Chapter - 7

Caps → Biodivesity : Balancing Commerce and Conservation

~~We do~~ Biodiversity is something that is talked about occassionally in India and often forgotten thereafter. Many (to be) get confused ~~with~~ biodiversity with protecting of environment with more tree plantation or saving the tiger etc. We do not intend to give a primer on Biodiversity in this chapter. We have given a simpler version in ~~the~~ our

book "Scientific Indian" published by Penguin, under the Chapter on Biosphere. Wikipedia carries a simple ~~article~~ but with wealth of information under Biodiversity; it may get updated from time-to-time.

Ever since the life appeared on the earth about 3.7 million years ago, many species have come and gone. Some estimates are that only about 1 to 3% of the species now survive (Source: Wikipedia) now. The real issue before us is how to

to conserve them and how to use them. Normal human tendency is and will be to not to care for things which are not beneficial or useful to them. When there is a commercial interest (through business or employment or payment for conservation), people take care!

There are variety of researches which indicate that conservation of biodiversity is in long term interest of the ecology of the Earth and therefore of human beings. But this conclusion has to be taken, by most of us, as

as a wise ~~Govt~~ counsel.
We cannot feel it in real life.
Therefore it becomes a public
good to be taken care of by
Govt., though people's money
collected as taxes. But there
are limits to taxation! Therefore
pragmatic approach to fullfilling
the duties towards the public
good called ~~Bi~~ conservation of
Biodiversity is to derive
some ~~be~~ commercial benefits
out of some of the diverse
biological organisms. Then public
support for the whole idea
will be good. For ~~ex~~ example

there will support to preservation and even propagation of medicinal plants, aromatic herbs etc.

Good understanding of the science (it is still a growing area of research and surprising results may come in future, negating some of our current assumptions), careful engineering (including genetic engineering), ~~and~~ and cautious commercial activities are required to balance the Conservation and Commerce. ~~Govt~~ Govt. policies should balance these carefully. They should also cover

the discounting dilemma
(how much to see the problems
of the present and how much
to account for future benefits
especially when the future is
far away, even generations
away!!)

As per the current
knowledge, terrestrial biodiversity
is about 25 times greater
than ocean biodiversity. But
this may change as we explore
oceans more. Another interesting
data from Wikipedia is that
new species are regularly
discovered (on the average

between 5–10000 new species each years, most of them insects). Many which have been discovered are not yet classified. Also as the new science of Soil Biology, that is the organisms underneath ~~the~~ the soil are studied more, we ~~the~~ may discover more!

As per the current knowledge ~~the~~ the number of species ~~of~~ in Earth and Oceans can be seen in Table 7.1 sources from Wikipedia.

→ Insert printed Table kept separately.

The above Table-7.1 is just to give the magnitude of the whole of Biodiversity. ~~We~~ Let us remember. We are all connected to everything in the world!

Indian Biodiversity

There is a good Chapter-3 in the Environment Audit Report No. 17 of 2010-12 (Downloadable in the web) of the report starts ~~with~~ with this summary statement.

"... and India is one of the 17 identified mega biodiverse

countries of the world. With only 2·4 per cent of the total land area of the world, the known biodiversity of India contributes 8 per cent to the known global biodiversity"

* Well, how proud we can be! But see the following sentence of the same quote:

"It has been estimated that at least 10 per cent of the country's ~~biodiversity~~ recorded wild flora and the same percentage of its

wild fauna, are on the threatened list, many of them on the verge of extinction."

Flora — plants and trees
Fauna — animals and birds

- The plant species in India are about 455,500.

- Animal species 91,000
- Insect species 59,353
- Fish species 2,546
- Amphibian " 240
- Reptile " 460
- Bird " 1232
- Mammal " 397

(Source: The Audit Report)

audit
The report lists the threats to Biodiversity in India. ~~Near~~ These are :

- Nearly 74% of India's population ~~depend up~~ substantially depend on biodiversity resources for fodder, fuel wood, timber etc
- Due to increase population land to man ratio and forest to man ratio has rapidly declined
- Therefor encroachments leading to unsustainable extraction
- Also unsound development strategies

etc.

