Chapter 3
Appropriate Technology – History, Concept And Evolution

3.1 Introduction

The present chapter attempts to trace the context of the evolution of appropriate technology. The relation between resources and technology are discussed, and the resource use pattern under different types of technologies are critically analyzed. The conventional development strategy and effects of technology on society are critically evaluated. The impact of modern technology on traditional technologies and the resource base is also looked into.

For the last 300 years science has proved itself an incredibly powerful revolutionary force.\(^1\) Never in the history has mankind achieved so much technological progress as in the last five decades. This is the age of glittering scientific and technological achievements.

But in spite of the marvellous achievements of science and technology the world order emerging since science and technology became a dominant factor in the socio-economic life of mankind is highly confusing. On one hand it has created peace and prosperity but on other hand it has produced war, break-down, exploitation, poverty etc.

3.2 Science and Technology: Definitions

Webster’s New Collegiate Dictionary defines science by referring to those following four aspects: knowledge obtained by study and practice; any department of systematic knowledge; a branch of study concerned with observation and classification of facts
and hypothesis; specific accumulated knowledge systematised and formulated with reference to the discovery of general truths or the operation of general laws, especially such knowledge when it is related to the physical world.

Science is not mere observation and classification of facts but which involves a capacity for controlled experimentation. It is this capacity for controlled experimentations that has given rise to technology.

According to Webster's Dictionary, technology is industrial science, applied science, and systematic knowledge of industrial art. Gendron (1977) defines technology “as a technology is any systematised practical knowledge, based on experimentation and/or scientific theory, which is embodied in production skills, organisation or machinery."

3.3 Science and Society

The effects of science and technology on society varies from society to society. According to Russel (1952), dispelling many of the traditional beliefs is the direct result of the intellectual influence of science and technology on society. Many of the taboos like attribution of illness to sorcery, failure of crops to angry Gods or malignant demons, practice of human sacrifice to promote victory in war and for fertility of soil, belief of eclipses and comets as presage of disaster etc. were removed in the scientific reasoning and outlook. There were three ingredients in the scientific outlook of eighteenth century.³

(i) statements of fact should be based on observation, not on unsupported authority;

(ii) the inanimate world is a self-acting self-perpetuating system, in which all changes conform to natural laws;
the earth is not the centre of the universe, and probably man is not its purpose (if any); moreover, "purpose" is a concept which is scientifically useless.

These items make up what is called mechanistic outlook. This mechanistic outlook bred a lot of invention which had great impact on the society.

Two discoveries of the late Middle Ages were of profound importance in the social and economic sphere. They were gunpowder and the Mariner's compass. The modern power of state began in the late 15th century and began as a result of gunpowder. The Mariner's compass made possible the age of discovery. The new world was opened to white colonists; the route to East round the Cape of Good Hope made possible the conquest of India and brought about important contract between Europe and China. The invention of steam engine was a great landmark in the history of mankind and in turn it was one of the most important elements in the Industrial Revolution. Transport facility brought by steam energy through steamer and railways had profound effect in society. Invention of electricity, oil, and the internal combustion engine had opened new vistas in use of energy.

Invention of telegraph was a milestone in the communication field. Atomic energy, and development of flying were major breakthroughs in the technological development of the humanity. A new source of power and a means of mass annihilation was invented through atomic fission and fusion. Aeroplane has conquered the space and time. But each invention was increasing the centralised control in the society. Also each invention was adding invention of power with a few. This was radically altering a million years of history of man's existence.
3.4 Technology, Development and Exploitation

The growth of scientific temper and technological innovations culminated in Europe and the West with what is called Industrial Revolution. The major technological innovation hitherto been scattered in European and Western societies were brought together through the revolution. The cumulative effect was a new production paradigm which apparently created peace and prosperity for the command area. A new development era took origin by the Industrial Revolution. The major features of the development were:

i) it was based upon energy and resource-intensive production technologies;
ii) it was based on centralisation of power and authority;
iii) it was highly capital intensive;
iv) it was based on mass production.

The new production paradigm spearheaded by the industrial technologies made alarming changes in Europe and the West where the revolution took its birth. The energy and resource-intensive production technologies introduced a long and indirect chain of resource utilisation which leaves invisible the real material resource demands of the industrial process.

The exponentially growing resource demand for the industries of Europe and the West was largely met by ruthless exploitation through colonisation. There was in fact a vicious circle acting between technology development and colonisation and so also was the case of technology development and economic exploitation. The Western technology of steamers enabled the voyages from Europe to the occupied territories to be considerably shortened. Technological domination also enabled the West to ravage the global resource base. The railway system is commonly assumed to be one of the benefits bestowed over India by the British. The railways played a major role
in the economic drainage of our traditional agriculture and industrial system. The
main period of colonial expansion was between 1850 and 1900. The colonial
exploitation extends to every aspect of the colonised person: body, mind, output land
resources, home, family, language, history, tradition, and so forth.

The Western Europe had a lead in making others colonised. Counties like India,
Nigeria, Tanzania, Sri Lanka, Malaysia, Zambia, Kenya, Uganda, Sierra Leone and
Jamaica etc. were major countries colonised by Great Britain. France, Belgium and
Holland etc. were the other countries that followed the path of Britain.

The colonial situation impoverished the colonised. According to Shiva et al. (1991),
colonial domination systematically transformed common vital resources into
commodities for generating profits and growth of revenues. The first industrial
revolution was to a large extent supported by this transformation of commons into
commodities that permitted European industries access to the resources of South
Asia. For instance the ever-increasing resource demands of the industrial revolution
in England were largely met from colonies like India.

3.5 Nationalism and Governmental Roles in Development

The Second World War marked an end of the colonial exploitation. Struggle for
freedom by the national parties and different groups culminated in the collapse of
international colonial structure. The United States, which emerged as one of the most
powerful nations, through the Second World War, supported the cause of freedom
movement. When a decade after Second World War, a number of countries gained
independence and establish themselves into sovereign countries. The process took
momentum and by 1960s all colonized countries became independent and got their
own ‘self rule.’ In the developmental scene these nations were watermarked as third,
fourth world countries (Diwan and Livingsten, 1979) or developing countries (Sachs, 1997).

