Adaptation of Digital and Physical Innovation in Agriculture with Special Reference to Academicians

K.Ramesh, Violet Glady.P

Abstract: Change is permanent in any area of business and every other sector. Digital transformations in agriculture sector stimulate to the growth and development in agriculture and to the economy at large. Digital innovation in agriculture is an inevitable concept to attain maximum output and yield that reduces the loss arising out of poor cultivation techniques. In India agriculture provides livelihood for about 60% of the population, among this population majority of them are small-scale farmers of which agriculture subsidies are majorly used by large-scale and medium-scale farmer. The unequal distribution of subsidies to farmer is one of the major causes for farmer's suicides in India which recorded for at least 10 per day as of 2017 and 2018 record. This situation can be combated by proper distribution of subsidy and by shifting cultivation methods and technique in nation at large. Indian farmers can attain profitability, productivity and progress only by adapting to technological innovation in production. This paper is an attempt to bring out the needs for change in agriculture production techniques by which farmers can expect maximum profit and maximum yield. It also elaborates how digital and physical innovation helps farmer in attaining maximum yield in limited time incurring less cost. This paper takes into account primary data to justify that transformation in agriculture is mandate to attain growth and development in this current era.

Keywords: Agriculture Production, Digital Transformations, Physical Innovation, Technological Innovation,

I. INTRODUCTION

The current era is termed as digital era. Innovation play's a dominant role in any sphere of business, inclusive of agriculture sector that occupies the dominant proportion in Indian economy. Digital and physical innovations in agriculture ensure sustainable growth and development and promote agriculture to new heights. The complex nature of Indian agriculture were single policy change will not rise the income level of the small scale farmers, but digital transformation in agriculture ensure progress in this sector.

At world food event in 2018, the following panel members discussed on "Transforming Indian agriculture through digital innovation", that emphasis on income revolution in agriculture sector specifically to marginal farmers. The following are the member's discussion towards transformation in agriculture.[1]**Ashok Dalwani,** chairperson of Doubling Farmers' Income committee and CEO of the National Rainfed Area Authority for the Ministry of

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Agriculture and Farmers' welfare, Government of India, mentioned India's focus towards an "income revolution" in the agriculture sector [2]**Purvi Mehta,** Head of agriculture for Asia at the Bill & Melinda Gates Foundation, speaks how digital innovations are ensuring focus towards higher incomes for small scale farmers or marginal farmers. [3]**Rohtash Mal,** chairperson of EM3 Agri-Services, explains on challenges and questions on how these innovations will be monetized towards small scale farmers. [4]**Anil Jain,** managing director of Jain Irrigation, explains the need to pair digital innovation with physical infrastructure.

1.1 New Applications in Digital and Physical Innovations:

Various new methods of Digi-Tech are applied in agriculture in many developed countries. Effective application of fertilizers and pesticides pose a major challenge in agriculture. The various new digital techniques that can be used in India are as follows:

i) Crop Sensor:

The use of crop sensor enables farmers to effectively use fertilizers and pesticides just as much required for the available crops. Variable rate technology becomes useful in this case. Sensor technology helps to sense how the crop feel and subsequently help to reduce leaching. Crop sensors are designed to estimate the time and amount of fertilizers required for crop cultivation.

ii)GPS and GIS Technology

Though the use of GPS, GIS and Remote Sensing, information required for improving land and water can be collected. GPS is taking its root in agriculture. The modern agriculture put into use of GPS to document the nature and status of agriculture land. GPS enable to determine the yield from a given farm and helps in recording the information. Such information is useful for farmers to make any decision regarding cropping pattern. The acquired information through GPS gives the entire summary of the full one year in the form of yield map. Yield map is useful and give adequate information of the status of the drainage system in the field. GIS (Geographic Information System) application is playing a dominant role in agriculture, the computerised GIS technology anticipate the geographical data's such as manipulating, analyzing, capturing, storing and managing. Crop production becomes easier to farmers by applying GIS technology that increases production; reduce cost and helps in managing the land resources very efficiently. The geomatic technology enables farmers to map and project current and future fluctuations in precipitation, temperature and crop output.

