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Impact of Artificial Intelligence in Agriculture with Special Reference to Agriculture Information Research

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Abstract

The study of intelligent machines that can perform like human beings is emphasised in the field of computer application known as artificial intelligence (AI). Artificial intelligence research is extremely specialised and technical. The role of Artificial Intelligence is inevitable in all the spheres of Business and technology and it would have a greater impact in the field of Education in the days to come. The Authors throws a light on the significance and impact of Artificial intelligence on Agriculture Information research. Artificial intelligence is now being used extensively in the agricultural industry. The Agriculture sector faces various threats and challenges and to mention a few, Information on pest control techniques, Yield Maximization, inappropriate Soil treatment, Pest control system, Disease control information, Information on farm technology and innovation etc,. In this paper, applications of AI in the agricultural sector are reviewed, with an emphasis on agriculture information.

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Agriculture Information; Artificial Intelligence; Agriculture Information System; Agriculture Research; Computer Application in Agriculture.

Introduction

The process of globalization and industrialization has brought significant developments in terms of technology and production. Many inventions in automation, Production systems are the by-products of industrialization. The roles of automized machines, simulating machines, computerized production processes have broughtin drastic changes in the whole manufacturing systems. The human society has started focussing on information handling, processing, storage and dissemination, retrieval of data utilizing microelectronic based technologies. The field of computers have significantly grown and now computers are capable of simulating human activities like speaking, reading, drawing observing, analyzing, calculating arithmetic, memorizing, Distinguishing numbers, making decisions and in effective interactive learning. Recent trends in AI involves in discovering AI systems which would simulate intelligent human behaviour

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which includes reasoning behaviour, human sensory capabilities, knowledge accumulation, and mechanical capabilities of Human beings. Erlangga, Wihardi, Y., and Nugraha, E., (2020)[10] have emphasized the need for developing a mobile learning platform that would use the internet and mobile cloud communications to provide information and interactive communication about agricultural production needed by farmers.

putting idea, for better information sharing, communication, and agricultural profitability The impact of AI would be soon visible in offices, manufacturing organizations, shopping malls, homes, Educational institutions and libraries.(AI) has begun to play a significant role in our daily lives, expanding our perceptions and our ability to modify our surroundings (K. Kundalia, Y. Patel, M. Shah(2020),[16] M. Gandhi, J. Kamdar, M. Shah (2020),[12] Ahir, K., Govani, K., Gajera, R., Shah, M.,(2020).[1] G. Idoje, T. Dagiuklas, and M. Iqbal (2021)[15] have expressed their views that IoT is frequently used in the modern technology of intelligent systems known as Smart Farming. Additionally, it provides hardware and software technological solutions to boost agricultural yields. Over the past ten years, it has undergone changes in how it is applied to agricultural land, starting with the use of holes and scissors to cultivate fields and machinery to harvest crops. As a result, smart farming was developed because it offers farmers efficiency by utilising IoT to be applied to all farming techniques and implementation methods.

Brief Review of literature on Artificial Intelligence

Frey and Osborne (2017)[11] estimated that the likelihood of the computerization of library technical staff would be ninety nine percentage that of assistant librarians would be ninety five percentage that of clerical workers would be 76%, that of archivists would be 76%, and that of librarians would be 65%.

Wood and Evans (2018)[29] described Artificial intelligence (AI) as referred as the replication of human intellectual procedures by machines, to be particular Robots and computers. In their 2017 study of library staff who belongs to various fields in USA, the results of the research showed that 56.3% of respondents felt that supercomputers would replace and this means 44% thought there would be less effect of Artificial intelligence on Librarianship.

