Modern Agricultural Technology Adoption its Importance, Role and Usage for the Improvement of Agriculture

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Abstract: The main purpose of this paper is to introduce the modern technology adoption its importance, usage and role in agriculture improvement. In the last century, the basic agriculture technology like machines has changed a little. Though the modern technology, planters and harvesters do a better job or are slightly tweaked from their predecessors. The US$250,000 combine of today still cuts, threshes, and separates grain in the same way it has always been done. However, the modern technology is changing the way that humans operate the machines, GPS locators, as computer monitoring systems and self-steer programs allow the most advanced tractors and implements to be more precise and less wasteful in the use of fuel, fertilizer or seed. In future, there may be mass production of driverless tractors and other agriculture machinery which use electronic sensors and GPS maps.
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1. Introduction

During the past fifty years, development in the agriculture sector and policies has been changed successfully at emphasizing external inputs to increase food production. This has led to growth in global inorganic fertilizer, consumption of pesticides, animal feedstuffs, and tractors and other machinery. These external inputs have substituted for natural resources and processes, rendering them less powerful. Pesticides have replaced biological, cultural, and mechanical methods for controlling pests, weeds, and diseases. Inorganic fertilizers have substituted for livestock manures, composts, and nitrogen fixing crops. The basic challenge of sustainable agriculture is to make better usage of these internal resources. These resources can be done by minimizing the external inputs used, by regenerating internal resources more effectively. Evidence is now emerging that regenerative and resource conserving technologies and practices can bring both environmental and economic benefits for farmers, communities, and nations.

The new or modern technology in agricultural sector can substantially improve the agricultural production and sustainability. For instance, best management practices for improvement of agriculture are widely applied nowadays. New disease resistant hybrids, reduced pesticide use, biological pest control, cultural practices which can reduce the incidence of pests and diseases. Insect-specific chemicals and biological insect controls are now being utilized, instead of broad-spectrum pesticides, which actually reduce the number of sprays needed and therefore its capitals. GIS, Crop models and remote sensing can provides information to farmers for realizing precision agriculture, which is done by matching inputs based on actual yields of different portions on the field. These tools play an important role and also allow agriculture to manage land for both agriculture and wildlife.

For increasing food production the evidence comes from some countries of Asia, Africa and Latin America where fanning has been largely untouched by the modern technology. There are three common elements in which these have success. They are using resource conserving technologies such as integrated pest management, nutrient recycling, soil and water conservation, water harvesting, and waste recycling. Some groups and communities are helping to farmers becoming experts at managing farms as ecosystems; they also have supportive and enabling external government and nongovernment institutions, which have reoriented their activities to focus on local needs and capabilities. Most policies still actively encourage fanning that is dependent on external inputs and technologies.

2. Existing Literature Review of Agriculture Modern Technology Adoption

For years, in the industrialized world scientific and technological advancements have benefited farmers by driving agriculture production. However, in the developing countries of the world smallholder farmers who are responsible for 80 percent of the food have yet to see similar gains. The majority of these farmers containing women, lack to access of many modern tools needed to be successful, such as crop management products, modern irrigation practices, fertilizers, postharvest loss solutions, improved seeds, mobile technology, as well as access to information and extension services.

According to Foster and Rosenzweig, 2010 [1]; Carletto et al, 2007 [2], there are two major drivers of successful agricultural technology in developing countries: first one is the availability and affordability of technologies; and second one is farmer expectations that adoption will remain profitable—both which determine the extent to which farmers are risk averse. There are number of factors which drive the above expectations, ranging from availability and size of land, family labour, prices and profitability of agricultural enterprises.

The conceptual framework presented here highlights the various pathways through which different factors influence household decisions to adopt agricultural technologies. One of the most highlighted constraints to agricultural technology adoption is the availability of cultivable land (de Janvry et al, 2011 [3]; Carletto et al, 2007; Pingali et al, 1987 [4]).

(de Janvry et al, 2011) [5], it is argued that the availability of land helps to reduce the liquidity constraints faced by households and also reduces risk aversion. On the other hand, ownership of large tracts of land can facilitate experimentation with new agricultural technologies, and also determine the pace of adoption as large land owners are more likely to be the early adopters. On the other hand, the limited availability of land may spur the use of organic fertilizers in a poor resource setting (Pingali et al, 1987) [4].

Furthermore according to (Carletto et al, 2007) [2], the quality of land may be a major factor in deciding the use of key inputs such as chemical fertilizers, or adopting improved crop varieties due to expected higher returns. In the case of a country such as Uganda, with entrenched overlapping and relatively unsecure property land rights (Deininger and Ayalew Ali, 2008) [6], availability of land alone may not spur agricultural technology adoption.