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iii)E-Commerce and E-Extension Services

In recent year E-Commerce found its way in agriculture. E-Commerce refers to buying and selling between parties involved in both goods and services. It also enables online payment through electronic means and it is also called internet retailing. E-NAM (Electronic National Agriculture Market) in India constitutes a good example of e-commerce module in agriculture marketing. E-NAM involves B2B trade where general e-commerce involves B2C trade. E-Commerce and E-Extension service gives improvised platform to farmers to establish their marketing with less expense. Farmers can advertise their produces through online base and can meet the growing demand without any delay.

iv)Block Chain and Smart Contracts

Block chain techniques make food product and transactions traceable and auditable through supply chains by assigning different digital identifier. It is believed that smart contracts can vibrantly establish the claims processing system towards settlement of agricultural insurance. Block chain management also enables procurement tracking and managing agricultural finance.

v)Artificial Intelligence

Opting to AI System improves the harvest quality and accuracy and according to management expression it is termed as "precision agriculture". Precision agriculture technique trough the application of AI aid in detecting diseases in plants and detect the poor nutrition value of plants. Based on many research AI in agriculture appears in 3 main areas namely: agricultural robots, crop and soil monitoring and predictive analytics.

vi)Cloud Computing and Big Data Analysis

Cloud computing ensures agriculture industry to grow faster. Farmers can use cloud computing to predict the accuracy of demand and adjust the production pattern accordingly. Cloud computing can be used to obtain data by applying various tools like soil sensors, satellite images, and weather stations to help farmers to make better decision regarding crop management. The Cloud computing techniques enable farmers to decide on production management in agriculture. On other hand big data is used to predict farming operation, real-time operations decision and redesign business process for game changing business models.

1.2 Significance of Digital and Physical Innovation in Agriculture:

Digital and physical innovation in agriculture is significant to ensure sustainable development in agriculture. Government vibrant funding in various technological transformations in agriculture sector ensures maximum yield and profit, thus it will provide a good standard of living especially for marginal or small-scale farmers. The following areas were digital innovation is important:

1. Incorporating sensor in field and equipment.
2. Making use of GPS and GIS technology.
3. Adapting to digital platform like e-commerce and e-extension services.
4. Developing block chain technology and smart contracts.
5. Vibrant use of artificial intelligence.
6. Adapting to cloud computing and big data analysis

1.3 Need for Digital and Physical Innovation in Agriculture:

There is a growing need to transform agriculture from traditional framing methodology to digital farming methods to ensure maximum income through adapting to productive farming techniques by using digital innovation. The following are the major need for digital innovation in agriculture:

1. Digital and physical innovation helps in increase of production in stimulates income growth.
2. The farmers become more efficient and self-dependent.
3. It helps in capture of more value chain for farmers.
4. Digital and physical innovation in agriculture ensures profitability, productivity and progress.
5. Digital innovation ensures sustainable development in agriculture.

1.4 Objectives of the Study:

1. To study the reasons for farmer's distress in India
2. To determine the association between the adaptation of digital and physical innovation in agriculture ensures increase in standard of living of farmers.
3. To analyze that that government funding is an inevitable source to meet the growing importance of digital and physical innovations.

1.5 Hypothesis of the Study:

$^1H_0$: To test that there is no difference exist between comparison value and true mean value in case of farmer distress in India

$^2H_0$: To test there is no association between adaptation of digital and physical innovation in agriculture ensures increase in standard of living of farmer's

$^3H_0$: To test the hypothesis that government funding is an inevitable source to meet the growing importance of digital and physical innovations.

II. REVIEW OF PAST STUDY

2.1 AnkurSeth&KaveryGanguly (2017), Study on Digital Technologies Transforming Indian Agriculture have stated that future growth strategy for agriculture have to recognize agriculture as a business enterprise inculcating digital and physical innovation catering to market demand. Thus, there should be a tremendous shift from production centric to product centric in agriculture sector. Agri tech is fast evolving in India and it should have the mix of business models that leads to successful commercialization and by acquiring right incentives and policy support. Digital technologies help in achieving the production with low cost and customized delivery. The great challenge for India is that to attain high growth with inclusive growth by way of leveraging technologies to attain the dual goals.

According to the study the agriculture development is based on three pillars namely: knowledge, infrastructure, and a robust delivery mechanism. Thus, digital innovation in agriculture ensures small or marginal farmers to meet the growing market demand by adapting to recent innovations in the field of agriculture.

2.2 P .K. Shetty, K. Manorama, M.Murugan and M.B. Hiremath (2014). Research paper on "Innovations that Shaped Indian Agriculture- then and now" states that agriculture is the main destination for raw materials for many industries and agriculture is the livelihood for majority of rural population in India. India had attained numerable transformation in the field of agriculture in terms of adapting to new farming techniques. In India in developed regions agriculture attained the state of self-sufficiency. But mere change in technology and change in government policies alone does not stipulates growth in this sector. There is a need for major transformation moving tech based to digital base innovation to meet the growing market demand. New innovations should be made in order to increase productivity without causing any harm to environment. In India agriculture science should be strengthen to establish more yield in short duration of time. Thus, future research should concentrate more on climate resilient agriculture, use of GPS and GIS technologies, introducing digital platform, incubating AI (Artificial Intelligent) techniques, establishing block chain and smart contracts and by making prompt use of cloud computing and big data analysis techniques to have connectivity with other regions. Thus, these innovations in agriculture make our future generations survive without any food shortage related problems.