After Independence and during fifties and sixties erstwhile colonised countries established their own governments by the national parties who spearheaded the freedom struggle. An endogenous development was expected from these countries under of the sovereign governments. But on the contrary many of the countries inherited the colonial traditions and the colonial governing apparatus with its associated mechanisms of repression against the opposition on the one hand, and privileges for those in control, on the other hand (for example, luxuriously furnished houses with servants, large posh offices with a hierarchy of bureaucrats and minions and so forth). Shiva et. al. (1991) reiterates the same; “However, resources use policies continued along the colonial pattern and, in the recent past, a second drastic change in resource use has been initiated to meet the international requirement and the demands of the elite’s in the third world.”

The classification of countries as developed and developing (countries) by Truman in 1945 was a landmark in the history of development of the erstwhile colonised countries hitherto been known by different names like underdeveloped, third world, fourth world countries etc.

Harry S. Truman’s famous statement of January 20, 1949 can be regarded as the official proclamation of the end of colonial age and the beginning of a new era in development. He announced a future strategy for economic growth and prosperity for the entire world especially for the developing world: “We must embark on a bold new program for making the benefits of our scientific advance, and industrial progress available for the improvement and growth of underdeveloped areas... The old
imperialism—exploitation for foreign profit—had no place in our plans... Greater production is the key to prosperity and peace and the key to greater production is a wider and more vigorous application of modern science and technical knowledge.9

3.6 Conventional Development Strategy

By the Truman’s proclamation the developmental paradigm of the developed countries (of the West) rationalised “as desired state of development” and made adaptable for the developing countries. For developing countries whose per capita income was very low, whose infrastructural facilities were inadequate, whose population and economy was mainly dependent upon agriculture, whose labour productivity particularly the manufacturing was very low, this was an attractive proposition. So the most of the newly independent developing countries opted for what may be called Conventional Development Strategy (CDS).

The conventional development strategy is based on two basic propositions:10

1) The developed countries of the West provide an example of the “desired state of development.” And so what is expected for the developing country is a replication of the policies and programmes of the developed countries.

2) Development is defined as increase in GNP per capita: The prevalent notion that GNP per capita provided a homely and acceptable index of development and so development is defined as an increase in GNP per capita.

A centralised mode of production came into operation with the borrowed industrial science and technology of developed Western countries. Obviously this had given a boosting for the desired GNP per capita. But the production technology used in the large-scale production was resource capital energy intensive that, the stock and flow
of the natural resources were affected by the mode of production. As the production process used was essentially a skill intensive one, the potential unskilled and plentiful labour force available in the developing countries also could not be made use of. The trickle-down effect of the mode was highly marginal if not negligible. This typical ‘top to down’ development plan has been in operation in most developing countries over the last 40 years. There were only a few success stories, but Conventional Development Strategy has created a number of problems whatever be their organisational structure. Both the advanced capitalist and communist countries follow the common principles of planning from above. In the former it was based on governmental rules and regulations, the setting up of welfare state in order to reduce ravages of capitalism or provide sufficient security and the creation of a new coalition of the classes that control the market on the one hand and the government on the other. In the other case it was a straight command planning from above that eliminated the market principles and forces. Nevertheless in both cases there was no concept of planning from below.

3.6.1 A Critical Evaluation of the Conventional Development Strategy

After forty years of development, the developing countries that adopted conventional development strategy have made great progress in terms of increase in per capita income of their rapidly growing population. The infrastructural, educational, and health facilities of the developing countries have also improved appreciably. But a close look at the development will reveal the fact that the achievement was not so uniformly distributed nor the problems were appreciably lessened “... despite this growth record, poverty has not been appreciably lessened. Levels of unemployment
and income inequality are increasing, as are the number of people living at or below subsistence level.\textsuperscript{11}

According to World Bank, there were by early 1980s over 800 million people (almost half of the total population of the developing world) living in absolute poverty. Such people are denied the basic compounds of a decent human life—adequate food supply, adequate clothing, and housing, and access to basic services such as clean water, energy, school, and health facilities—which are taken for granted by the people in developed countries.\textsuperscript{12}

Sachs (1996) observes, “After forty years of development, the state of affair is dismal. The gap between front-runners and strugglers has not been bridged; on the contrary, it has widened to the extent that it has become unimaginable that it could ever be closed. The aspiration to catch up has ended in a blunder of planetary proportions. The figures speak for themselves: during the 1980s, the contribution of developing countries, where two-third of humanity live, to the world’s GNP has shrunk to 15 per cent, while the share of the industrial countries, with 20 per cent of the world’s population has risen to 80 per cent . . . . On the global as well as on the national level, there is a polarising dynamic at work, which creates an economically vigorous middle class on the one side and large sections of socially excluded population on the other side. The best one can say is that development has created a global middle class of those with cars, bank accounts, and career aspirations. It is made up of the majority in the North and small elites in the South and its size equals roughly that 8 per cent of the world population which owns an automobile.”\textsuperscript{13}

Sachs continues, “after all, with the fruits of industrialism still scarcely distributed, we now consume in one year what it took the earth a million years to store up.
Furthermore, much of the glorious productivity is fed by the gigantic throughput of fossil energy; on the one side, the earth is being excavated and permanently scarred, while on the other a continuous rain of harmful substances drizzles down—or filters up into the atmosphere. If all countries 'successfully' followed the industrial example, five or six planets would be needed to serve as mines and waste dumps. It is thus obvious that the 'advanced' societies are no model; rather they are most likely to be seen in the end as an aberration in the course of history. The arrow of progress is broken and the future has lost its brightness.\textsuperscript{14}

According to Dunn (1978), the conventional development model creates a number of capital plants like steel works, chemical works, roads, dams, airports, power stations etc. “These are undoubtedly an essential component of development but are by no means the whole story. One result of such programmes has been the growth of a dual society, islands of development, usually in the towns populated by a highly educated elite but surrounded by a stagnant rural sea. It is in the rural areas where most of the population live, typically 70-80 per cent, and here the pattern is not of growth but of decay, lack of development, mounting unemployment and drift to the towns.”\textsuperscript{15} So it is seen that a lop-sided development is taking place by the application of the modern capital-intensive technologies. Its effects on society, culture, and economy are critically evaluated below.