As it is so in most other areas of activity in India, we have most of Laws (Acts) ~~etc~~

~~Ba~~. biodiversity. These are described in the Report. A gist:

India is a party to Convention on Biological Diversity (CBD) since 1984. To give effect to CBD, the Biological Diversity Act (BDA) was enacted in 2002. As provided in ~~the Act~~ BDA, a National Biodiversity Authority (NBA) was established by Govt of India in ~~Oct~~ 2003 located at Chennai. ~~It~~ NBA comes under Ministry of Environment and Forest (MOEF) of Govt of India.

There are so many actions to be taken by NBA.

The report ~~chastises~~ them. By and large it is a slow story of forming Expert Committees which work for a few years, then there are no notifications or new Committee formed etc. Many State Govts do not have the corresponding SBA's.

Even decisions to have a data base is not implemented as also many issues relating to Intellectual Property Rights (IPR) which are important when it comes to commercialisation, exchange of research articles etc. Indian researchers are unable to file patents without their guidelines are lost out in international cooperation agreements. Partly it is understandable because MOEF has many other

firefightings to do as we have noted in the earlier chapters. They get their They need to deal with ~~at~~ multitudes of voices from the activists to pressures on behalf investors (from other Govt. departments) to academic intellectuals to corruptions at various levels in various pollution control matters.

WHAT NEXT?

This is an important subject and ~~to~~ looks esoteric to most persons in the decision making levels. Many confuse environmental protection ~~to~~ with

Biodiversity. Look at the violent reactions to the reports on Western Ghats.

The development lobby to the conservation lobby, mostly the positions taken are extremist and adversarial. Some manage to bring people for agitation.

We do not have easy solutions to offer.

In a situation when India's rapid economic growth has hit a major road block of ~~stag~~ slow down and stagnation, thus causing inflation in daily-life products coupled with

loss of jobs and ~~nearly~~ very little new job creation, the entire pressure will be to regain the growth and move forward with good incomes to people.

This IMMEDIATE is and will be overwhelming. We understand that need fully and support it. As pointed out earlier some of the ~~At the same time we wish to flag~~ a rich mineral wealth of India (coal, aluminium, iron ore etc) are in the forested areas. There is a dilemma.

At the same time we

(346)

like to alert Indians to the need about Biodiversity protection. Instead of agitating or ~~stopp~~ stopping all developmental work / writing doomsday articles, some cool minds with deep knowledge of biodiversity, practical needs of ~~the~~ local people, the economic needs of India, ~~etc~~ better engineering practices to minimise disturbances to biodiversity etc, ~~are required~~ ~~to~~ need to sit together and make judgement on how to go about. It is difficult to come up with practical solutions

for the ~~vast~~ whole of biodiverse India. Let the approach be to focus on a few, initially especially where there are pressures from development needs and people's life styles.

We are confident if this is attempted sincerely, the ~~best brains of Our to~~ India can bring good practical solutions to balance various needs including the need to ~~Cons~~ conserve biodiversity

Chapter – 8

CHEMISTRY OF LIFE : FROM ENERGY TO FOOD TO CLOTHES TO HEALTH TO COSMETICS

Chemistry is the very basis of Life on Earth; our lives; and ~~almost~~ all of our Surroundings. So much so that in our colloquial use, we tend to explain good relations with people as: "We have good chemistry". Even in the ancient times Indians were very good in use of chemicals.

Even considering the modern times the Indian Chemical Industry (ICI) is one of the oldest in India. ICI stands sixth position worldwide - third position in Asia.

Most materials of common usage or daily usage come from the Chemical Industry : textiles, paper, paints, varnishes, leather, plastics, soap, shampoo, perfumes, cleaning materials, personal hygeine products etc come from chemical industry. On the bigger side many energy

industrial products derivatives of coal, gas, petroleum etc (as well as fertilisers, pesticides etc) come from use of Chemical Engineering. Some persons tend to associate chemical industry with pollution. The reality is that even pollution mitigation and waste management is to be done by chemical processes. Also the advances in chemical technology and engineering are leading to many processes which are CLEAN unlike in the past.