In order to address the liquidity and supply constraints faced by poor farmers with regard to technology adoption, a number of African countries have implemented various forms of 'smart subsidies' that target specific farmers (Minde et al, 2008) [7]. Based on extensive studies in Ethiopia, it has been shown that life cycle effects are important drivers of agricultural technology adoption (Kebede et al, 1990 [8]; Asfaw and Admassie, 2004) [9].

In particular, younger as well as much older household heads are risk averse and are less likely to adopt new technologies. On the other hand, the availability of adult family members within households may facilitate the process of technology because most farming households cannot easily acquire hired labour due to liquidity constraints (Carletto et al, 2007) [9].

Kijima et al, 2011 [10], a key determinant of sustained adoption is the profitability of agricultural enterprises and changing prices for agricultural products are shown to be a major factor in agricultural technology adoption. It is initially attracted by higher product prices; farmers can abandon the technologies if the expected benefits from adoption are lower than the prevailing costs. There are a number of ways through which profitability of products may be lowered. The declining prices cotton in the global subsidies in developed countries best illustrates this fact (Minot and Daniels, 2005) [11].

According to Oster and Thorton (2009) [12], in any technology adoption process, peer effects work in three major ways: first one is that individuals profit from acting like friends/neighbours; second one is that individuals gain knowledge of the benefits of the technology from their friends; and third one is that individuals learn about how to use a new approach from peers. With regard to agricultural technology adoption, peer effects can lead to economies of scale by lowering transportation costs but can also lead to increased competition and land prices, which can spur dis-adoption (Carletto et al, 2007) [2]. Constraints to Agricultural Technology Adoption in Uganda 94 Poverty, price volatility, efficiency and the impacts of population shifts showed that learning by doing influenced technical change in pineapple cultivation.

3. Modern Agricultural Technology and Machinery Usage in Agriculture

Modern technology and machinery in agricultural employed today is below with details;

***1.* Autopilot Tractors**

New GPS tractors and sprayers machines can accurately drive themselves through the field without drivers. On the board of computer system, a user has told how wide a path a given piece of equipment will cover he will drive a short distance setting A & B points to make a line. The GPS system will have a track to follow and it extrapolates that line into parallel lines set apart by the width of the tool in use. The tracking system is tied to the tractor's steering, automatically keeping it on track freeing the operator from driving. This allows the operator to keep a closer eye on other things. Guidance is great for tillage because it removes human error from overlap, saving fuel and equipment hours.

***2.* Crop Sensors**

Crop sensors are going to help farmers apply fertilizer in a very effective manner, maximizing uptake. Sensing how your crop is feeling and reducing potential leaching and runoff into ground water. This is taking variable rate technology to the next level. Instead of making a prescription fertilizer map for a field before you go out to apply it, crop sensors tell application equipment how much to apply in real time. Optical sensors are able to see how much fertilizer a plant may need based on the amount of light reflected back to the sensor.

***3.* VRT and Swath Control Technology**

Through VRT and swath control technology, guidance really begins to show a return on investment. Swath control is just what it sounds like. The farmer is controlling the size of the swath a given piece of equipment takes through the field. The savings come from using fewer inputs like seed, fertilizer, herbicides, etc. Since the size and shapes of fields are irregular you are bound to overlap to some extent in every application. The GPS mapping the equipment in the field already knows where it has been and swath control shuts off sections of the applicator as it enters the overlap area. VRT works in a similar fashion. Based on production history and soil tests a farmer can build a prescription GPS map for an input.

***4.* Monitoring and Controlling Crop Irrigation Systems via Smartphone**

Mobile technology is playing an important role in monitoring and controlling crop irrigation systems. With this modern technology, a farmer can control his irrigation systems from a phone or computer instead of driving to each field. Moisture sensors in the ground are able to communicate information about the level of moisture present at certain depths in the soil. This increased flexibility allows for more precise control of water and other inputs like fertilizer that are applied by irrigation pivots. Farmers can also combine this with other tech like VRT mentioned earlier to control the rate of water applied. It's all about more effective and efficient use of resources.

***5.* Biotechnology**

Biotechnology or genetic engineering (GE) is not new technology, but it is an important technology with much more potential yet to be unleashed. The form of genetic engineering, most of the people have probably heard of is herbicide resistance. Crops can be made to express toxins that control particular pests. Many employ toxin that is the same toxin found in some organic pesticides. It means a farmer won't have to make a pass through his fields to apply pesticide, which is not only saves on pesticide, but labor, fuel and wear on equipment too. There is another way to look at it would be that farmers who irrigate their crops can cut back on water use and not see yields suffer. Nitrogen use efficiency is a lot like that except you're doing it with fertilizer instead of water.