3.7 Effects of Technology on Society

3.7.1. Cultural distortions and formation of dual societies:

The basic objectives of every society are to reduce the gap between its rich and poor. The experience so far in the developing countries by the introduction of conventional industrial technology is that the gap is widening. In sociological terms, their pattern
of development has created a dual society composed of two separate societies. One is a very small fraction of the population made up of rich, elite, urbanised and powerful. The other is the large majority of poor, exploited, rural and powerless people.

The modern technology in the developing countries has attempted to develop the same cultural trends and values as those of industrialised countries. It has fuelled the same pattern of consumerism and consumption. The cultural pattern emerging as a result of the use of the products of modern technologies is largely alien to the traditional societies of the developing countries.

### 3.7.2 Extravagant resource use and growth of consumerism

One of the most important features of modern technology is its strikingly high rate of resource utilisation. This feature of the conventional technologies was under severe criticisms from the era of technological revolution. In fact modern industrial technologies have created an invisible or indirect chain of resource use and the process is often irreversible that the resources are eventually being converted into commodities. This is creating breakdown and conflicts in society and is causing severe ecological and cultural criticism.

The natural resources, which are detrimental to the prosperity and well being of man and society, were under different mode of use across the history of mankind. Gadgil and Guha (1992) distil four distinct modes of resource use from the long sweep of human history. They are

(i) Gathering (including shifting cultivation);
(ii) Nomadic pastoralism;
(iii) Settled cultivation;
(iv) Industrial mode.
Human being had exercised prudence up to an extent in their use of resources under the modes of gathering, nomadic pastoralism and settled cultivation. Technologies used during these three modes were comparatively simpler and they included simple artefacts and naturofacts.

3.7.2.1 Resource Use in Gathering Mode

Resources for the survival under gathering mode, which was the largest period of human history, were acquired within a small area, at best, a few hundred square kilometres. “In gathering mode, societies depend almost exclusively on human muscle power and wood fuel as sources of energy and in naturally available plants, animals and stones, to fulfil their material demands.”

3.7.2.2 Resource Use in Nomadic Pastoralism

In the pastoralism mode the exclusive gathering habit came to a close with domestication of plants and animals. Pastorals have used animal muscle power in addition to their own power for the survival. They moved over large distances with their access to animal energy and gathered food for their needs.

3.7.2.3 Resource Use in Settled Cultivation

Settled cultivation was a landmark in the history of development of mankind where societies learnt to cultivate plants and grow animals. Probably this mode was in operation for the last 10,000 years. Techniques of seed selection, plant protection, manuring, harvest and post-harvest activities, water resource management etc. were evolved during this period. “Pre-industrial agricultural societies (more properly, peasant societies) have a fairly substantial knowledge base in relation to husbanded plants and animals; they also view nature as being subject to human control to a very
significant extent.” But in the industrialised world cultivation has come to depend increasingly on fossil-fuel energy.

The settled cultivation mode of resource use had its impact over the ecology. The impact may be characterised as intermediate. Conversion of forests, marshes or natural grasslands into artificial crop field or grasslands began by settled cultivation. Fire and artefacts like stone axes, metal axes were aiding the process of conversion. "The cumulative impact of these interventions is a striking change in the landscape, which very likely becomes heterogeneous, manifesting a variety of successive stages within a mosaic. It could also result in the local extinction of some species of plants and animals.”

3.7.2.4 Resource Use in Industrial Mode

An altogether different mode of resource use was set in the industrial mode that was the latest mode of resource use to appear in human history. This mode was in operation for just about two hundred years and it has given rise to an unprecedented and colossal exploitation of resources. Both non-renewable and or renewable resources were affected by the market-oriented industrialised technology. These resources formed by unknown process of natural cycle of the nature through millions of years were ruthlessly converted into commodities for market and for ‘development’. This has given rise to a number of conflicts on one hand and severe ecological and environmental breakdown on the other hand. Shiva (1997) observed three great myths of development that have caused severe ecological and cultural erosion in India and elsewhere are:20

1) Nature is uncreative, unproductive and valueless until exploited as "raw material" for industry.
2) Cultures and knowledge systems that build on nature's creativity are also uncreative, unproductive and valueless.

3) There is no knowledge, no economy, no culture, no rights prior to establishment of industrial civilisation. They gain value only as raw material for industrial civilisation.

Over the last three centuries, industrial societies have steadily expanded their resource base for their ever-increasing demands for resources to sustain the pace of development. "This has been achieved by gathering knowledge about the working of nature—through the hypothetic deductive method of modern science and by the links established between scientific discoveries and practical application—in order to keep additional sources of energy, process and materials etc."21

The intensification of resource exploitation by the industrially-advanced countries of the North and the industrial enclaves in the underdeveloped countries of the South in the colonial and post-colonial period through the rapid spread of energy- and resource-intensive production technologies has created a number of conflicts in the developing societies.

For centuries, vital natural resources like land, water, and forests had been controlled and used collectively by village communities. The heuristic knowledge of these communities was such that they were ensuring a sustainable use of these renewable resources. The industrial revolution and technological revolution that went hand in hand in Europe and the West has created unprecedented demand for resources. It has already discussed that the search for newer and newer sources of resources to feed the industrialisation process of Europe and the West has resulted in colonising a number of countries of the third world. The colonial domination was an assault over the
resources hither to been used and enjoyed by the village communities. Shiva (1991) observes, "The first radical change in the resource control and the emergence of major conflicts over natural resources induced by non-local factors was associated with colonial domination of this part of the world. Colonial domination systematically transformed the common vital resources into commodities for generating profits and growth of revenues." The production paradigm in the post-colonial period hadn't have any qualitative change but continued along the colonial pattern. The sovereign governments that took governance in erstwhile colonies continued the resource exploitation by the borrowed or transferred industrial and agricultural technologies of the developed countries for building their economy. But this has also produced conflicting situation in the society. The survival needs of a large section of population who were politically weak and socially disorganised were worse affected and they became the victims of the development process.

