IMPACT OF EMERGING TECHNOLOGIES IN AGRICULTURAL EDUCATION ON FOOD SECURITY IN PLATEAU STATE

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Abstract

Emerging technologies have the potential of improving the food supply to the huge nation's population instead of relying on traditional farming implements. The technologies reduce drudgery among farmers and attract more young farmers into farming industry. The study determines impact of emerging technologies in agricultural education on food security. The study adopted survey research design. Two research questions and two hypotheses guided the study. The study was carried out in Plateau State. The population for the study was 102 made up of 34 extension agents and 68 lecturers. Simple random sampling method was used in sampling the population of farmers. Structured questionnaire was used for data collection. The instrument was face validated by five experts. Cronbach Alpha reliability coefficient of 0.83 was obtained for the instrument. Data was collected by the researchers with the help of three research assistants. Data collected were analyzed using mean, standard deviation and t-test. The study identified 18 artificial intelligence (AI) skills required by farmers for prompt decision making in Plateau State and 17 skills use in operating global position system (GPS) by farmers for commercial agriculture in Plateau State. The study recommends the adoption of the skills in the state to improve food security to attain local and international needs.

Keywords: Emerging technologies, technology, agricultural education and food security.

Introduction

Farming has evolved from basic hand-held tools to modern sophisticated machinery. Today, more than 800 million people across the universe go to bed with empty stomach every night, most of them are subsistence farmers who highly depend on agriculture for their livelihood (United State Agency for International Development, USAID, 2020). The world population according to United Nations (2019), will increase by 2 billion from 7.7 billion to 9.7 billion in 2050. Production in agriculture must double in the next 27 years to sustain the population growth. To ensure people have sufficient food, short-term and long-term developmental strategies should be aligned considering the steady evolvement of technologies.

Technology is the continues improvement on present physical and skills for better output. Technology according to Burgleman, Maidique and Wheelwright in Wahab, Raduan and Osman (2017), is the theoretical and practical knowledge, skills, and artifacts used to develop products and services as well as their production and delivery systems. Kumar, Kumar and Persaud in Wahab, Raduan, and Osman (2017), asserted that technology consists of physical and informational components, physical component is made up of products, tooling, equipments (sic), blueprints, techniques, and processes whereas informational components consists of know-how in management, marketing, production, quality control, reliability, skilled labour and functional areas. National Science Teachers Association, NSTA, in Warner, Bell, and Odom, (2018) asserted that technology is a wide range of technologies to serve as tools to engage students with real-world problem solving, conceptual development, and critical thinking. In the context of this paper, technology is defined as neither software nor hardware where the software deals with services whereas hardware deals with products. The continues unveiling of new technologies in agriculture give birth to emerging technologies.

Emerging technologies make farming operations better through improved output. Emerging technologies according to Rotolo, Hicks, and Martin (2018), are radically novel and relatively fast growing technology characterized by a certain degree of coherence persisting over time and with the potential to exert a considerable impact on the socio-economic domain(s) which is observed in terms of the composition of actors, institutions and patterns of interactions among

those, along with the associated knowledge production processes. Winston and Strawn (2015), stated that emerging technologies refer to technologies that are presently developing, expected to be available in future, reserved for technologies that are creating, or expected to create, significant social or economic effects. This study defines emerging technologies as improvement in the present technology, up-coming and sophisticated technologies to better human interaction with the environment. The emerging technologies include but not limited to sensors, blockchain, mobile devices, Internet of Things (IoT), global positioning system (GPS), and artificial intelligence (AI).

Artificial intelligence (AI) thinks like human and even faster. AI is the ability of a computer to imitate human mind and actions of the human body (McKinsey, 2017). Artificial intelligence High-level Group, AIHELG, in Baerdemaker (2023), asserted that AI refers to systems designed by humans with complex goals, act in the physical or digital world by perceiving their environment, interpreting the collected data, reasoning on the knowledge derived from this data and deciding the best act(s) to take and achieve a given goal. When events such as soil condition, water usage and weather condition are monitored AI uses such data to make decisions (Peasley, Anger & Neitz, 2020). Whereas global positioning system (GPS) is a global navigation satellite system that provides location, velocity and time synchronization. GPS provides precise location information at any point on the earth's surface (Shields, 2019). Currently, tractors equipped with GPS technology coupled with automatic steering systems are used to improve the placement of seeds on the farm, which reduces waste and cost of production The AI and GPS technologies can be impacted onto farmers through agricultural education.