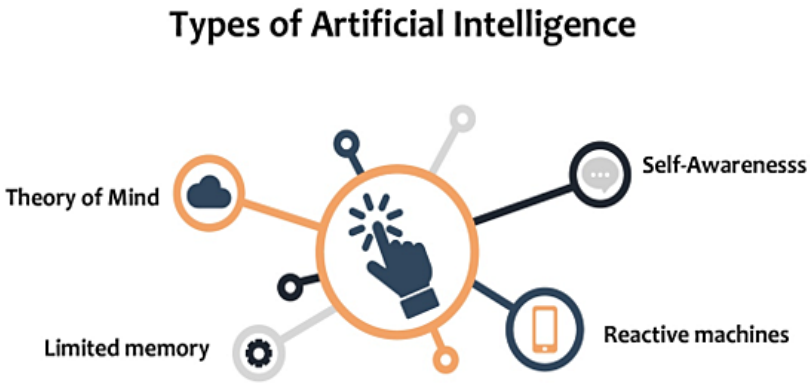
"Artificial intelligence will change library services, permanently changing the range of expertise and equipment required to provide our clients," claims *Arlitsch and Newell* (2017).[4]

Definition

Tredinnick(2017)[27] defines artificial intelligence as "A cluster of technologies and approaches to computing focussed on the ability of computers to make flexible rational decisions in response to unpredictable environmental conditions"

Types of Artificial Intelligence

Arend Hintze, an associate professor of integrative biology and computer science and engineering at Michigan State University, divides artificial intelligence (AI) into 4 categories, starting with the frameworks which are currently available to conscious frameworks that doesn't. These are his classifications.



Type 1: Reactive Machines

Deep Blue, the IBM chess programme that defeated Garry Kasparov in the 1990s, serves as a model. Dark Blue has the capacity to recognize the coins on a chessboard and foresee, except it lacks memory so that it is unable to draw insight from the past into the present. It analyses potential moves, both its own and those of the opposition, and selects the most important move. Only with a lot of work can Dark Blue and Google's Alpha GO be applied to a different situation because they were designed for specific purposes.

Type 2: Limited Memory

These AI frameworks can make decisions by using experiences from the past. This is how some of the fundamental leadership tasks in self-driving cars are organised. Perceptions indicate that certain events, like a vehicle changing lanes, will take place soon. These ideas are not entirely forgotten.

Type 3: Theory of Mind

This term from brain science alludes to the knowledge that people make decisions based on their own beliefs, desires, and objectives. There isn't currently any AI of this kind.

Type 4: Self-Awareness

Artificial Intelligence frameworks contain cognizance and a sense of self. Technologies with mindfulness are aware of their present circumstances and can use this knowledge and simulate other people's emotions. There isn't any AI like this yet.

Agricultural Information Systems

The significant feature which affects other production aspect is agricultural information. Maningas, R. V., Perez, V. O., Macaraig, A. J., Alesna, W. T., and Villagonzalo J. (2000)[20] says that by having the best possible control over their resources and the ability to make wise decisions, farmers will feel more empowered as a result of the information at their disposal. The researchers found that providing farmers with essential information and technology services in an effective and efficient manner aids them in making decisions that will improve agricultural production and marketing. Food and Agriculture Organization (FAO) opines that since an increase in agricultural productivity will depend on an increase in the income of the farming community, agriculture information system is crucial for rural development. To achieve sustainable agricultural development, there is a need for enhanced idea on productive technologies in agriculture along with appropriate communication systems. IoT messaging protocols that were considered to be the main choices for IoT applications in smart farming were studied by Dr. Dimitrios Glaroudis, Dr. Athanasios Iossifides and Dr.Periklis Chatzimisios (2019).[9] They presented seven protocols, compared them based on how well they performed, and measured them using pertinent key performance indicators.

An agricultural information system (AIS) is a system in which the data on agriculture is collated with intent to be utilized by farmers.Over the years, farming has been reimagined by technology, and technological advancements have had multiple effects on the agriculture sector. In many countries around the world, agriculture is the main industry. With a populace which may is expected to risefrom seven point five billion to nine points seven billion by 2050, according to UN estimates, land will be under more pressure because only 4% of the land will be used for agriculture. Farmers will have to do more with less because of this. In order to provide food to the added 2 billion populations there is a need for sixty percentage more production. However, conventional approaches are insufficient to meet this enormous demand. As a result, farmers and agri businesses are seeking novel strategies for reducing waste and increasing production. With the advent of AI Technologies there is a possibility of growth in agricultural productivity with a development in quality of the crops, production quantity and best time taken to reach the market. Ma, Y.Q., and Sun, X., (2020)[18] have viewed that the agricultural machinery that is intelligent can operate in a standard, comfortable, and interactive manner. It is capable of independently completing various operations, including cultivation, sowing, transplanting, and fertilisation, spraying of drugs mechanism for feeding, water supply for crops, picking mechanism, and harvest mechanisms. It can also gather data on crops, aquatic products, soil quality, and water quality, offering technical support for the implementation of precision agriculture and healthy breeding.