A very large population of the developing countries always lived by biomass-based subsistence economy. The rural folk eked out their living from the products obtained directly from plants and animals. This lifestyle of 'living within the limit' of the resource potential of the society is by and large treated as poverty by the West (Dasgupta and Mater, 1996). And so the 'poverty' faced by them were interpreted as the society's incapability in utilising/exploiting the natural resources. “If there has been a single thread running through forty years of investigation into the poverty of poor countries, it has been the neglect of this resource base.”

But low level of resource utilisation of the indigenous societies of the third world countries especially of the East was part of their worldview and way of life. The traditional societies in all their diversity have shared a common set of characteristics
for their use of resources. "They have used natural resources prudently to satisfy minimum needs sustainably over centuries. Such resource use was based on:"

(i) A knowledge system with an ecological understanding of nature;

(ii) A technological system for processing resources to satisfy human needs with minimum resource waste, and

(iii) Rationality criteria for demarcating vital and non-vital needs and between resource destructive and resource enhancing technologies.

The scientific and technological development hitherto hadn't enhanced these basic communities but it was rather doing the opposite. The different manifestations of science and technology in the form of huge dams and machines questioned the very survival of these communities. This is by depriving them of the access to the resources over which they build their survival economy. So the modern 'efficient' and 'productive' technologies created within the context of growth in market economy couldn't solve the problems but instead created a newer set of problems. Social and ecological problems are mushrooming out of the indiscriminate application of modern technology. Quite a few thinkers and visionaries warned about the problems of technological development. They include Gandhi, Kumarappa, Schumacher, and Ivan Illich etc. A mention has already been made about their vision in the 'Review of Literature' part. But one remarkable work by the Club of Rome—'The Limits to Growth: The Predicament of Mankind'—needs special mention. A group of researchers from Massachusetts Institute of Technology (MIT) made a study of the human predicament using computer modelling and world dynamics approach. The result was published as a report of Club of Rome—'The Limits to Growth'. The
message of this report is that infinite growth in a finite environment is not possible and that if the world insists on a continuation of the trends of the last twenty-five years, there will be death by growth. That “if the present growth trends in world population, industrialisation, pollution, food production and resource depletion continue unchanged, the limit to growth in this planet will be reached sometime within the next one hundred years.”25

3.7.2.5 The Theory of Limits to Growth

It is on the following that the Limits-to-Growth theory is built. Most resources, particularly minerals and non-solar energy, are in some sense finite. The faster they are used, the sooner they will be exhausted. Exponential growth in resource use will result in sudden and catastrophic collapse. Increased efficiency in resource use, new technologies, recycling and other forms of resource conservation will only postpone (generally for a decade or less) but not prevent collapse. The only long-term solution to finite reserves is population control, zero economic growth and a shift to renewable resources in all areas of human life.

Through the report raised severe criticism as ‘doomsday prophecy’26, ‘twenty-ninth day riddle’27 etc., it could remind the world that natural resources were exhaustible and a judicious use of the resources was the way to sustainability.

3.7.2.6 Functional view as opposed to Limits-to-Growth view

There are other views like the functional or cornucopian view, radically opposing the Limits-to-Growth theory. According to the functional view, “there are no such things like natural resources. Human intelligence creates resources. Nature, the physical environment, or whatever one chooses to call it, provides the building blocks and the limits within which human ingenuity, operates to fashion a way of life.”28
Scientific and technological advancements had obviously made more resources available for man to cater his various needs. Advances in geology, geography, breakthroughs in remote sensing, satellites etc. had led to a number of useful discoveries. Technologies created were substituted for many resources and which in turn saved exhaustible energy resources. A new and more productive and potentially inexhaustible source of energy was also created out of the geothermal, tidal, solar, nuclear fission and fusion sources.

This indeed is creating a technological optimism and a techno-centric worldview. But practice for the last forty years uncover the fact that this techno-centric approach is not found to be the sustainable solution to the problems, the humanity is confronting. When technology creates a new resource and solves a problem it also creates a new set of problems. These problems are multiplying. So the technological development has become synonymous with problem solving and problem creating processes and in many cases the latter outweighs the former.

Despite the claim that the problem of production is over or the scarcity of resource is addressed, the very concrete instances of problems are below our nose tips. The World Commission on Environment and Development in its report in 1987 draws a clear picture of the emerging crisis and resource shrinkage. "There are also environmental trends that threaten to radically alter the planet, that threaten the lives of many species upon it, including the human species. Each year another six million hectares of productive dry land turns into worthless desert. Over three decades this would amount to an area roughly as large as Saudi Arabia. More than 11 million hectares of forests are destroyed yearly, and this, over three decades, would equal an area about the size of India. Much of this forest is converted into low-grade farmland
unable to support the farmers who settle in it. In Europe, acid precipitation kills forests and lakes and damages the artistic and architectural heritage of nations; it may have acidified vast tracts of soil beyond reasonable hope of repair. The burning of fossil fuels puts into the atmosphere carbon dioxide, which is causing gradual global warming. This 'greenhouse effect' can in early next century, increase the average global temperature enough to shift agricultural production areas, raise sea levels to flood coastal cities and disrupt national economies. Other industrial gases threaten to deplete the planet's protective ozone shield to such an extent that the number of human and animal cancers would rise sharply and the oceans' food chain would be disrupted.\[^{29}\] The plant and animal species are under severe stress. The diversity of species is necessary for the normal functioning of ecosystems and the biosphere as a whole. This species diversity is fast disappearing by the indiscriminate exploitation for commercial needs. It is estimated that around 27,000 odd number of plant species are disappearing every year by the human intervention.\[^{30}\]

Fossil fuel scenario also shows a crisis, WCED reports, "many forecasts of recoverable oil reserves and resources suggest that oil production will level off by the early decades of the century and then gradually fall during a period of reduced supplies and higher prices. Gas supplies should last over 200 years and coal about 3000 years at present rates of use."\[^{31}\] Water, one of the critical resources of the planet, is depleting and getting contaminated at an alarming pace. Symptoms of a crisis are visible around the world. A number of countries are facing acute shortage of water.