Agricultural education is a discipline for transmission of agriculture skills to persons. Phipps, Osborne, Dyer, and Ball (2018), defined agricultural education as systematic instruction in agriculture at elementary, secondary, postsecondary or adult levels to preparing people for entry in agricultural occupations and job creation. According to this study, agricultural education is defined as the art and science of communicating the skills in cultivating and improving crops and livestock for man's use. Having informed decision by the farmer, facilitates production of crops and livestock by human which leads to availability and sustainability to food security.

Food security ensures human existence with better health condition. Food security according to USAID (2020), is having at all times, both physical and economic access to sufficient food to meet dietary needs for a productive and healthy life. Food security as opined by Coleman-Jensen, Rabbitt, Gregory and Singh (2015), has two extremes including high food security-disruption of normal eating pattern due to lack of food or resources to buy food. The United Nations (2015) simply defined food security as "availability at all times of adequate world supplies of basic food-stuffs". This is why all developed and some developing countries make considerable efforts to increase their food production capacity. Several evidences have suggested that majority of the world's food insecure live and work in the rural areas [International Food Policy Research Institute (IFPRI), 2018] indicating that reducing rural food insecurity is very important to reducing overall food insecurity. The authors opined that food security is defined as accessing sufficient and nutritious diet by all persons and at all time. Food security is highly needed in Plateau State.

In Plateau State, there are over 1,204, 763 farmers out of 3.5million people (Yisa, Coker, Etonihu, & Adewumi, 2019). Most of these farmers are active and can be taught various skills in emerging technologies relevant to agriculture industry. Due to the large number of farmers using local tools, there has being low harvest compared to steady increase in number of households that are poorly fed and skipped meals due to food insecurity among populace, farmers inclusive. Emerging technologies have the capacity to mitigate the two problems at a time. Furthermore, Plateau State has the human resource that are available to create opportunities in artificial intelligence (AI) and global position system (GPS). These available resources are not effectively use in agricultural education as a means of disseminating the skills in emerging technologies (AI and GPS) to mitigate food insecurity in the State. This is mainly due to unavailability of skills set required to achieve food security in Plateau State. Hence, it became necessary to ascertain the skills to determine the effect of emerging technologies in agricultural education on food security in Plateau State. The use of AI and GPS in farming operation could hasten the production of food availability in the affected area, sustain the provision of food in each farming season, improve food intake among many households and farmers will become more technologically inclined during farming operations. Having ascertained the skills, they will be disseminated to farmers through extension agents in the informal sector while to students through lecturers in the formal sector. Despite the usefulness of emerging technologies, their impacts in farming operations in Plateau State has not been fully explored.

This study therefore, hopes to provide empirical evidence on the impact of emerging technologies in agricultural education on food security, as a means of mitigating hunger and intensify the use of emerging technologies for food security and sufficiency in the state and beyond.

Purpose of the Study

The main purpose of the study was to ascertain the emerging technologies in agricultural education on food security in Plateau State. Specifically, the study sought to ascertain the:

1. Artificial intelligence (AI) skills required by farmers for food security in Plateau State.
2. Global position system (GPS) skills required by farmers for food security in Plateau State.

Research Questions

1. What are the artificial intelligence skills required by farmers for food security in Plateau State?
2. What are the global positioning system skills required by farmers for food security in Plateau State?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance.

1. There is no significant difference between the mean responses of Extension Agents and Lecturers on artificial intelligence skills required by farmers in Plateau State.
2. There is no significant difference between the mean responses of Extension Agents and Lecturers on the global positioning system for food security in Plateau State.