~~We said~~ We don't

~~See~~

Chemical products ~~exist~~ visibly as an automobile or as a computer or as a bridge or as a nuclear reactor or as an aeroplane or a shoe (or a cloth), but several chemical are essential to make them. See the paint of the ~~auto~~ automobile. Many things in the seat; tyres. The fuel used; inside of the batteries ... all are chemicals. For a textile even the natural cotton (as distinct from the artificial chemical fibres like ~~rayon~~ rayon, nylon etc) or silk, right from the thread formation

to weaving and to giving colours (dyes); various chemicals are required. The wood cannot become a beautiful furniture without the use of chemicals. In fact at the raw wood stage itself certain ~~cer~~ chemical treatments ensure that later they are not attacked by pests like wood ~~boor~~ borers. Those who have ~~wood from~~ wooden cupboard with pale yellow powder coming out will know the problem of such wood borers. In the

(P.T.O)

(353)

In the modern times, most of these are treated chemically so that the consumer has no problem. The varnishes make the wood beautiful.

The ink used in ~~b~~ ball pens ~~or~~ are chemicals; also involve some sophisticated processes.

~~P~~ The reader may look at many other products. There is no modern life without chemistry, chemical engineering, chemical plants and ~~hundreds and~~ thousands of chemicals. One is glad to note that India has a good base of chemical industry.

But in the modern world, competitive one cannot rest on past laurels or the present ~~conf~~ comforts. There are constantly occurring innovations in technology, business models and customer services. Customer preferences change. Since the modern instrumentations have improved many fold leading to detection of chemicals ~~Occurs~~ of one part in a million and even one part in a ~~multi~~ billion, newer and newer standards

(P.T.O)

(3530)

Of chemical standards for purity or safety are brought out. Most pesticides used about 50 years ago globally are now considered toxic. For ~~thiro~~ products like leather which used azodyes, cannot be sold when the residues are only in parts per million (ppm) levels. Azodyes are ~~pta~~ replaced by other chemicals.

There are many such examples of new discoveries of potential toxicities due to advances in life science researches. In addition some countries adopt different business models to sell better chemicals with cheaper

OVERVIEW OF INDIAN CHEMICAL INDUSTRY

prices. As per a TIFAC report
of Jan 2014, ~~about~~ from which we will
quote extensively later, there
are about 40,000 chemical
manufacturing units in India,
of which 80% is in the small
scale sector. This industry as
a whole produces nearly 70,000
type of commercial products
over a wide range of categories
ranging from cosmetics and
toiletries, to plastics and pesticides.
There are about 3.3 million
are employed in the sector. It is
thus a great job producer, as well
As per the report, the chemicals
can be categorised as three broad
areas:

Basic chemical form 53%

Knowledge Chemicals 29%

Speciality Chemicals 18%

Basic chemicals total production volume is about US $ 57 billion.

Further four level classification of Basic Chemicals ~~are~~ and their percentage market share are:

Organic Chemicals } 10%

Inorganic chemicals

Fertilisers } 90%

Petrochemicals

BASIC CHEMICALS

There is an excellent recent report by TIFAC and Indian Chemical Council (ICC).

Chemical Council (Jan 2014)

It is titled "TIFAC – ICC Study on "Indian Chemicals Industry Technology Imperatives and Business Opportunities for Basic Chemicals. January 2014. (See www.tifac.org.in). TIFAC and ICC had drawn up ~~the~~ services of CP Computing Services Pvt Ltd. The report ~~has made~~ ~~the~~ covers ~~&~~ global scenario, ~~status~~ of Indian chemical industry (in terms of each of the chemicals), classification factors influencing investment in ~~the~~ chemical industry, industry characteristics and structure of basic chemical industry.

Under Organic Chemicals it has dealt with in detail Methanol, Formaldehyde, Acetic Acid, Acetic Anhydride, Acetaldehyde, Ethyl Acetate, Pentaerthritol, Phenol and Lactic Acid.

Under Inorganic Chemicals, the detailed treatment is on: Salt industry, Soda Ash, Caustic Soda, Chlorine, Carbon Black, Titanium Dioxide, Calcium Carbide, Aluminium ~~Eto~~ Fluoride, Sodium Chlorate, Poltasium ~~Chlorate~~ Chlorate, and Red Phosphorous.