"Water tables are falling by six inches to four feet per year beneath one-fourth of U. S. irrigated cropland."\[^{32}\]
“Water tables beneath [Beijing] have been dropping one to two metres a year.”

“Diversions from the Logone River . . . are causing water tables to fall beneath some 150,000 hectares of the Logone floodplains.”

“In Jakarta, city dwellers extract groundwater at roughly three times the rate of recharge.”

“India like many other countries is exhausting its underground water stocks, in the past decade water tables have fallen 25 to 30 meters (82 to 98 ft).”

The following statements will sufficiently explain the Indian scenario.

“A whole range of these resources, regulated and utilised in many different ways, is under great stress. There are very few deer and antelope left to hunt for hunter—gatherers such as the phasepardhis of Maharashtra. A majority of the shepherds in peninsular India have given up keeping sheep for want of pastures to graze them. The shifting cultivators of north-eastern India have drastically shortened their fallow periods from a traditional fifteen to a current five years. All over, peasants have been forced to burn dung in their hearths for want of fuelwood, while there is insufficient manure in fields. Ground-water levels are rapidly going down as commercial farmers sink deeper and deeper bore-wells. There are long shutdowns in industry for want of power and raw materials, and every urban centre is groaning under acute shortage of housing, fuel, water, power, and transport.”
3.7.3 Technology, Elitism and Consumption

The modern technology in general, is elitist and sophisticated in character. It has largely sub served the interest of a few—the privileged and rich. Benefits for the poor, villager, the tiller of the soil, the craftsman etc. were marginal if not negligible. Pyarelal (1998) evaluated the effects of science and technology in society. "Science and technology have hitherto been used by and large to sub serve the interest of entrenched power—big industry, big finance, the sophisticated townsfolk. The villager—the peasant, the handicraftsman, and the artisan—has benefited by it only incidentally." The highly sophisticated modern technology requires training in special skills and entrepreneurship. Since the cost of acquiring the skills is prohibitive, it is not possible for a common man to acquire them.

3.7.4 Rural-Urban Conflict

Approximately eighty per cent of the population in developing countries are living in rural areas and agriculture constitutes their major occupation. As there are no non-farm employment opportunities in the village there is mass migration of people especially younger people to cities where development effort is concentrated and where it is easiest to establish new industries. The majority of the migrated population is forced to satisfy with jobs like shoe shining, selling matches, selling lottery tickets etc. This situation is one which Schumacher (1973) has aptly described as a 'process of mutual poisoning', whereby industrial development in the cities destroys the economic structure of the hinterland and the hinterland takes it revenge by mass migration into the cities, poisoning them and making them utterly unmanageable. So it becomes obvious that cities could only maintain themselves by sucking in people and resources from outside. According to Tickel (1995), there are three main contributory factors for urbanisation. They are "dependence on external
resources, hazards to health through concentration of numbers and liability to environmental change."

Growth of cities will create enormous requirement of food, water energy resources and building material and which will have its impact on the hinterland, the villages and on the surrounding areas. Growth of an urban industrialised centre will correspondingly create conflicts in hinterlands and surrounding villages because of the siphoning of the resources. Earlier this exploitation was confined to the immediate vicinity but later this has crossed even the national boundaries. A very different mode of resource exploitation by the industrialised countries like Japan, USA and former USSR is given by Gadgil and Guha (1992) which characterises prudent resource use at home and profligate resource use abroad. For instance, Japan, one of the highly industrialised urban country, has best-preserved forest cover while the forests of the neighbouring countries like Malaysia and Indonesia—which have large populations dependent on primitive agriculture—are being devastated. Japan maintains its forest cover, in spite of its enormous per capita consumption of timber, only by shifting the pressure on to Malaysia and Indonesia, precisely the countries which suffer devastation. Japan also exploit their coastal fisheries very conservatively, while refusing to give up whaling in international waters. These will inevitably create conflicts between cities and rural areas in the national context and between industrialised and non-industrialised countries in the international context.

The industrial technologies create huge quantity of rubbish sewage and wastes of all kinds in cities that are very hazardous to health. A good quantity of these wastes is disposed in villages and causes the healthy environment in the village to get
contaminated and polluted. This will also generate conflict between rural and urban areas.

All the above factors make considerable changes in the environment. Public anxiety over the changing climatic conditions is also growing. The public and institutional response in this regard is vindicated by the UN Conference on Environment in Stockholm in 1972, followed by the creation of the UN Environment Programme, the first World Climate Conference in 1979, the production of many papers, including Global 2000, the Brundtland Commission Report on Environment and Development and declarations on the environment by industrial and non-industrial countries alike. Then came the second World Climate Conference in 1990 and the Earth Summit at Rio in June 1992.

Majority of the Indians have been traditionally living in the villages. Technological growth in the country promoted the growth of large industries and it has resulted in concentration of population around these areas. The high rate of urban growth has created a number of economic and social problems. “In 1961 there were 2700 cities and towns in India with a total population of 78–94 millions. In 1971, the number of cities and towns shot up to 3126 with a total population of 107 millions.”

3.7.5 Destruction of Traditional Technologies

The science and technology that has become part of the daily life of people in the Western world is now increasingly being superimposed on the non-Western countries. This superimposition and domination over the non-Western cultures and their technological system are no way a recent phenomena but it was there even from the very inception when the western science became a dominant factor in public life. The effects of this domination was a gradual withering of many cultures, sub-cultures and
the associated technological systems, commonly known by names such as traditional
technologies, indigenous technologies, people’s technologies, survival technologies,
etc.