Methodology

Two research questions guided the study while two null hypotheses were tested at .05 level of significance. Survey research design was used for the study. Survey design collects large amounts of data from a large population at a relatively low cost and short time bound (Saunders, Lewis, & Thornhill, 2009; Arthur, Brafi & Kuranchie, 2013; Asenahabi, 2019). The design was considered appropriate for the study questionnaire was used to elicit responses from both extension agents and farmers in Plateau State. The state was chosen to carry out the study because of the common use of local farm tools in the area despite the farmers were known to be hardworking yet faced with inadequate skills to use emerging technologies to inhibit food insecurity. The research was carried out in three local government areas including Shendam, Kanke and Bassa across the three senatorial districts of Plateau State. The sample of the population for the study was 102 comprised of 34 extension agents and 68 lecturers in the study area. A simple random sampling (balloting) was adopted in determining the sample. A questionnaire made up of 35 items was developed from literature and used as the instrument for data collection. The scale for the questionnaire was: Strongly Agree (SA)-4, Agree (A)-3, Disagree (D)-2 and Strongly Disagree (SD)-1. The questionnaire was face validated by five experts of agricultural education. Cronbach Alpha was used to determine internal consistency of the questionnaire which yielded .83 coefficient. The questionnaire was administered on 102 respondents and collected with the help of three research assistants. There was 97% return rate which equated to 99 respondents. Mean statistics was used to answer the research questions, while t-test statistic was used to test the hypothesis at .05 level of probability. The cut-off point of 2.50 was applied in decision making for the research questions thus; 1.00-1.49 – Strongly Disagree, 1.50-2.49- Disagree, 2.50-3.49 – Agree and 3.50-4.00 – Strongly Agree. The standard deviations (SD) of the items were also analyzed. Any item with SD value of 1.96 or below indicated that the respondents were close to the mean and to each other in their responses. On the other hand, any item with SD value above 1.96 indicated that the respondents were far from the mean and to each other in their responses. The two null hypotheses were upheld when the calculated level of significance was greater than .05 or otherwise rejected.

Results

Research Question 1**:** What are the skills in artificial intelligence required by farmers for food security in Plateau State?

Ho 1: There is no significant difference between the mean responses of Extension Agents and Lecturers on artificial intelligence skills required by farmers in Plateau State.

Table 1: Mean ratings and t-test analysis of lecturers and extension agents on skills in artificial intelligence required by farmers for prompt decision making in Plateau State

N=102(34 extension agents & 68 lecturers)

S/N	SKILLS	G $\overline{X}$	SD	$\overline{X}_1$	SD_1	$\overline{X}_2$	SD_2	Sig	Dec
	Ability to:								
1	analyze data on soil quality	3.27	.68	3.35	.69	3.19	.67	.29	*NS
2	analyze data on weather conditions	3.43	.63	3.38	.69	3.49	.58	.52	*NS
3	predict crop yields	3.41	.74	3.32	.80	3.50	.68	.31	*NS
4	use AI-powered sensors to monitor soil moisture level	**3.25**	**.75**	3.24	.74	3.26	.76	.81	*NS
5	recommend irrigation schedule using outcome of data analyzed on soil condition	3.34	.61	3.29	.67	3.40	.55	.19	*NS
6	schedule fertilizer application using outcome on soil condition analyzed	3.39	.55	3.35	.59	3.43	.52	.48	*NS
7	monitor crop health with the aid of AI	3.47	.54	3.41	.55	3.53	.53	.82	*NS
8	detect early signs of disease in crops with AI-powered sensors	3.46	.59	3.35	.69	3.57	.49	**.06**	*NS
9	detect early signs of nutrients deficiencies	3.32	.64	3.32	.63	3.32	.65	.75	*NS
10	reduce environmental impact	3.40	.66	3.35	.73	3.46	.60	.12	*NS
11	prevent spread of infections	3.51	.59	3.53	.56	3.49	.63	.32	*NS
12	read appropriate treatment measures suggested by AI-powered systems for proactive action by farmers	3.43	.62	3.50	.56	3.37	.68	.13	*NS
13	set unmanned vehicle equipped with sensors for planting	3.49	.53	3.50	.56	3.49	.50	.15	*NS
14	use unmanned vehicles equipped with AI-algorithms and sensors in harvesting	**3.54**	.56	3.59	.55	3.50	.58	.41	*NS
15	support agricultural education through virtual reality (i.e. human-computer interface)	3.53	.55	3.53	.50	3.47	.61	.12	*NS
16	virtual reality provides rigorous training experiences	3.53	.55	3.53	.56	3.54	.55	**.93**	*NS
17	make decision in realistic virtual environments	3.51	**.51**	3.47	.50	3.56	.52	.75	*NS
18	practice farm management techniques by students	3.50	.54	3.50	.56	3.50	.53	.61	*NS