A full large chapter is on various forms of fertilisers, various and another large one / Petrochemicals, ~~In the most of areas of Recent~~

Also covered are the new areas of Process Intensification ~~Which~~ and Green Chemistry which are knowledge intensive. Individual key chapters are on:

Road map on Feed Stock
" " of Technology & Research & Development

One full chapter discusses the Business opportunities for all the above.

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(361)

IIHMR DELHI

image001.png
92K

The Chapter on Conclusions and Recommendations gives all essential steps. We will quote a few. One important emphasised is that the chemical industry by its very nature is energy intensive in the manufacturing processes and also in terms of use of raw materials. It draws the very same" energy & raw materials" like gas, oil, coal etc. Therefore one continual action for competitiveness

362

is to strive for more and energy efficiency. In addition govt should create enabling mechanisms to ~~provide low cost~~ provide to the chemical industry, access to cheaper energy sources; ~~they~~ industry should strive too!

→ Insert (A) shown as page 362A

~~Key~~ KEY RECOMMENDATIONS FOR BASIC CHEMICAL SECTOR IN INDIA.

We draw these from TIFAC-ICC report for ease of presentation.

(d) Firstly the Industry

Insert in Page 362 as indicated

362 A

The TIFAC-ICC report is full of data comparing energy efficiency of various sectors of chemical production in India.

We give one example from the fertiliser industry. The energy consumption trend in (average) Indian Ammonia plant (actual a graph in the report from 1987-88 to 2009-10.) The unit of energy consumption figure is Gigacalories per ~~million~~ Metric tonne of Ammonia (GCal/MT)

1987-88	12.48
1997-98 (Times of India 2020 book)	11
2009-10	8.78
World Bench Mark	6.78

Some individual plants are around 7.70.

Should look for feed stocks alternate to the current mode of crude oil & natural gas. Indian reserves in this are low. India imports heavily. Alternative processes with suitable technologies are available to coal, biomass and possibly ~~oil~~ shale oil (estimated reserve to be between 8.50 trillion cubic metre to 59.44 trillion cubic meter)

(2) We import PVC, acrylic acid, phenol and methanol, in large quantities. Govt to provide stimulating policies to make entrepreneurs to invest on such plants in India

(3) Domestic feedstock

Supply can be enhanced considerably by ensuring adoption of Consortium Cracker Approach. Every Petroleum, Chemicals and Petrochemicals Investment Region (PCPIR), which are specialised SEZ's (Special ~~PCPIR~~ Economic Zone) dedicated to chemical industry. ~~must~~ must have a Naptha Cracker ~~unit~~ which produces all the building blocks such as ethylene & propylene as ~~and~~. Such crackers can be set up by Govt or in PPP mode as a consortium. This consortium could offer the necessary building blocks to the promoters interested in setting

up down stream petrochemicals and intermediate. This will considerably enhance value addition and also production of such high value chemicals in India. Currently ~~the such~~ manufacturers desirous of such production have to depend on imports and attendant problems.

(4) Shale gas needs urgent attention, even as we step up Coal related activities in a major way. Let us not waste our time on starting Shale Gas exploration, ~~and~~ technology pursuit and production, as we have done for decades with Coal.

(5) Methonal to Gasoline (MTG) is fully compatible with conventional refinery gasoline. This route need to pursued vigorously and ~~fast~~ speedily

(6) Most of Indian fertiliser plants are more than 15 years old. These old units bring down the average of energy efficiency. There are many cost effective technologies available. These old

P.T.O

(367)

units may be retrofitted, repaired and upgraded. Some may have to be closed. This should a MISSION as it will help not only the competitiveness of Indian Chemical Industry but also help farmers by lowering their input costs over a medium term.

Govt may keep apart some funds as easy loans to incentivise the investors

(7) As we had pointed out in an earlier chaper on Minerals, India is still not well explored for minerals, including in the coast.

If done, many more rich sources will be available around ~~which~~ which many chemical industries can grow

(8) Focussed R&D to improve the competitiveness ~~may~~ is ~~be done~~ the need of the hour. It has to be industry as the current method of relying on the national laboratories has not yielded good and speedy results. This may be done in an industry-driven Consortium mode with Govt. giving substantial seed money

(P.T.O.)