The traditional technologies were evolved indigenously in different cultural contexts
and they were results of ‘people’s innovations’ and people’s research done at little
cost and without support of any theory. The plurality of cultures within and outside
national boundaries also produces technological pluralism. Jungk (1973) notes “the
idea that there may be an alternative technology in itself implies the idea of
technological pluralism in place of the until now almost universally accepted
technological monism. In this case each social system and each political ideology
indeed each culture would be free to its own particular line. Why should there not be
a specifically Indian technology alongside Indian art and why should the African
temperament express itself only in music or sculpture and not in the equipment which
Africans choose because it suits them better?”

These know-how or traditional knowledge bases pertaining to all sphere of activity
like agriculture, animal husbandry, health, industry etc. might have been refined by
long process of empirical experiences. The skills for such technologies have been
passed on from one generation to another. But unlike the modern technologies its
diffusion even to a neighbourhood society might have taken years, but knowledge
about modern technology tends to circulate very rapidly. Even in the most remote
regions of the world farmers have heard about such things as the moon landing, the
jumbo jet or the achievements of modern medicine, and their awareness of both of
modern technology and the way of life that goes with it is one of the many reasons for
their emigration to cities. This knowledge, which is usually of a rather general nature,
is propagated by hearsay, by the stories of town-dwellers or foreign emigrants who return to their home village, by transistor radios and by illustrated magazines, whose carefully cut-out pages are pasted on inside walls of the farmers' huts. But traditional technologies spread only by the demonstration effect and by oral communication. A particular technology may diffuse to a few neighbours only despite the fact that it is not covered by anything corresponding to patent or intellectual property rights that could possibly limit their dissemination.

Traditional technologies encouraged self-reliance and use of local resources in accordance with the resource endowment of the society and the country. "Traditional technologies are of immediate relevance to the people in the region in which they are developed . . . Farmers may develop a botanical insecticide because a pest has attacked their crops, or artisans may develop a new plant-derived dye for the cloth they weave. Institutional entomologists, chemists, veterinarians and other specialists usually do not use the techniques they develop directly for their own sustenance. Their main purpose is to publish and patent, though there may be exceptions, but these exceptions are working against the rules of the system rather than with them." Traditional technologies allowed people the freedom to exercise their creativity to solve their problems and to have control over their environment. They were mostly based on renewable raw materials including sources of energy. All these features of traditional technologies make them socially appropriate and more appropriate than Western technologies.

Many of the non-Western countries like China, India, Korea, Africa etc. had their own indigenous technological system and with which they managed their whole range of problems. But the replication and extension of the Western paradigm of cultural and
technological development from the era of industrial revolution made a vast array of changes in these countries. India for instance was a vast reservoir of the traditional wisdom. The country had produced its own technological paradigms in agriculture, industry, medicine etc. which some would accept while some would ridicule by saying that it was primitive. Dharampal (1971) narrates the characteristic features of Indian technologies, “The sciences and technologies of the non-European world had different seeking and developments to those of Europe. Further, in countries like India, their organisation was in tune with their more decentralised politics and there was no seeking to make their tools and work places unnecessarily gigantic and grandiose. Smaller and simplicity of construction as of the iron and steel furnaces or of the drill ploughs, was in fact due to social and political maturity as well as arising from understanding of the principles involved. India appear to have developed from a great deal of sophistication in theory and an acute sense of the aesthetic.”

India had a unique knowledge base of its own in geometry, astronomy, metallurgy, medicine, agriculture, water resource management, animal husbandry, textile and other traditional industries. As noted earlier their knowledge base was a part and parcel of the composite culture of Indian life. From the scanty descriptions in travellers reports and other documents we get a faint picture of the knowledge base of the country in the last two three millennia. A brief note on the traditional wisdom of the country is given below.

3.7.5.1 Traditional Indian Agriculture

Agriculture was the major occupation of the Indians for about four thousand years and till 19th century Indian agriculture occupied a major position among other countries in terms of its productivity. Historically a package of technologies was evolved
indigenously covering various aspects of agriculture including plant protection, breeding, seed selection, manuring, water management, seed storage etc. This people’s knowledge base was the backbone of Indian agriculture.

Colonel Alexander Walker (1820) had prepared a very comprehensive report on the agriculture of Malabar and Gujarat. Walker writes, “In Malabar, knowledge of husbandry seems as ancient as their history. It is the favourite employment of the inhabitants. It is endeared to them by their mode of life, and the property that they possess in the soil. It is a theme for their writers; it is a subject on which they delight to converse, and with which all ranks profess to be acquainted. Their sacred bulls, and their superstitious regard for the cow, have their foundation in the great service they render to husbandry.”

Walker, an agricultural expert from Europe, found that Malabar plough was more appropriate in Indian conditions than the European ploughs. It was found to be very light so that it can be carried on a man’s back. More important, it was accommodated to soil that was light, unobstructed by stones and softened with water. But the European plough, experimented at Saleette in Goa, was found to be inappropriate because of its heaviness and high cost. Alvares (1991) observes, “In a climate where the productive powers are so great, it is only necessary to put the seed a little deep into the ground... It must be a strong proof that the Indian plough is not ill adapted for its purpose, when we see arising out of the furrows it cuts, the most abundant and luxurious crops. What can be desired more than this?”