Key: N= Population, G $\overline{X}$ = Grand mean, $\overline{X}$ 1 = mean of extension agents, $\overline{X}$ 2 = Mean of potato farmers, SD1= standard Deviation of extension agents, SD2 = standard deviation of potato farmers, S = Significant, NS= Not significant, *= Required, N=Not Required.

In Table 1, it is revealed that all the items had mean values range from 3.25 to 3.54. the values were more than the mean cut-off point of 2.50 indicating that all the items were required. Indeed, the 18 items were required by farmers in the use of artificial intelligence for food security. The standard deviation of the items ranged from .51 to .82. each of the values was below 1.96 which indicates that the respondents were close to the mean and to each other in their responses.

Consequently, data presented in Table 1 showed that the calculated level of significance for 18 items ranged from .06 to .93. Each of the significant level was greater than .05 indicating that there was no significant difference between the mean responses of extension agents and lecturers on artificial intelligence (AI) skills required by farmers for food security in Plateau State. Hence, the null hypothesis of no significant difference was upheld for all the 18 items.

Research Question 2: What are the global positioning system skills required by farmers for food security in Plateau State?

Ho_2: There is no significant difference between the mean responses of Extension Agents and Lecturers on the global positioning system for food security in Plateau State.

Skills of Global Positioning System for Farming:

N=102(34 extension agents & 68 lecturers)

S/N	SKILLS	G $\overline{X}$	SD	$\overline{X}_1$	SD_1	$\overline{X}_2$	SD_2	Sig	Dec
	Ability to:								
1	create precise field maps with combined data from satellite, drones and Internet of Things (IoT) devices	3.30	.68	3.29	.67	3.31	.69	.91	*NS
2	create accurate digital map of farms	3.36	.65	3.35	.69	3.38	.62	.43	*NS
3	capture detailed information about boundaries	3.40	.66	3.41	.65	3.40	.67	.96	*NS
4	capture detailed information on topography	3.37	.71	3.41	.65	3.34	.78	.35	*NS
5	capture detailed information on soil characteristics	3.41	.61	3.50	.56	3.32	.67	.45	*NS
6	analyze data from satellite and weather patterns with geographic information systems (GIS)	3.45	.56	3.56	.50	3.34	.63	.15	*NS
7	monitor soil moisture with the aid of GPS	3.42	.59	3.50	.50	3.34	.68	.16	*NS
8	monitor temperature of farm with GPS	3.44	.54	3.32	.58	3.56	.50	.47	*NS
9	monitor crop growth with GPS	3.39	.56	3.44	.56	3.35	.56	.78	*NS
10	use GPS technology to facilitate data collection	3.42	.58	3.53	.50	3.31	.67	.25	*NS
11	integrate GPS-based guidance system in tractors for precise operations	3.43	.60	3.59	.50	3.28	.70	.10	*NS
12	integrate GPS-based guidance system in harvesters for automated operations	3.40	.58	3.26	.66	3.54	.50	.11	*NS
13	evaluate agricultural activities like irrigation	3.49	.52	3.41	.55	3.57	.49	.23	*NS
14	evaluate crop growth with GPS	3.55	.52	3.62	.49	3.49	.56	.07	*NS
15	assess the effectiveness of different practices and technologies	3.53	.50	3.56	.50	3.50	.50	.33	*NS
16	track agricultural products through the supply chain (production to consumption)	3.50	.53	3.47	.56	3.54	.50	.12	*NS
17	ensure transparency in agricultural products between producers and consumers	3.61	.48	3.65	.48	3.57	.49	.13	*NS

The data in Table 2 revealed that the 17 items had mean values ranging from 3.30 to 3.54. the values were above the cut-off point of 2.50 indicating that the 17 items were required. The 17 items were global positioning system skills required by farmers for commercial agriculture in Plateau State. The standard deviation of 17 items ranged from .51 to .82. each value was below 1.96 indicating that the respondents were near the mean and to each other in their responses.