(369)

initially and smaller project grants later, for items in which "public good" aspects are more. Global Laboratory Practices (GLP) may also be researched and knowledge disseminated.

(8) Safety aspects ~~for~~ workers, public and plants is important. Here again industry driven consortium mode Institute may be established with substantial govt. grants to assist extension services for smaller plants, for developing (safety related) human resources in colleges, polytechnics etc and for retraining the existing work force.

~~360~~
(370)

(9) In addition, at ~~At~~ the policy level, well executed short-term and medium-terms plans are required to address the critical concerns articulated in the IIFAC-ICC report, reproduced below

" "

13.3

Insert X next page

"

This is all

~~(10) In addition~~

(10) We should also try to catch up in Green Chemistry and Process Intensification technologies and then take a part- leadership through production of IPR and actual product. These may dominate Chemical Industry in a decade or two from now.

KNOWLEDGE CHEMICALS

They derive thus name due to the higher degree

of new knowledge ~~has~~ domains involves in producing such chemicals. They include items like pharmaceuticals, biotechnology and agrochemical sectors. ~~These~~ All these are very vital for India and the world. India has developed some edge at a global scale in high quality pharmaceutical manufacturing.

Excellent work has again been done by TIFAC along with Indian Chemical Industry (ICC). They had drawn

upon the ~~DEAL~~ ~~DEA~~ Services of ICRA Management and Consulting Services Ltd (~~ICMA~~ the (ICMaCS) to conduct a study. The study is entitled "TIFAC-ICC Study on Indian Chemical Industry — Technology Imperatives and Business Opportunities for Knowledge Chemicals" (2012). Refer to ~~life~~ TIFAC website for details. The report covers in detail

~~Traditionals~~
- Traditional Pharmaceutical
- Biopharmaceuticals
- Chemical Pesticides
- Bio pesticides
- Industrial Biotechnology & Industrial Enzymes

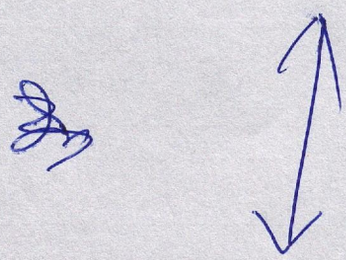
The status of Indian industry is compared with those of a few leading countries: US, the EU & countries, Japan and China: Indian Industry has been surveyed in detail.

As per the report, Global pharmaceutical industry is estimated at US Dollar 858 billion (2010) with annual growth of about 4.5% in USA, EU & Japan consume a large percentage (80% in value) of medicine products. The growth would thus be in Asia (except Japan)

which is already a huge consumer), Latin America, Australia and Africa with likely annual growth rate of 11 to 14%.

Top 10 companies ~~accoun~~ in the world account for around 41% of pharma sales (~~See Table~~) (See Table 8.1)

Table 8.1



as in separate copy

Biotechnologically produced drugs, known as biopharmaceuticals or biologics, have been the major

driver of growth for the global pharma market: The report adds that global sales of biopharma products generate US $80 billion in revenues for the companies (2009) (that is about 10% of the total pharma sales quoted before) There are about 174 products being sold worldwide. USA itself consumes about $60 billion of this (2010).

Characteristics of a pharma industry are

- High knowledge base and intensity
- Capital intensity
- Long cycle time for a product

to reach market due to various safety related tests and regulatory regimes and also

- High uncertainty of R&D outcomes. Together it make it difficult for a company to acquire leadership.

R&D Spending.

// Total amount of R&D spending to result in a successful drug (not all findings end up as drug, that too a successful one!) goes on increasing. Therefore the number of breakthrough technologies are diminishing despite high spending on R&D; because the new molecules fall through

at some stage of clinical and regulatory approval tests.

Therefore a number of "generics" (generic drug) are emerging. They are biologically equivalent to the orginal branded innovative drug. To give some cost and time comparisons, (from the report) it takes around 7 to 10 years and over US Dollar 1 billion to build an innovative drug and patent it (patent alone is not enough to bring it to market further stages of tests are needed).

But generics which is essentially a good copy with different processes, takes only 2-3 years to develop at a much lower cost of a few million US $.