III. RESEARCH METHODS

The present study focuses on the adaptation of digital and physical innovation in agriculture sector. The parameter for this study is 50 samples collected from academician. Primary data is collected to justify that digital and physical innovation is inevitable for sustainable growth and development in agriculture. The samples obtained for this study is purely from academician working in colleges, B-Schools and Universities within Chennai. This study paper consists of three main hypotheses namely, [1]the typical reason for farmer distress in India, [2]association between adapting digital and physical innovation in agriculture ensures increase in standard of living of farmer's, and [3]government funding is an inevitable source to meet the growing importance of digital and physical innovations in agriculture. The hypothetical condition is tested using one sample t-test, paired sample t-test and chi-square test using Statistical Package for Social Sciences (SPSS) software.

IV. ANALYSIS AND INFERENCE

[1]One – Sample Test to reveal that farmers distress continue in India due to the following mentioned reasons below:

H_0: To test that there is no difference exist between comparison value and true mean value in case of farmer distress in India

$H_0: \mu_d = 0$, $H_A: \mu_d > 0$

Table: 4.1

Reason for farmer's distress in India	Test Value = 0					
					95% Confidence Interval of the Difference	
	T	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
[1]Unfair Distribution of Subsidies	32.859	48	.000	4.327	4.06	4.59
[2]Rigid Government Policies	64.826	49	.000	4.320	4.19	4.45
[3]Obsolete Technology for Farming	43.386	49	.000	4.260	4.06	4.46
[4]Unaware of Digital and Physical Innovation techniques in Agriculture business	62.688	49	.000	4.420	4.28	4.56
[5]Poor Export Market	31.454	49	.000	4.060	3.80	4.32
[6]Production-Centric than Market-Centric	51.559	49	.000	4.360	4.19	4.53
[7]Absence of Advertisement	49.484	49	.000	4.300	4.13	4.47

For the above output t-test is used to determine the farmer's distress is still prevalent in India. The calculated t value are 32.859, 64.826, 43.386, 62.688, 31.454, 51.559 and 49.484 respectively, while the associated significant value is .000 (<.05) for all the factors responsible for farmer distress in India, Hence H_0 is rejected at all level. Thus, the alternative hypothesis is accepted. It is clear from the study that the following factors contribute to the distress level in farmers namely, unfair distribution of subsidies, rigid government policies, obsolete technology for farming, unaware of digital and physical innovation techniques in agriculture business, poor export market, production – centric than market – centric and absence of advertisement.

[2]Cross Tabulation Comparing Adaptation of Digital and Physical Innovations in agriculture ensure high standard of living among farmers:

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Table: 4.2

		Digital and Physical Innovation increase the standard of living of farmer's			Total
Adaptation of Digital and Physical innovation		Yes	No	Maybe	
[1]Increase in Production stimulates Income growth	Neutral	0	0	0	0
	Agree	16	0	7	23
	Strongly Agree	27	0	0	27
Total		**43**	**0**	**7**	**50**
[2]Increase the efficiency of farmers	Neutral	3	0	0	3
	Agree	11	0	3	14
	Strongly Agree	29	0	4	33
Total		**43**	**0**	**7**	**50**
[3]Capture more value chain for farmer's	Neutral	0	0	0	0
	Agree	14	0	3	17
	Strongly Agree	29	0	4	33
Total		**43**	**0**	**7**	**50**
[4]Innovation ensures profitability, productivity and progress	Neutral	0	0	0	0
	Agree	14	0	3	17
	Strongly Agree	29	0	4	33
Total		**43**	**0**	**7**	**50**
[5]Sustainability in agriculture	Neutral	0	0	0	0
	Agree	13	0	3	16
	Strongly Agree	30	0	4	34
Total		**43**	**0**	**7**	**50**

The above table summarizes the digital and physical innovation in agriculture ensures high standard of living. The respondents in all cases have given a positive response towards the inclusion of digital innovation in agriculture.

[3]Chi – Square Test to reveal the goodness of fit in association between adaptation of digital and physical innovation in agriculture ensures increase in standard of living of farmer's:

H₀: To test there is no association between adaptation of digital and physical innovation in agriculture ensures increase in standard of living of farmer's

Table: 4.3

		Value	df	Asymp. Sig. (2-sided)
[1]Increase in Production stimulates Income growth	Pearson Chi-Square	9.555[a]	1	.002
[2]Increase the efficiency of farmers	Pearson Chi-Square	8.227[a]	2	.003
[3]Capture more value chain for farmer's	Pearson Chi-Square	.285[a]	1	.542
[4]Innovation ensures profitability, productivity and progress	Pearson Chi-Square	9.285[a]	1	.002
[5]Sustainability in agriculture	Pearson Chi-Square	8.441[a]	1	.003

The above outcome is tested using Pearson Chi-Square to determine whether adaptation of digital and physical innovation in agriculture ensures the standard of living of farmers. The calculated Pearson Chi-Square Values are 9.555, 8.227, 0.285, 9.285 and 8.441 for which the p-value given against Asymp. Sig. is 0.002, 0.003, 0.592, 0.002 and 0.003 respectively. In this scenario the p-value is less than 0.05 (p<0.05) for four cases. Thus, null hypothesis is rejected and alternative hypothesis is accepted stating that adaptation of digital and physical innovation in agriculture ensures good standard of living among farmers in respective terms namely, [1]increase in production, [2]increase the efficiency of farmers, [4]innovation ensures profitability, productivity and progress and [5]sustainable growth in agriculture.