Importance of Agriculture Information

Information about marketing, credit programs, agricultural technology, agricultural inputs, and

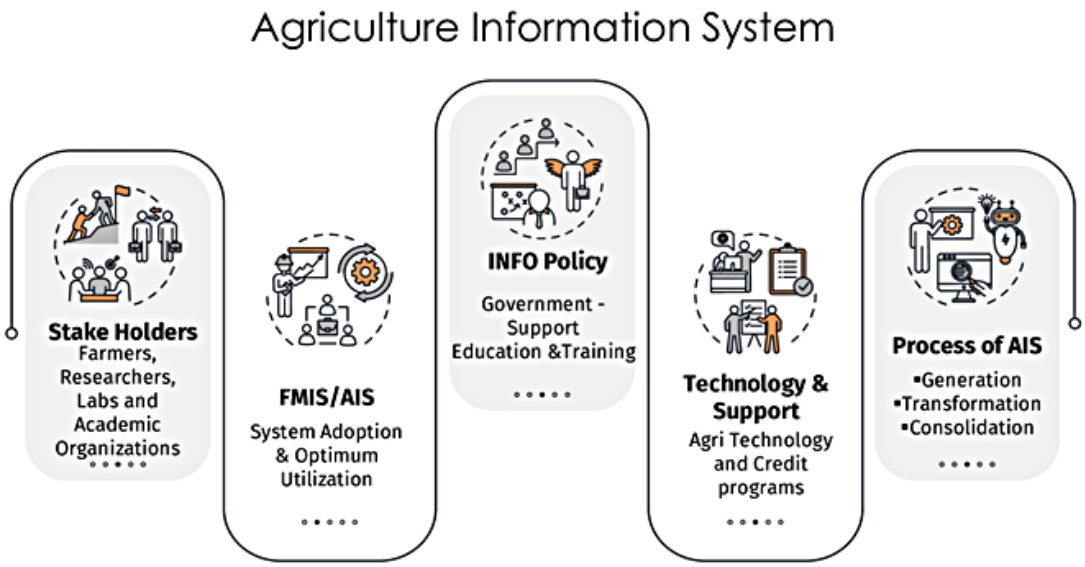
education about extension programs are all part of agricultural information systems. (Lu, Pan, Lu, Qin, & Wang, 2015).[30] The adoption of new technologies, which can increase farmers' incomes by lowering the marginal cost of production per unit of output, is one example of a direct effect (Berdegue & Escobar, 2001).[31] Alternative impact of technical advancement is to offer cheaper foods which are a result of enhanced production in agriculture and creation of more employment opportunities. Agricultural data systems have the capability todo it simpler to provide information to farmers, enabling them to take advantage of market opportunities and make better decisions. Having knowledge and access to accurate and timely information can boost agricultural productivity.

Systems for Agricultural Information According to Ahmadvand and Karami (2011), AIS primarily consists of three components: research, extension, and user subsystems. They also place a strong emphasis on the two main components of AIS: the creative component and the interactive component. The interactive dimension focused on the various roles played by actors in the AIS, while creative aspect addressed the ways to solve problems linked with agriculture. For successful adoption and use of AIS, both of these dimensions must be recognised and addressed (Ahmadvand & Karami, 2011). A. Sharma, A. Jain, P. Gupta, and V. Chowdary (2021)[22] have viewed that one might speculate that as the population grows; the amount of agricultural land will drastically decrease in the years to come. The most significant causes of decreased food production are poor planning, inappropriate harvesting, unpredictable weather, irrigation methods, and other issues like neglected livestock. While governments invest in providing assistance to the functioning of AIS, Bitrus *et al.* (2019) note that these programmes may not be successful unless the farmers' intention to continue using AIS is evaluated. FMIS (FARM MANAGEMENT INFORMATION SYSTEM) can help farmers' access agricultural information via digital technologies, potentially increasing farm yield by 4% and increasing the likelihood that recommended farm yield will be adopted by more than 22%. (Fabregas, Kremer, & Schilbach, 2019).[32]

The current Farm Management Information Systems now provide sophisticated systems containing component supporting features like automated data collection, farm management, and agricultural yield monitoring (Köksal & Tekinerdogan, 2019). Planning, organising, monitoring, and controlling farm activities are all part of the management component of FMIS (Husemann & Novkovi, 2014). The advent of precision agriculture and smart farm technologies, FMIS which at first came out as straightforward information system that aided agriculturists in tracking their agricultural and account system, fundamental farming and accounting needs have been gradually developed.

