

Human civilization is characterised by a miraculous evolution called 'agriculture'. This evolution a complementary race between artificial and natural selection operating with unusual 'pace', space and scope.

It may be useful to list several elements of 'agricultural history' that have observable evidence and these also epitomise highly innovative changes and dramatic shifts.

Agriculture is essentially modifying, tempering and transforming plants and animal species suited to human convenience, need and desires. Several thousand to hundred years witnessed gradual and cumulative changes due to both limited 'natural' as well as 'artificial' selections. e.g. genetic changes that produced non-dehiscent or not-so-dehiscent pods of legumes was 'natural' but choosing them for purposeful cultivation was 'artificial'. Similarly, evolution of wheat from 24 chromosomes to 36 chromosomes to 48 chromosomes was natural (though accidental) but the vast propagation and spread of 48 chromosomes, wheat-bread was artificial.

This melange, mostly epitomised as 'domestication' of erstwhile wild forms, is the backbone of early period agricultural revolution. Let us call this as Agriculture 0. [This is just mimicking the recent practice of labelling industrial development phases of evolving software versions!]

Agriculture 1.0 onwards we have ever-enduring process of mass-migration of 'domesticable' or domesticated species across continents. The wild 'Vavilov' centres supplied early materials for i.e. plant species and varietal transformation. Many of them gradually left their 'birth' centres and managed to survive in somewhat different agro-climatic conditions (including stressful competition from co-existent species). From agriculture 1.0 onwards, history evidences proliferation of identification as well as isolation of varieties having greater yield and survival capacities. These were also supplemented by artificial cross-breeding across varieties. A cursory look at the varieties of 'Shalee' (Rainy season rice) and Vrihi (winter/Autumn season rice) listed in Charak as well as 'Sushrut' with their agronomic habits and medicinal/therapeutic properties would evidence this.

Plants migrate through water, birds, and animals and of course distinct class of animals called 'Humans'. A very large class of staple-food grains (mostly *monocotes*) of African 'wild-origin' made agriculture based life viable in the regions which were less endowed with assured water availability. (e.g. Jowar, Sorghum, Rye in Deccan and Southern India)

Agriculture 2.0 which pertains to the period of so called period of rising trade and early industrialisation is remarkable. Global warming since 9th century enlarged prospects of agriculture in temperate zones (including snow covered Nordic region). But this suffered reversal with 'Little Ice Age'. This resulted in Europe's fascination, even obsession, with industrialization was partly triggered by sustained failure of crops and frequent droughts'.

Trade ventures of Spanish, Portuguese and Italians in South America unleashed a new additional wave of introduction novel 'plant species and their migration'. Some of them have impacted food preferences and cuisine cultures very deeply and made food across world appear close and similar in its palpable elements. e.g. 'Potatoes', 'Chilly' and 'Tomato', all of them from 'Solanaceae' family (otherwise despised as poisonous and 'night-shade') are now ubiquitous across many cuisines!

India is one of the large producer of all three of them. The visible but unnoticed hand of artificial selection that converted these poisonous fruits into cherished edible food. Paradoxically one more so called poisonous member of Solanaceas that has Indian wild origins and long history artificial selection within India, is being denied any further artificial selection through genetic technology namely 'Brinjal'! Failure to recognise role of artificial reflection is at the root of this denial.

Agriculture 3.0 is marked by mechanisation of agriculture which is being practised all over the world though with differential depth (These differentials are largely due to differential land-man ratios and average farm size across countries). Agriculture 3.5 is characterised by the breakthrough that Haber achieved in synthesizing urea artificially in laboratory. This heralded chemical revolution phase in managing agriculture! A variety of ingredients, macro as well as micro-nutrients, insecticides, pesticides, weedicides etc. are produced in large quantities This phase is also marked by some remarkable fusion breeding in Rice and wheat and emergence of genetic technologies. These have and will continue to replace traditional bio-metric cross breeding methods is development of plant varieties.

Agriculture 4.0 is an evolving complex of propagation based plantation material a) These guarantee predictable, uniform growth patterns, simultaneous flowering of millions of plants simultaneously and that too with stable uniform quantitative/qualitative traits (b) Treatment of plants as stable reproductive mechanism with well-established protocols of macro-micro nutrients, water requirements, hormones as well as size of canopy, foliage, controlled size of flowering and fruition. (c) Managing micro climate together with controlling a-biotic stress

by well anticipated design of farm, light and moisture availability timely quick response for shifts and protection aided by short terms weather forecasts. All this is accomplished, through use of 'Sensors'. This augurs a potential A-I advents in agriculture as well. More importantly, there would be greater use of 'micro-natural extracts' than presently popular 'chemical approach'. Production of soil-like substance, rapid organic decomposing, hydroponics, are likely to be widespread. Precision Agriculture (PA) and the integration of digital technology are set to become the most influential trends in the agriculture sector, as a growing number of farmers start to adopt digital technologies to run their businesses. Precision Farming can potentially help farmers in producing higher yields achieving less crop damage and fewer quantity of inputs such as water, fuel and fertiliser. These technologies are still expensive to most farmers, especially for the smaller ones. Developed countries are also facing an ageing workforce on farms, and the introduction of new technologies could result in a "two-speed" agriculture.

Since last 50 years similar and parallel shifts have begun occurring in post-harvest aspects of agriculture: harvesting, packaging, pre-cooling, cold claims, have witnessed dramatic improvements with value chain being stretched till retail ends. Post-harvest managements now consist of range of additional services and standardised trade practices with backward traceability up to farm-level. Backward and forward linkages of every aspects of agriculture are far more organised, articulated and catered by visible service sector economy within agriculture. Consequently, demand and supply of nature of human skills, employments opportunities within rural areas have already begun changing. Contrary to popular imagination this process is already operative in several LDC countries including India.

Weakest link poses strongest challenges. There are some notable weaknesses of over populated LDCs.

- (a) They are relatively land scarce countries and extant land rights (including tenancy relation) pose a serious obstacles more flexible access to land resource. Innovative and competitive agriculture markets require that for land should become open and flexible, in absence of such market any prospective investment (and investors) will continue to shy away from agriculture.
- (b) Traditionally, industrialised countries have produced historical legacy of tilting terms of trade against agriculture and in favour of non-agriculture sector. This needs to be

reversed for some period. (As China allowed and tolerated higher food inflation while liberalising and dismantling pervious collective farms).

- (c) Providing institutional framework for competitive markets for farmers to participate and breaking extant monopolies or oligopolies of few traders who presently control so called regulated markets.
- (d) Providing infrastructure for post-harvest and processing industries
- (e) More stable open predictable export-oriented trade policy for agriculture produce.

Every epoch of rapid industrialisation across countries have witnessed massive transfer of labour away from agriculture. With emerging novel technologies modern agriculture will absorb enough manpower around agriculture than within agriculture. The most ethical question is, “How a sizable layer of farmers would be shifted away and out of agriculture without severe survival and economic disruptions.” History so far shows that ‘similar outcomes’ but not ‘same process’ of transformation. This is the policy question that awaits social and political innovation.

Innovation led modern agriculture is a more assured way of industrialization than forcing agriculture to pay ‘tribute’ for advancing industrialisation as Stalin demanded in his regime.