value chain", OECD Conference the food economy: Global Issues and Challenges', Den Haag Netherlands, 18-19 October 2007, 2007.
- [15] JGAJ. vander Vorst, AJM. Beulens, P. Van Beek, "Innovations in logistics and ICT in food supply chain networks", Innovation in Agri-Food, 2005.
- [16] P. Vithayasrichareon, IF. MacGill, T. Nakawiro, "Assessing the sustainability challenges for electricity industries in ASEAN newly industrialising countries", Renewable and Sustainable Energy Reviews, Vol. 16, no. 4, pp. 2217-2233, 2012.
- [17] CW. Sealey, JT. Lindley, "Inputs, outputs, and a theory of production and cost at depository financial institutions", The Journal of Finance, Vol. 32, no.4, pp. 1251-1266, 1977.
- [18] GM. Grossman, E. Helpman, "Endogenous innovation in the theory of growth (No. w4527)", National Bureau of Economic Research, 1993.
- [19] RG. Newell, AB. Jaffe, RN. Stavins, "The induced innovation hypothesis and energy-saving technological change (No. w6437)", National Bureau of Economic Research, 1998.
- [20] T. Hussain, "Influence of Facebook in Pakistani Pedagogy", Media Watch, 326.
- [21] NG. Barnes, S. Jacobsen, "Adoption of social media by fast-growing companies: Innovation among the Inc. 500", Journal of Marketing Development and Competitiveness, Vol. 7, no.1, pp.11, 2013.
- [22] DY. Alia, T. Nakelse, A. Diagne, "Rural media, agricultural technology adoption and productivity: evidences from small rice farmers in Burkina Faso", In 2013 AAAE Fourth International Conference, September 22-25, 2013, Hammamet, Tunisia (No. 160674). African Association of Agricultural Economists (AAAE), 2013.
- [23] S. Lall, "Technological change and industrialization in the Asian newly industrializing economies: achievements and challenges", Technology, learning, & innovation: Experiences of newly industrializing economies, pp.13-68, 2000.
- [24] Kumari, Sneha, Patil, Yogesh "Achieving Climate Smart Agriculture with a Sustainable Use of Water: A Conceptual Framework for Sustaining the Use of Water for Agriculture in the Era of Climate Change", In: Reconsidering the Impact of Climate Change on Global Water Supply, Use, and Management (Edn. Prakash Rao & Yogesh Patil), IGI Global Inc., USA, pp. 124-146, 2016.
- [25] G. Chicco, P. Mancarella, "Distributed multi-generation: a comprehensive view", Renewable and Sustainable Energy Reviews, Vol.13, no.3, pp. 535-551, 2009.
- [26] AJ. Alston, WW. Miller, DL. Williams, "The future role of instructional technology in agricultural education in North Carolina and Virginia", Journal of Agricultural Education, Vol. 44, no.2, pp. 38-49, 2003.
- [27] J. Labrecque, S. Charlebois, E. Spiers, "Can genetically modified foods be considered as a dominant design? An actor-network theory investigation of gene technology in agribusiness" British Food Journal, Vol. 109, no. 1, pp. 81-98, 2007.
- [28] S. Beckman, KK. Sinha, "Conducting academic research with an industry focus: Production and operations management in the high tech industry", Production and Operations Management, Vol. 14, no.2, pp. 115, 2005.
- [29] H. Yasuda, "Formation of strategic alliances in high-technology industries: comparative study of the resource-based theory and the transaction-cost theory", Technovation, Vol. 25, no.7, pp. 763-770, 2005.