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SIGNIFICANCE OF EVOLUTION OF AUTOMATION ENGINEERING IN AGRICULTURE

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INTRODUCTION

The real meaning of automation is that it implies the elimination of all man force or manual labour by using automatic controls. It helps in achieving great accuracy and quality. Trends in the evolution and development of agricultural field machinery are often shaped by these technological developments.

Nowadays, new age agriculture is no longer limited to improvement and development of cultivation tools but also focuses on advanced Hi- tech. control and automation. It includes local and remote sensing, post-harvest treatment of biological materials, interaction of machine and soil testing before preparation of agricultural fields. Agricultural auto mechanization includes the partial or full replacement of human energy and animal powered equipment by power driven equipment. The mechanization of farming practices throughout the world is the beginning of new revolution in food production. It is enabling human civilization to maintain its pace with their population growth. Automation of agricultural mechanization is the vast area of research and development. It also emphasised on enhancement of food quality, comfort and safety of operator, work environment and conservation of energy.

HISTORY

There is a long history lies behind the agricultural mechanization which includes human and animal powered rather than engine powered.

The first extensive mechanization of agriculture came with the introduction of plough, usually powered by animals. It was invented in ancient Mesopotamia. The beginning of agricultural practices was done manually which required huge man force for example, huge man force was needed during threshing operations in farms which was very time consuming operation. Finally in 1794, the threshing machine was invented. It completely simplified the threshing operation and now animal power could be used. But later in 1880, the reaper and the threshing machine were combined into the combine harvester. Large teams of horses or mules were used to drive these machines. In the late 19th century, steam engines were used to power threshing machines.

Chronological Development of Auto Mechanization

S. NO.	YEAR	Agricultural Auto Mechanization Timeline (United States)
1.	1902	First U.S. factory for tractors driven by an internal combustion engine [established by Charles Hart and Charles Parr].
2.	1904	First Crawler tractor with tracks rather than wheels.
3.	1917	Ford Motor company begins production of the Fordson tractor.
4.	1922	International Harvester introduces a power take off.
5.	1931	Caterpillar manufactures a crawler tractor with a diesel engine.
6.	1932	Rubber wheels improve the tractor.
7.	1932	First pickup baler manufactured.
8.	1933	Hydraulic draft control system developed
9.	1935	First research on conservation tillage [It involves various methods of tilling the soil, with stubble mulch and different types of plows and discs, to control wind erosion and manage crop residue.
10.	1938	Massey-Harris introduces the first self-propelled combine- a thresher and a reaper in a single machine.
11.	1954	Corn head attachments for combines are introduced.

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Proposed Sixteen Links in the Peninsular Component

12.	1966	Electronic monitoring devices allow farmers to plant crops more efficiently.
13.	1994	Farmers begin using Global Positioning system (GPS) receivers.

AUTOMATION OF INDIAN AGRICULTURE

"Agriculture is the backbone of the Indian Economy"- said Mahatma Gandhi. Even today, in present scenario the situation is still the same as almost the major part of Indian economy is taken care by agriculture. Agriculture not only takes care of our economy but it is the backbone for our sustenance too. The major difference between the today's world and past times is that, Labours are not available for agriculture. Now, this is the need of time to bring automation and improves the mechanization in our agriculture system so that the back-bone of our country strengthens and can easily pace it up with the growing population of India.

India first saw the automation in agriculture during the time period between 1960s-70s when green revolution came to India. Green revolution was applied basically in various parts of Haryana and Punjab. Green revolution could only become successful if use of modern machinery was introduced, so government started working on the new and improved technology in the field of agriculture. Multiple cropping and high yield variety of crops were achieved because of increasing use of machinery and other modern equipments such as tractors, pump-sets, power tillers, tube-wells, harvesters, mechanical threshers etc. Now the machinery and modern equipments were there but the majority of Indian farmers were too poor to afford the new technologies at that time. So, the government introduces various credit schemes for the farmers to overcome the lack of financial resources. These credits were provided by the National Bank for Agriculture and Rural Development, commonly known as NABARD. Till 1976-77, mechanization in Indian agriculture was at its peak, for an instance, in 1965-66, number of tractors was 10636 but in 1977, number of tractors was 60762[increased nearly 6 times in a span of 10-11 years].

Green revolution followed by mechanization. The combination of both played a very important role in increase of grain production and completely revolutionizes the way of agriculture. It not only affected the agriculture but also opened up new channels for mankind and helped in improving the status of women. Now labourers were needed in agriculture, so opportunity was created for women to work in the family agricultural work. This active participation in the fields affected the status of women. Now the women were easily able to operate the new machines on farms.