[4]Paired Samples Test is done to reveal that government funding is an inevitable source to meet the growing importance of digital and physical innovations.

H₀: To test the hypothesis that government funding is an inevitable source to meet the growing importance of digital and physical innovations.

$H_0: \mu_d = 0$, $H_A : \mu_d > 0$

Table: 4.4

| | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | t | df | Sig. (2-tailed) |
				Lower	Upper			
1.	3.460	.762	.108	3.244	3.676	32.125	49	.000
2.	3.160	.976	.138	2.882	3.438	22.883	49	.000
3.	3.500	.678	.096	3.307	3.693	36.522	49	.000
4.	2.680	.741	.105	2.470	2.890	25.586	49	.000
5.	2.580	1.090	.154	2.270	2.890	16.742	49	.000
6.	2.760	.916	.130	2.500	3.020	21.304	49	.000

Header spanning: "Paired Differences" spans Mean through t columns.

1. Use of sensor in field and equipment's /Government should extend its support by providing fund for technological extension in agriculture sector.

2. GPS and GIS technology /Government should extend its support by providing fund for technological extension in agriculture sector.

3. Digital Platforms: e-commerce and e-extension services / Government should extend its support by providing fund for technological extension in agriculture sector.

4. Block chain and smart contracts - 8. Government should extend its support by providing fund for technological extension in agriculture sector.

5. Artificial Intelligence / Government should extend its support by providing fund for technological extension in agriculture sector.

6. Cloud computing & Big data analysis tools /Government should extend its support by providing fund for technological extension in agriculture sector.

The samples are tested using t-test to determine that government funding is inevitable source to meet the growing importance of digital and physical innovation in agriculture. The calculated t-values are 32.125, 22.883, 36.522, 25.586, 16.742 and 21.304 and the corresponding p-values are 0.000 for all determinants. In this sampling the p-value is less than 0.05 ($p<0.05$) for all the determinants. Thus, it is clear that the government funding is inevitable factor to meet the growing digital needs for agriculture. Government funding is highly essential for the following areas according to the study namely: sensor in the agriculture field to study the crop pattern, GPS and GIS technology for mapping, e-commerce services, block chain, smart contracts, artificial intelligence and cloud computing techniques.

V. RESULT AND DISCUSSION

1. The study have supported that the following factors contribute to the distress level in farmers namely, unfair distribution of subsidies, rigid government policies, obsolete technology for farming, unaware of digital and physical innovation techniques in agriculture business, poor export market, production – centric than market – centric and absence of advertisement.

2. The respondents in all cases have given a positive response towards the inclusion of digital innovation in agriculture.

3. The Study have found that the adaptation of digital and physical innovation in agriculture ensures good standard of living among farmers in respective terms namely, [1]increase in production, [2]increase the efficiency of farmers, [4]innovation ensures profitability, productivity and progress and [5]sustainable growth in agriculture.

4. The study have analysed that Government funding is highly essential for the following areas according to the study namely: sensor in the agriculture field to study the crop pattern, GPS and GIS technology for mapping, e-commerce services, block chain, smart contracts, artificial intelligence and cloud computing techniques.

VI. CONCLUSION

Agriculture being the livelihood for above 60% of population in India it needs more concentration on part of the government and policy makers to eradicate poverty and bring the agrarian society under the ambit of digitization. This paper insists on adaptation of digital and physical innovation in agriculture that ensure increased standard of living of farmers. The study expressed a positive output for adaptation of digital and physical innovation in agriculture. It is to be noted that schemes and subsidies introduced by government is not the only needed assistance to the farmers; the agrarian society should also be boosted with the use of digital technology in the field to match the production capacity. The sustainable growth and development in agriculture is also dependent on government funding through which the agriculture sector can procure the required technology-oriented machines and equipment's. In this study nearly 80% of the sample's opinion is to adopt various digital technologies in agriculture namely: use of sensor in the field activities, GPS and GIS technologies, E-Commerce and E-Extension services, Block Chain and Smart Contracts, Artificial Intelligence, Cloud Computing and Big Data Analysis tools for smart agriculture practices that ensures progress, productivity and profitability.

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