According to Carrer, Filho, Batalha, and Rossi (2015), farm owners who use information systems may initially benefit more than those who do not, but these benefits may not last in the long run unless these information systems are continued to be adopted and utilized. Two of the many factors that affect the acceptance and constantutilization of Farm Management information systems for effective information processing and adequate training to farmers.

Tambo and Abdoulaye (2012) contend that for the purpose of analysing the benefits inspite of drawbacks in adopting farm technology, one must first understand the factors that influence adoption. To encourage farmers to espouse technologies in agricultural system, effective steps have to be taken to enhance association with agencies dealing with farms, possible ways for farm loan options, educational background, and skill enhancement. Zhang, Wang, and Duan (2016) claim that a variety of challenges, including inadequate infrastructure, absence of quality appraisals, inadequate technical support staff, and a dearth of knowledge sources hinders the utilization of the Agriculture based Technology Information systems.



Artificial Intelligence Within Agriculture Information System

Intelligent Chemical Spraying Made Possible by AI Saves Money.

Every day, farms produce numerous data points about the weather, land, temperature, usage of water, etc. Artificial intelligence and machine learning models captures the information in real-time to derive practical insights to offer insights on the season for seed, the variety to choose for better yielding etc. AI is used for optimization of spraying pesticides and in the research done by Indu, Anurag Singh Baghel, Arpit Bhardwaj and Wubshet Ibrahim (2022),[14] they have found that in order to ensure that farmers only apply pesticides to the necessary area, the data from pesticides sprayed on crops is processed using a machine learning algorithm, and the area which do not require pesticides sprayed again is centroided. Compared to the exit concept, this idea has paved way for decreasing pesticide repetition by at least 20%.

Precision Farming and Predictive Analytics

An integrated information and production-oriented farm system that focuses on improving site-specific, long-term, and overall farming production, effectiveness and profitability, at the same time minimising unintended effects on the environment and wildlife is known as precision agriculture as described by Tan XJ, Cheor WL, Yeo KS, Leow WZ (2022).[23]

The employment of AI in farm and agriculture management has led to the creation of software programmes and equipment that give agriculturists with the right solution on matters such as Irrigation systems, harvest technologies, rotating crops, the variety of crop suitable for cultivation ideal conditions for cultivation, attacks of insects and pests, and nutrient administration. AI-enabled technologies use algorithms in conjunction with satellite images to anticipate weather conditions, identify the best crop for the season. It evaluates the possibility of crop disease, need for nutrients and fertilizers by utilizing statistics on weather, Speed of winds and emission of the sun. Agriculturists who do not have internet access would benefit from AI with a basic set of tools like the Sowing App and an SMS-capable phone. Farmers who have access to local area wireless technology can use AI utilities to avail a constantly customised arrangement for their territory in the interim. Farmers can use these AI and IoT-driven solutions to increase production and profits while meeting the world's need for more food in a sustainable manner. This prevents the depletion of priceless resources which are available naturally. AI assists farmers to evolve as agricultural scientists in the days to come by utilising the statistics to optimise production in every square feet of their lands.

The detection of plant diseases, pests, and inadequate farm nutrition is made easier by AI technology. Before choosing which herbicide to apply in the area, the sensors of AI would recognise and gives appropriate action against the elimination of weeds. The utility of herbicides have drastically decreased, hence the expenses are decreased. Numerous technological entities have developed robots which would precisely handle sprinkling mechanisms using AI technology. AI supported machines would eliminate eighty percentage of the synthetic compounds that are routinely applied to crop yields and reduce herbicide usage by 90%. These sophisticated artificial intelligence (AI) sprayers could significantly lower the quantity of chemicals used in thelands which would definitely enhance the yield and remains cost effective.