Efficiency of machinery is needed for increasing timely farm operations and increasing productivity by 25-30%. Crop intensity can be raised by limiting the turn around time by using better and more efficient engineering inputs. Thus, high precision and timeliness in agricultural operation can be achieved by development and introduction of high capacity, reliable and energy efficient equipments.

In the present scenario, India is the largest producer of tractors in the world with 2,60,000 tractors per year and 13 manufacturers. In the last 30 years, there comes a very rapid boost in agricultural mechanization at very high rate, during 1970-90, the annual growth in the sale of power engine tractors were more then 8% and in the last 20 years(1991-2000-01), about 205 million tractors and 1,17000 power tillers were sold in the country. Total power availability is also increased during this period. It increased from 0.295kw/ha to 1.231kw/ha. Till now after so much mechanization, only 35-40% of the agricultural land is being tilted through mechanical power sources.

Use of pump-sets for irrigation played a very important role in the mechanization of agricultural practices. Major water sources are from rivers, lakes, canals, reservoirs, tanks and ground water. In India, most of the water is used in agricultural sector (approx. 88 percent of water), covering around 80Mha area under irrigation.

Recent Technological Developments

Areas	Technology Developed
Farm Machinery Power	Light weight power tiller, and tractor operated inclined plate planter, technology for rice-wheat mechanization, high capacity pigeon pea threshe.
Irrigation and drainage equipment	Irrigation equipment system and testing facilities, tractor operated mould plough, water harvesting, recycling and recharge system, remote controlled pump switch off device, water level indicator.
Agro-Processing	Fruit grader, low cost technology for pulse storage, bamboo stick making machine, improved dal mill.

Source: Anonymous. CIAE. 2000. Two decades of agricultural engineering research at CIAE, CIAE, Bhopal.

According to the survey done by Ministry of agriculture, Government of India in 2003-2004, there are about 16 million electric motors and 9 million diesel engine pump-sets for lifting water from various sources. And the total electricity consumption is about 90 billion kWh of electricity and 3.6 billion litre of diesel annually. Efficiency of diesel operated pumps is about 12.7 percent and electrically operated pump is about 31.1 percent.

Following is the table presents **advantages of mechanization**

Increase in productivity up to 12-34%
Seed-cum-fertilizer drill facilitates saving in seed by 20% (approx.)
Savings in fertilizer utilization 15-20% (approx.)
Enhancement in cropping intensity by 5-22% (approx.)
Increase in gross income and return of the farmers by 29-49% (approx.)

Source: Report of the sub- group on Agricultural Implements and Machinery for Formulation for 9th Five Year Plan, Govt of India, 1996.

Population growth trends in stationary farm power sources in India for pump-sets (In millions)

Mechanical power	1961-62	1971-72	1981-82	1991-92	1996-97	1997-98	2003-4
Electric pump	0.1	1.63	4.33	9.34	11.57	11.85	16
Diesel pump	0.23	1.55	3.1	4.59	5.58	5.84	9

Source: Agriculture Statistics at Glance, 2004

FUTURE PROSPECTS IN MECHANIZATION OF AGRICULTURE

The central institute of agricultural engineering, Bhopal has identified the various issues and adopted strategies in different areas to meet the challenges of precision agriculture. Advantages of adopting various strategies makes the country more secure in meeting the future food grain requirements, provide nutritional and health securities and also helps in creating new employment opportunities in rural areas. Following are the various issues being dealt are:

Advance technologies for tools improvement, mechanization of various agricultures such as horticulture and hill agriculture with precision farming, extraction of energy from various sources such as biomass, use of bio-diesels etc.

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Arthropods: The animal group with startling biodiversity

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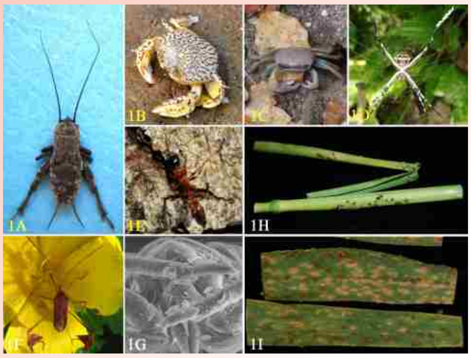
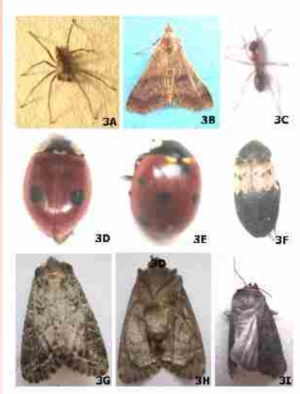
Arthropods are highly diverse. The group accounts for over three-quarters of all currently known living and fossil organisms. They are the most successful type of living organism known on the earth as is showcased by the huge number of known species. Over 50% of the total described animal species known till date are represented by the arthropods. The exact number of living arthropod species is unknown since many have yet to be identified, especially those inhabiting tropical rainforests and oceans. It is believed that so far only 1/5th of the available species of arthropods has been discovered, so a big number of species are believed to inhabit different ecosystems and environment of the earth beyond the limits of our current knowledge database. Arthropods derive their name from their jointed legs. One of the most interesting facts about the group is their cosmopolitan distribution varying from terrestrial as well as fresh and marine aquatic ecosystems; such as deep seas and oceans, lakes, ponds, ditches, rivers, rivulets and swamps to tropical rain forests and reef ecosystems to isolated islands, deserts and even mountains. Arthropods are also predominant in all scrublands, grasslands and all kinds of forests, estuarine and brackish water ecosystems, coastal ecozones, riverine regions and even in the arid regions of the world.