Ibn Battutta and Bartholomew, two visitors extensively travelled in India had reported about different agriculture and their practices. “Mulaybar, which is the pepper country, extends for two months journey along the coast... there is not a foot ground
but what is cultivated. Every man has his own orchard with his house in the middle and a wooden palisade round it.\textsuperscript{49}

Bartholomew mentions about pepper, paddy, millets, ginger, gram, horsegram, gingerly and pulses. He also talks about practices like parboiling of rice, growing of three crops of paddy in an year and about use of irrigation in paddy cultivation.\textsuperscript{50}

The homestead farming, an unique farming method in Kerala is an excellent example of farmers' heuristics and innovation in agriculture. So it is difficult to consider that Indian agriculture in ancient times were inappropriate, inefficient or primitive. But one can only think as Walker examines: "it shows that the practices of an Indian farmer is founded in the most enlightened principles of modern farming."\textsuperscript{51}

3.7.5.2 Traditional Indian Industry

Next to agriculture, textile industry constituted the principal economic activity in the Indian sub-continent. Alvares (1991) observes that up to 1800, no country produced a greater abundance or variety of textiles in the world than India had produced. China remained the only close rival, in 1700 alone; India was the largest exporter of textiles in the world. Dubois wrote "with such simple tools the patient Hindu, thanks to his industry, can produce specimens of work which are often not to be distinguished from those imported at great expenses from countries."\textsuperscript{52} The remarkable feature of the textile industry in India was that very large quantity of goods were produced by simplest tools and the industry provided employment to hundreds of thousands inhabitants of the country. Again it was not confined to a particular region but decentralised such an extent that one can see countless unit from 'the banks of the Ganges to the cape', 'on the coast of Coromandel and in the principal town, it is difficult to find a village in which every man, woman or child is not employed in
making a piece of cloth. Till then certain centres like Ahmedabad, Surat, Kashmir stood different because of its production of special variety and quality of textiles. 'Finest Indian brocades, the richest silk stuffs of all kinds, calicoes and muslins' were produced from Surat while Ahmedabad manufactured 'brocades of gold and silver, carpet with flowers of gold, though not so good as the porcine velvet, satins, and taffetas of all colours, stuffs of silk, linen and cotton and calicoes.' The woollen industries of Kashmir produced extraordinary Cashmere shawls that were also famous.

India has been one of the countries with very good deposit of iron ore. Techniques to separate iron and steel from its ore were also available in the country. Archaeological studies reveals that steel and alloys of steel had been widely used in this country.

Jean Baptiste Travernier, the French traveller who visited India had made a visit to Hyderabad where Indian steel was believed to be manufactured. He writes, "The natives are using a broad-edged sword made of steel as that of sword. The quality of iron gun pistols is better than that manufactured elsewhere. The iron they are using is far more good than ours." The traveller, Al Idrisi who visited the country in A.D. 12 also write, "The Indians had some preparations with which they converted the raw iron into steel. There were workshops to manufacture iron swords which were of excellent quality." Dharampal writes about the quality of Indian wootz: "The qualities were thus ascribed to the quality of the ore from which it came and those qualified were considered to have little to do with the techniques and processes employed by the Indian manufacturers."
3.7.5.3 Traditional Indian Medicine

There is vast literature on traditional Indian medicine. There were also innumerable practices to prevent disease and for treatment. Alvares (1991) cites the letter of Dr. H. Scott, which was written on 12th January 1792 to show the uniqueness of traditional Indian medical care and treatment, “In medicine I shall not be able to praise their science very much. It is one of those arts that are too delicate in its nature to bear war and oppression and revolutions of Governments. The effects of surgical operation are more obvious, more easily acquired and lost by no means so readily. Here I should have much to praise. They practice with great success the operations of depressing the crystalline lens when become opaque and from time immemorial they have cut for the stone at the same place which they now do in Europe. There are curious facts and I believe unknown before to us.”

Till it was banned or disrupted by the English authorities in 1802-03 the inoculation against small pox disease practised in both north and south India. Modern medicine touts the introduction of the vaccination as one of the major invention in the history of modern medical care. But this system was in practice in India much before the western invention of vaccination by Jenner.

Ayurvedic system of medicine was a holistic way of healthcare treatment in India, used to be in existence from time immemorial.

3.7.5.4 Traditional Technologies in Other Areas

Craftsmanship of the Ancient Indians was famous throughout the contemporary world. A number of monuments such as Ajanta caves, Kailash temple (Ellora) etc. verifies the architectural skills of Indians. In south India, Kerala was a centre of vast traditional wisdom.
Technology of iron and steel extraction from different ore deposit of the state were available in the State. Archaeological studies by Kerala State Archaeological Department at Kollam in 1991 showed that there were evidences of iron being extracted as early as 1000-810 B.C. In the British colonial period also iron extraction was common in Travancore and Malabar. Different ethnic groups like blacksmiths were engaged in the vocation. W. Kullan (1852), the resident of British East India Company had given some information on the places of iron extraction in Travancore. Neyyattinkara, Nedumangad, Kollam, Kunnathur, Chengotta, etc. were some areas where iron production was being done according to Kullan. Chengotta was very famous for iron extraction. It was reported that around 150 tons of iron plates were produced here annually. Buchanan who visited Malabar during 1800s and collected information on the trade in the coast had reported about iron extraction centres of Malabar. Buchanan describes about an iron production centre near Valancherry during his travel in South Malabar. T. J. Nox worked out the cost of production of iron in oothala.

1. Cost of one ton of iron ore – Rs. 2-3.
2. One basket fuel of cha – ½ anna.
3. Wage of a blacksmith – 4-8 anna.

So the production cost of one ton of iron ore was rupees forty-six and fourteen paisa and this could be sold at a price of sixty per ton. Some other reports says that Malabar alone produced 475 tons of iron per year. Table 3.1 shows the list of iron extraction centres prepared by Konoi in 1854.

Unique techniques for hardening the iron were employed by the blacksmiths. A number of plant products were used for the purpose. Parts of different plants like
mango, mymosa, etc. were widely used in the hardening of the iron and steel. In addition to plant parts, salt had been used in the process. Techniques to anneal the iron were developed and extensively used by the natives.

Table 3.1 List of iron extraction centres prepared by Konoi in 1854

<table>
<thead>
<tr>
<th>Taluk</th>
<th>Village</th>
<th>The place of institution of oothala</th>
<th>No. of oothala</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kurumbanadu</td>
<td>Madavoor</td>
<td>Chikkalod</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Mumbanda</td>
<td>Nanmanda</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Kunthara</td>
<td>Modakkalloor</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ollathoor</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thottugalparambu</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kunthala</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cholakkal</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vallama</td>
<td>2</td>
</tr>
</tbody>
</table>

Source: Dhirar (1994).