In agricultural IoT, information is primarily received through a variety of sensors. Electrochemical, optical, electrical, and remote sensing are all components of the sensor's information-sensing system. Spectrophotometry and Fluorescence quenching effect are the two main optical sensing mechanisms that are used to examine soil and calculate its chlorophyll content (Li *et al.*, 2017).[17]

Agricultural Robotics

Companies working on artificial intelligence (AI) are manufacturing robots which would carry out a wide range of tasks in farming fields with ease. These robots are taught to manage weeds and harvesting crops faster than human beings may do. Such robots have been customized to pick and pack produce simultaneously to ensure that the quality is good and to eliminate the waste. These Robots play a significant role in removing the hindrances faced by the agriculturists. Robots have the capacity to operate in bulk quantities with excellent speed and accurate standards the traditional farm workers are not these machines. Such robots facilitate the reduction of wastage of crops in the cultivated land. Manas Wakchaure, B.K.Patle and A.K.Mahindrakar (2023)[19] have described in their research study that the use of robots in farming has improved productivity and made it more popular. AI techniques frequently provide data in real-time, reducing the chance of human error and enhancing decision-making skills. According to the thorough review, modern technology and AI methods outperform conventional methods with the least amount of human effort and in the shortest amount of time. Instead of the core agricultural activities of the farming, scrutinizing and harvesting phases, AI techniques have primarily been used to solve path planning problems of the agriculture robot.

Many entities are taking effective steps to improve farming productivity. Mature apples can be plucked from trees by an automated picking machine. These picking machines would choose the best fruit or vegetable which is suitable for harvest using intelligent sensors, AI Technology and technically augmented vision system. Farming being the 2nd biggest industry wherein robots are being utilized professionally, behind defence. The number of agricultural robots sold is equal to the number of military robots, claims the International Federation of Robotics.

Land and Plantfitness Monitoring System

Nutrition of the soil has a significant impact on the variety of crops grown and the quality of those crops. The assessment of soil quality because of the declining condition of the soil brought on by the increasing rate of deforestation. German technology startup PEAT created Plantix, an AI-based application. It can spot plant pests and diseases as well as nutrient deficiencies in the soil, and farmers can use this knowledge to recommend fertilizer applications that enhance the quality of their harvest. This app is powered by image recognition technology. Farmers can photograph their plants using smart phones. This would enable the farmers to see methods for restoring soil, advice with the aid of video graphs available in the system.

Arshad Jalal a, José Carlos de Oliveira Junior at, Janaína Santos Ribeiro a, Guilherme Carlos Fernandes a, Giovana Guerra Mariano a, Vanessa Dias RezendeTrindade a, André Rodrigues dos Reis (2021)[2] have stated in their research study that while climate change and severe events such as droughts and heavy precipitation causes plant stress with serious consequences for food production (yield potential and stability) and in particular also decreases plant fitness, identification of efficient natural defence mechanisms are thus highly needed. However, the stress from low doses of herbicide for example, however can also have a positive effect on plant fitness through hormesis.

Similar to that, Trace Genomics which AI enterprise which facilitates agriculturists to analyzes soil fertility and its ingredients. This type of app makes it simpler for farmers to monitor the condition of pertaining to the fitness of their land, attributes related to the crops which would facilitate better crop harvesting and enhanced profit.

Drone Analysis of Crop health

P. Velusamy, S. Rajendran, R. K. Mahendran, S. Naseer, M. Shafiq, and J.-G. Choi (2021) 26 have described in their research study that Unmanned aerial vehicle (UAV)-based identification methods, also referred to as low-altitude distant location technologies, are now widely used in contemporary fields and guarantee high data reliability. Farm diseases and pests assessment systems should be standardised and digitised whenever drones are used to detect the presence of insects and pests. However, a drone on a far-off large farm must deal with problems like a short flight time and frequent charge changes because of its limited carrying mass and storage capacity. These characteristics now influence the creation and application of drones in contemporary farming. Sky Squrrel Technologies has introduced aerial imaging drone programmes to assess healthiness of crops. Experts analyse the data after it has been transferred from the drone to the computer using a USB drive. The system employs drones which gather information from the land. The organization administers algorithms for the purpose of evaluating and examining the pictures captured by the drones and offers a comprehensive report on the health of the crops. By identifying bacteria and pests, it helps farmers take the necessary action quickly using pest control and other methods.