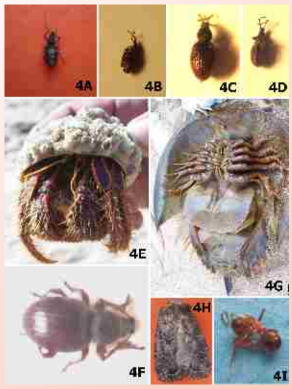
The phylum Arthropoda is classically grouped into five distinct sub-phyla: i. Trilobitomorpha (represented by fossil Trilobites), ii. Chelicerata eg. horse shoe crabs (Fig 4G), spiders (Fig. 1D & 3A), scorpions (Fig 2F) etc., iii. Myriapoda eg. centipedes and millipedes, iv. Crustacea eg. shrimps, prawns, lobsters (Fig. 2I), copepods, crabs (Fig. 1B-C & 4E) etc., and; lastly v. Hexapoda (represented by insects (Fig. 1A, 1E-I, 2A-E, 2G-H, 3B-3I, 4A-4D & 4F-4I), collembola etc. The living arthropods currently believed to have evolved from living onychophorans like Peripatus with similarities to members of Annelids and are divided into three subphyla, 16 classes and innumerable orders and families. Around 90% of arthropods are represented by insects and the remaining by other known (crabs, spiders, scorpion, prawns, shrimps, centipedes, millipedes etc) and a wide variety of lesser-known members from the other subphyla.

Arthropods are bilaterally symmetrical with conspicuous segmented bodies with paired and usually jointed appendages on some or all of the body segments. They have rigid and hard, chitinous exoskeleton protecting their bodies from desiccation and is molted regularly. After every molting process it is replaced by the new exoskeleton connected to a complex muscle system (both longitudinal and circular bands) that enable smooth and free movement and guides their locomotion. Strangely too they have highly sophisticated nervous system among evolutionary advanced members of the group in the form of brain and double nerve chord, nerve organs like compound eye are extremely interesting among insect members.



Due to the wide diversity arthropods are of unparallel; importance to the global. It can be said that in absence of the arthropods, life on this planet would simply collapse and would cease to exist altogether. Arthropds also have huge economic importance constituting several industries as sericulture, lacculture, fisheries (such as prawn, shrimp, crab productions etc). They constitute an important food source for a wide range of vertebrates inhabiting both terrestrial and aquatic ecosystems and indirectly are parts of innumerable food chains and food webs. In the form of insects their invaluable as pollinators of flowering plants and thereby plays a key role in multiplication, propagation and conservation of global floral diversity as well as modern agriculture. They are also responsible for a wide diversity of species of pants and animals and are hence also responsible for huge global economic losses and resulting in widespread crop failures as well as death of domesticated animals, livestock and wildlife globally.

Arthropods play great importance in the global ecosystems and agriculture by playing vital roles in both functioning as an important integral constituent representing different environments as well as corner stones of different food chains. The world without arthropods is indeed a vacant world in which the founding pillars constituting the central tower of life have been abruptly removed. While we mostly worry about the vertebrates such as the fishes, amphibians, reptiles, birds and mammals from the conservation perspective; we often overlook the smaller invertebrates that are consistently present in every possible ecosystem we can take into consideration-freshwater, marine and terrestrial. Already severe anthropogenic pressures have been causing destabilization of arthropod populations across the globe. The wide diversity of this group startles our imagination and the loss of several species through acute environmental pollution, loss of habitats, anthropogenic pressures for various commercial proposes and overexploitation with no long term planning, diseases, introduction of unwanted exotic species in vulnerable ecosystems, over application of various agricultural chemicals particularly indiscriminate applications of different pesticides without regulation are responsible for serious damages to the global arthropod populations. Furthermore, several arthropod members such as butterflies and other insects with luxuriant beauty and display particularly from the global tropical regions are regularly illegally captured and sold in under ground exotic pet markets or for illegal collectors of such biological species both dead and alive for various purposes.