Traditionally some villages in Kerala were famous for certain finished products, particularly the *Aranmula kannady* (Aranmula Mirror) was considered to be very superior product, and was optically as clear as any glass mirrors with amalgam coating. These products were the blend of people’s local wisdom and the locally available resources.

Valancherry in north Malabar was famous for long and stern swords which were widely used in wars. Steel knives produced in the Thottara village of Palakkad district were also famous. Surgical instruments were also produced in this village by a specific ethnic groups traditionally. The production is still continuing. Malabar *Hukka* (smoking pipe) was another local product from Koyilandi village of Kozhikode district.

The indigenous technological and production system had undergone drastic changes during the colonial domination and thereafter during the era of development. Quantification of the extent of destruction of traditional technologies and the
traditional production system is very difficult in a national context because of the plurality of cultures and subcultures within a nation. Each culture or subculture had its own knowledge base and artefacts for addressing their problems. Many were crushed down and some were assimilated into the mainstream during colonial and post-colonial development era.

3.7.5.5 Colonial Exploitation and the Destruction of the Knowledge Base

History of colonialism is the history of economic exploitation and crushing down of the traditional knowledge and technological bases of the colonised people or the colonised country. Dutt (1906) evaluates the legacies of British Empire in India. “The Indian empire will be judged by history as the most superb of human institutions in modern times. But it would be a bad story for future historians to tell that the Empire gave the people of India peace, but not prosperity; the manufacturers lost their industries, the cultivation were ground down by a heavy and variable taxation which precluded any saving . . .”59 Surendranath Banergee observed, “it had been the settled policy of England in India ever since her rise in political power to convert India into a land of raw products for the benefit of the manufacturers and operatives of England.”60

Chandra (1982) writes, “one of the most momentous consequences of the establishment of British supremacy in India was the disruption of the centuries old union between agriculture and manufacturing industry as a result of progressive decline and destruction of the Indian town handicrafts and village artisan industries.”61
... up to the 18th century, the economic condition of India was relatively advanced, and the Indian methods of production and of industrial and commercial organisation could stand comparison with those in vogue in any other part of the world.\textsuperscript{55}

The industrial policy of British rule in India had been given by Ramesh Dutt, "Endeavours were made, which were fatally successful, to repress Indian manufacturers and to extend British manufacturers. The import of Indian goods to Europe was repulsed by prohibitive duties; the export of British goods to India was encouraged by almost nominal duties. The production of raw materials in India for British industries, and the consumption of British manufactured goods in India, were the two-fold objects of the long commercial policy of England."

But because of the British intervention and exploitation "by the end of the 19th century, however, most of the indigenous industries of India had either decayed beyond recovery or were on road to ultimate ruin, while the modern industry was yet to reach considerable proportions."\textsuperscript{62}

The Indian spinning and weaving and other handicrafts had provided whole-time or part-time employment to millions of men and women. But all these had gradually disappeared with the advent of the British, and India had lost not only its foreign market, but also its internal markets. According to Dutt (1906), this displacement of the Indian manufactures by foreign products formed one of the sadist chapters in the history of British India.

One of the basic propositions with the colonial ideology was that everything associated with the coloniser is "good" and everything associated with colonised is "bad." Naturally this involves appreciating everything associated with the coloniser
and rejecting everything associated with colonised. A wholesale rejection and condemnation of the history, practical traditions and wisdom of the home society is the natural corollary of the view. The rich technological traditions and practices of the colonised were treated as primitive and inferior and thereby accepting the technology of the coloniser.

Dharampal (1971) and Alvares (1991) ascribe that it is British colonialism that rejected and crushed down the traditional technological base of India. But it was during the ‘modern scientific age’ that the traditional wisdom and the associated technologies were rejected in toto if not sidelined from the mainstream. Various techno-centric movements like Green Revolution, White Revolution, and Blue Revolution etc. have also acted as significant contributors to this process.

It took nearly two to three decades of intense activities and promotion to ignore and sideline traditional agriculture. Former agricultural scientist, Dr. Richaria had collected around 20,000 local seed varieties from India that had of great resistance and productivity, during this period. Even now around 8.3 crores of cattle are used for various agricultural operations like transportation and tilting the soil. In energy equivalent terms the work done by cattle force will be of 30,000 Mega watt which is around half of the total energy produced capacity of the country. This cattle force are ploughing around 2.5 crores hectares of agricultural land which comes around two-third of the agriculture land in India. This work could have been mechanically done by two crores of 30 HP tractors. This requires an investment of rupees two lakh crores. In addition to that a minimum of Rs. 6000 crores required per annum for the fuel requirement of these tractors.
In the transportation front there are as many as 1.5 crores of bullock carts in this country which transport around 2500 crores tons of luggage. This will also save 60 lakh tons of oil. The cattle not only save the precious fossil fuel, but they also contribute significantly to our resource base, in many forms. Millions of tons of organic manure are produced by the cattle, which apart from fertilising the crops, improve and conserve the soil also.

3.8 Conclusion

Conventional development strategy is essentially high technology-intensive and requires the extensive use of non-renewable resources. This strategy, which was a misfit in the developing and underdeveloped world, has created a plethora of problems, essentially springing from the use of high technologies that the nation states themselves are not capable of developing and maintaining. Such technological development in the past four to five decades in many of the nations, which were erstwhile colonies and had access to Western technologies has been proved to be a social and ecological failure, where the negative externalities of such technologies far outweigh the benefits whatever created.
Notes and References


4. ibid., p. 29.


12. ibid.


14. ibid., p. 3.


17. ibid., p. 15.

18. ibid., p. 31.

19. ibid., p. 39.


27. ibid., p. 50.

28. ibid., p. 58.


31. ibid., p. 174.


41. ibid.


61. *ibid*.