Predictive Analytics by Artificial Intelligence

The ability to foresee the ideal time for seed germination can mean the difference between a successful and an unsuccessful year. To address this, ICRISAT researchers used a predictive analytics tool to determine when to plant seeds for the greatest yield. It offers information pertaining to the healthiness of the land meant for cultivation, the need for fertilizer for the land and also weather forecast for 7 days.

Pest Detection System Made Possible by AI

One of the farmers' most formidable foes, pests cause crop damage. Using AI algorithms, artificial intelligence systems compare satellite images with empirical statistics to determine the landing of a foreign insect which is undesirable for the cultivation which would damage the crops. Also, send alarms to ranchers to their cell phones so ranchers can play it safe and utilize expected bother control along these lines simulated intelligence assists ranchers with battling against bugs. Chen, Ching-Ju& Huang, Ya-Yu & Li, Yuan-Shuo & Chang, Chuan-Yu & Huang, Yueh-Min (2020)[7] in their research study, for the purpose of identifying pests, artificial intelligence and image recognition technologies were integrated through environmental sensors and the Internet of Things (IoT). Based on intelligent pest identification and environmental IoT data, real-time agricultural meteorology and pest identification systems were evaluated. The quantity of pesticides utilized and the amount of soil damage caused by pesticides can both be effectively reduced through precise positioning. To achieve the goal of smart agriculture, the research gave farmers information on the location of the insects and the coverage of the pests so they could accurately apply pesticides at a precise time and place and thereby reduce the agricultural workforce needed for timely pest control.

Weather Forecasting

Farmers find it difficult to know when to sow seeds because of climate change and pollution. However, with the help of artificial intelligence, they can use weather forecasting to analyze the conditions and plan when to sow seeds and what kind of crops can be grown. Puyu Feng, Bin Wang, De Li Liu, Cathy Waters, Qiang Yu (2019)[21] in their research study found that wheat yields were modelled successfully, outperforming conventional statistical techniques. In the study carried out in Australia, machine learning techniques were used to identify rising heat events as a significant factor contributing to yield losses in the future.

Price Forecasts and Crop Yield Predictions

The fluctuation in crop prices is a major source of worry for many farmers. Because of fluctuating costs,

agriculturist could not decide a specific cultivation pattern. These kinds of issues are very widespread in crops with a short shelf life, such as tomatoes. Businesses utilizeclimate information along with satellite images to scrutinize crop health in real time and assess crop acreage. The advent of scientific technologies like artificial intelligence businesses would be able to forecast prices, make estimates on the crop yield, cognize possibility of pest infection and disease infection. On potential price trends, consumer demand, the best crop to plant, the use of pesticides, and other issues, they can offer advice to farmers and governments.

Innovative new companies have been utilizing AI technology in agricultural sector. A German agricultural technology start-up developed a multilingual disease and pest diagnosis application which analyses different plant images to identify infectious disease patterns, after an image from a Smartphone is matched with an image from a server, an intelligent spraying technique is used to apply a diagnosis of the disease to the crop. This technology utilizes the technology of artificial intelligence and machine learning for address diseases and infections to crops. More than 7 million farmers have used this app to detect around 385 types of crop infections and diseases in Fruits and vegetables.

Conclusion

Artificial Intelligence will be powerful tools that can help businesses to administer the problems and complex issues faced in agriculture. It significantly paves ways for the problem of shortage of manpower. Artificial Intelligence techniques will undoubtedly improve farming practices and pose a challenge to current decision-making techniques. Because of these technological advancements, farmers' lives will probably be better in every way, and agricultural practices and yields will probably improve as well. These tools would definitely facilitate the farmers to bring automation and computerization of the processes involved and shifts toward precision resulting excellent quality and desirable yielding at less resource consumption. More practical applications in this area will become available as technology advances, helping the world address issues related to food production for a growing population.

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Conflict of Interest

The authors have no conflicts of interest to declare that are relevant to the content of this article.

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