The ravages of deep sea fishing, illegal exploitation of marine arthropods, exploitation of marine resources by site poisoning or by using indigenous explosives, trawl net fishing irreversibly destroying the sea floor bottom; all have cumulative impacts on the rapid degradation of marine arthropods significantly destroying human employment and human food resources in different parts of the world from the point of long term sustainability. The practice of dumping untreated sewage, domestic and toxic industrial wastes directly into estuarine and brackish water pools connected to open seas and oceans are another source of pollution that is degrading the marine ecosystems destroying vulnerable populations of commercially as well as ecologically important arthropods around the globe. Not only the losses are impacting human food chains; this is also seriously disrupting several complex food chains and foods webs dependent on various marine arthropods of the oceans that have evolved over several millions years of evolution. It will be important to develop a global consortium to work in a coordinated fashion towards the conservation of global arthropod biodiversity.

Next Generation Sequencing: A Revolution for Horticultural Crops

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Dr. Nimisha Sharma

Horticulture is one of the important sectors of agriculture. With the growing population, demand for horticultural products is gradually increasing. The most important challenge in many of the fruit species is the unavailability of well defined molecular genetic linkage maps. Many times these species are difficult to study at genetic and molecular levels because of their perennial nature and due to this, development of mapping population and map based studies are not easy.

Therefore, genome sequence is a prerequisite resource for understanding completely the roles of genes in development, driving genomics-based approaches to systems biology and efficiently exploiting the natural and induced genetic diversity of a species. Initially only plants with relatively small genomes were selected for sequencing. A decade ago, technological limitations forced the plant biology community to select a few species as models. As a consequence of continued improvements in sequencing technologies, methods and bioinformatics capabilities, sequencing goals need no longer be limited. With the development of next-generation sequencing (NGS) technologies, this paradigm can change and plants can be prioritized for sequencing in relation to their value to humans. NGS provides the possibility of cost-efficient transcriptome profiling. First plant genome sequence, Arabidopsis (*Arabidopsis thaliana*), in 2000 spawned an expansion in genomics-based research and the exploitation of annotated genes to explore orthologous genes in other plants. It also paved the way for sequencing several other model plant genomes and a few crop genomes. Being complex genomes of horticultural crops, it would also be difficult to sequence these species de novo using NGS technologies. Latest genomic technologies can be effectively used in horticultural crop improvement programmes. Availability of NGS technologies like FLX-454, Illumina, SOLiD and Helicose have brought hopes to generate genomic resources for many more horticultural crops in few years time. Therefore, the horticulture breeders should equip themselves to make use of this extensive genome information in their varietal development programmes.Genomic research has great potential to revolutionize the molecular biology research in horticultural crops in many ways. Among fruit crops, first draft with 8× high quality grapevine sequence was released by the International Grape Genome Project (IGGP). The second fruit crop transgenic 'SunUp' papaya was sequenced by the Hawaii Papaya Genome Project. Sequenced genomes of fruit and vegetable crops are presented in Table 1. Status and availability of genomic resources in horticultural crops can be utilized for the efficient exploitation of the current research in developing improved varieties and also defining future goals. Recent advances in automation and high throughput techniques used in decoding plant genomes play an important role to speed up the genomic research. With the establishment of genome and transcriptome sequencing projects for several horticultural crops, huge wealth of sequence information have been generated. These sequence information have been used extensively for analyzing and understanding genome structures and complexities, comparative and functional genomics and to mine useful genes and molecular markers.

Table 1: List of sequenced genomes of fruit and vegetable crops

Plant	Genome Size	No. of Predicted Genes	Year of Completion
Beta vulgaris (Sugar beet)	714–758 Mbp	27,421	2013
Solanum lycopersicum (Tomato)	900 Mbp	34,727	2012
Solanum tuberosum (Potato)	844 Mbp	39,031	2011
Prunus persica (Peach)	265 Mbp	27,852	2013
Phoenix dactylifera L (Date palm)	605.4 Mb	41,660	2013
Musa acuminata (Banana)	523 Mbp	36,542	2012
Citrus sinensis (Sweet orange)	367 Mbp	29,445	2012
Citrullus lanatus (Watermelon)	425 Mbp	23,440	2012
Cucumis melo (Muskmelon)	450 Mbp	27,427	2012
Fragaria vesca (Wild Strawberry)	240 Mbp	34,809	2011
Malus domestica (Apple)	742 Mbp	57,386	2010
Cucumis sativus (Cucumber)	350 Mbp	26,682	2009
Carica papaya (Papaya)	372 Mbp	28,629	2008
Vitis vinifera (Grapes)	487 Mb	30,434	2007

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