***6.* Documentation of Fields via GPS**

Due to on-board monitors and GPS the ability of document yields and application rates are becoming easier and more precise every year. In fact farmers are getting to the point where they have so much good data on hand that and figure out what to do with all of it. The favourite form of documentation of every farmer's is the yield map and it sums up a year's worth of planning and hard work on a piece of colourful paper. The equipment's of harvesting rolls through the field and it calculates yield and moisture as it goes tying it in with GPS coordinates. The field is printed when finished a map of yield. These maps are often called heat maps. Now the farmer can see what varieties had the best, worst, or most consistent yield over varying conditions. Maps like this can tell a farmer how well a field's drainage system is working.

***7.* Ultrasounds for livestock**

Ultrasound is not only for checking on baby animals in the womb, also can be used to discover what quality of meat might be found in an animal before it goes to market. The testing of DNA helps producers to identify animals with good pedigrees and other desirable qualities. For improving the quality of the herd, this information can be used to helps the farmer to improve quality.

***8.* Usage of Mobile Technology and Cameras**

Mobile technology and cameras are playing big role for farmers and ranchers are using all the social media sites for all types of reasons. Some are using apps like foursquare to keep tabs on employees. Putting up cameras around the farm is a trend that's catching on. Livestock managers are wiring up their barns, feedlots, and pastures with cameras that send images back to a central location like an office or home computer. They can keep a closer eye on animals when they are away or home for the night.

4. Top Fifteen Countries using Modern Agricultural Technology with Agricultural Outputs in 2015

The top fifteen countries using modern agricultural technology with agricultural outputs in 2015 with GDP in million USD are mentioned in table 1.

Table 1. GDP Millions of USD

Serial No.	Country Name	Year	Agricultural outputs in USD Billions	GDP Millions of USD
1	China	2015	1,088	10,356,508
2	India	2015	413	2,051,228
3	European Union	2015	333	18,527,116
4	United States	2015	290	17,348,075
5	Indonesia	2015	127	888,648
6	Brazil	2015	110	2,346,583
7	Nigeria	2015	106	573,999
8	Pakistan	2015	63	246,849
9	Turkey	2015	62	798,332
10	Argentina	2015	59	543,061
11	Japan	2015	51	4,602,367
12	Egypt	2015	51	286,435
13	Thailand	2015	47	404,824
14	Russia	2015	47	1,860,598
15	Australia	2015	46	1,442,722

Graphically agricultural outputs and GDP are shown in figure 1 and figure 2.

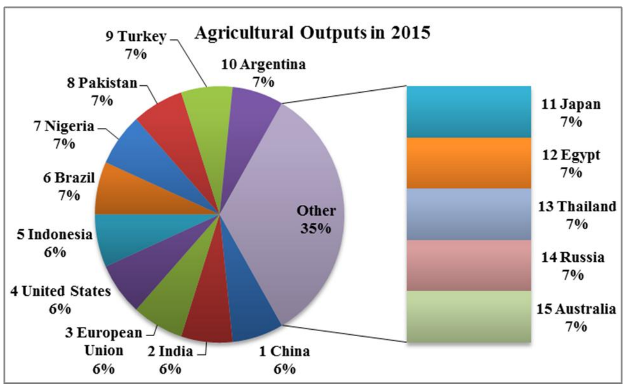

Figure 1. Top Fifteen Countries with Agricultural Outputs in 2015
Data Source: IMF and CIA Fact book 2015

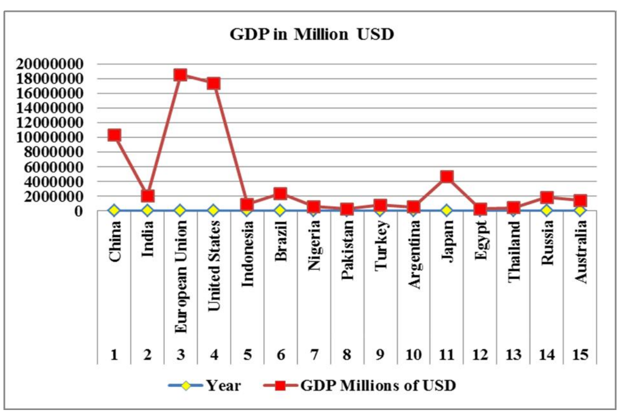

Figure 2. Top Fifteen Countries GDP in Million USD
Data Source: IMF and CIA Fact book 2015

Conclusion

Modern agricultural technology has been developed with keeping two important things in mind: first thing is to obtain the highest yields possible and second thing is to get the highest economic profit possible. To achieve these goals, six basic and important practices have come to form the backbone of production in agriculture: application of inorganic fertilizer, irrigation, intensive tillage, monoculture, chemical pest control and enatic manipulation of crop plants. Autopilot tractors, crop sensors, VRT and swath control technology, monitoring and controlling crop irrigation systems via smartphone, documentation of fields via GPS, biotechnology and ultrasounds for livestock has backbone for production and is using for its individual contribution to productivity.

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