In addition, data in Table 2 showed that calculated level of significance of 17 items ranged from .06 to .93. each significant level was greater than .05 indicating that there was no significant difference between the mean responses of extension agents and lecturers on global positioning system skills required by

farmers for commercial agriculture in Plateau State. Thus, null hypothesis of no significance was upheld for all the 17 items.

Discussions

The findings of this study on impact of emerging technologies in agricultural education on food security in Plateau State revealed that the artificial intelligence skills include ability to: analyze data on soil quality, analyze data on weather conditions, predict crop yields, use AI-powered sensors to monitor soil moisture level, recommend irrigation schedule using outcome of data analyzed on soil condition, schedule fertilizer application using outcome on soil condition, monitor crop health with the aid of AI, detect early signs of disease in crop with AI-powered sensors, detect early signs of nutrients deficiencies, reduce environmental impact, prevent spread of infections, read appropriate treatment measures suggested by AI-powered systems for proactive action by farmers, set unmanned vehicle equipped with AI-algorithms and sensors in harvesting, support agricultural education through virtual reality (human-computer interface), virtual reality provides rigorous training experiences, make decision in realistic virtual environments, and practice farm management techniques by students. Equally, the findings revealed that there was no significant difference between the mean responses of extension agents and lecturers on artificial intelligence (AI) skills required by farmers on food security in Plateau State. The findings are in line with Ali and Hassanein, 2020; Taki, Abdanan, Rohani, Rahnama, and Rahmati-Joneidabad (2018), that implementations of intelligent algorithms focus on predictions of indoor climate and microclimate. The findings also agree with Reissig, Oliveira, Costa, Praise, Pereira, & Sousa (2021), who found out that AI predicts yield, quality aspects of vegetable crops and growth indicators.

The findings of the study on global positioning system (GPS) skills required by farmers in Plateau State include ability to: create precise filed maps with combined data from satellite, drones and Internet of Things (IoT) devices, create accurate digital map of farms, capture detailed information about boundaries, capture detailed information on topography, capture detailed information on soil characteristics, analyze data from satellite imagery and weather patterns with geographic information systems, monitor soil moisture, monitor temperature of farm, monitor crop growth, use GPS technology to facilitate data collection, integrate GPS-based guidance system in tractors for precise operations, integrate GPS-based guidance system in harvesters for automated operations, evaluate agricultural activities like irrigation, evaluate crop growth, assess the effectiveness of different practices and technologies, track agricultural products through the supply chain, and ensure transparency in agricultural products between producers and consumers. Findings equally showed that there was no significant difference between the mean responses of extension agents and lecturers on global positioning skills required by farmers in commercial agriculture in Plateau State. The findings are in line with Radocaj, Plascak, Heffer and Jurisic, (2022), who found out that GPS gives accurate assessment of agricultural machineries like tractors and harvesters and equally stimulates the actual movement of the agricultural machinery during agrotechnical operations and precision agriculture. The findings are also in line with Panamaldeniya (2021) who found out that GPS helps to tract migrating animals and birds.

Conclusion

The study was carried out to determine the impact of emerging technologies in agricultural education on food security in Plateau State. Artificial intelligence (AI) and global positioning system (GPS) were used as some of the emerging technologies in determining skills for farmers on food security in Plateau State. The AI skills on food security include ability to: analyze data on soil quality, predict crop yield, monitor soil moisture level, monitor crop health, detect early signs of disease in crops, detect early signs of nutrients deficiencies, reduce environmental impact, prevent spread of infections, among 10 others. The GPS skills on food security are ability to: create precise field maps, capture detailed information on topography, capture detailed information on soil characteristics, monitor soil moisture, monitor temperature of farm, monitor crop growth, and track agricultural products through the supply chain among 10 other skills. The skills determined in AI and GPS will make impact on food security in Plateau State when efficiently impacted onto students and farmers. The responsibility of impacting these skills to the farmers will be carried out through lecturers in tertiary institutions in formal system and through extension agents in the informal setting.

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