Before the patent regime of WTO ~~came~~ (World Trade Organisation) came into full force with amendment to the Indian ~~patent Act~~ in 2005, ~~Ind~~ many Indian companies built up global level and global standards of generics. Generics have an additional advantage that they do not have

to go through extensive clinical trials because the earlier innovative (thus patented and branded) molecule has gone through ~~Several~~ many of these. // Thus the generic manufacturer does not carry risk of uncertainty of the drug and also incurs much less expenditure. Looks so good! Isn't it? But the catch is with the WTO regime being in operation, the generics can come into the market only after the patent for the original

innovative molecule expires ~~fat~~ (normally 20 years). In the USA typically generics come into market ~~within~~ in about 2 years in 80% cases. The generics manufacturer starts all the processes before expiry and rushes into market. A number of them enter unlike the earlier monopoly of the original ~~inve~~ innovative company. Thus the competitive drives the generics prices substantially down about one-fourth to one-fifth; thus having narrow profit margins.

OVERVIEW OF INDIAN PHARMA INDUSTRY

Indian pharma industry has come a long way, being a visible actor in the global level. Some vital statistics derived from TIFAC-ICC report.

- Annual Production US$ 21.2 billion (2009-10)
- World status → 14th in terms of value (money terms)
  → 3rd in terms of volume of production
  → 10% of global production
- Composition of pharma product → 80% formulation
  → of which 85% domestic consumption.

~~A~~

Active Pharmaceutical Ingredient (API)

- Top 5 producers of API's (Active Pharmaceutical Ingredients)
  - Over 400 API's producers in India
- Largely ~~self~~ sufficient in production of API's and also supplies API's in global market.

See Table 8.2 for some macro level statistics on Indian Pharma Market

Table 8.2

↑
↓

It may be seen that import share is going, mainly because

the import of API's from China which are 10-15% cheaper. It is to be noted that it is happening for other Basic Chemicals as well. Cost competitiveness for Indian chemical industry is a crucial issue ~~with respect~~ when compared to China. A major reason is the cost of electricity, water and other energy and several infrastructural constraints, outside the control of the companies, unlike it is for Chinese companies.

~~Indian~~

Structure of Indian Pharma Companies

- World's most competitive
- Formulation Drugs from 8174 ~~units~~ manufacturing units out of 10,563 total units

- Has large, medium and small companies.
- Maharashtra, Gujarat, West Bengal, Andhra Pradesh, and Tamil Nadu account for about two-thirds of total ~~production~~ number of manufacturers.
- Major focus generics. Faces ~~con~~ significant competition from China.

// Indian Biopharma Industry is estimated at US$ 1.8 billion (2009-10) Annual growth 12%: Main products are Vaccines, Diagnostics, Therapeutics,

Indian Vaccine market is largely driven by domestic needs.

It has done wonders for the Indian public health system. Domestic sales is about 60% there is also good export growth.

~~Here~~ ~~On this sector again~~

~~Generics~~

Other emerging areas are biosimilars, novel drug delivery systems, biopharmaceutical therapeutics, combination vaccines, contract research and manufacturing services (CRAMS), contract manufacturing services, contract ~~Indian~~ research services, clinical trials and ~~herbal~~ herbal actives, Indian Pharma Industries are active in all of these areas.

Readers may be interested to learn about the herbs exported from India. (See Table 8.3)

Table 8.3

As per the TIFAC - ICC report "India having one of the richest repositories of herbal medicines with almost 25,000 effective plant-based formulations, has the potential to tap this growing market. A key factor that supports the growth of this industry is India's rich biodiversity"

costs and sound infrastructure, is an ideal candidate for taking up outsourcing of clinical trials for pharmaceutical companies all over the world.

The clinical trials market in India is estimated at US$275 million (2008), and is expected to grow at a CAGR of about 24%to reach US$ 608 million in 2011[18]. The leading players in India include Clinigene International, Vimta Labs Ltd, and Lotus labs, besides multinationals like Quintiles Spectral, Pharmanet, SIRO Clinpharm and Clintec, who take up multi-centre trials.

- **Herbal actives**

Herbal medicines have been used since the beginning of civilisation, playing a large role in both the healthcare and functional foods markets. Recently, the industry has seen an upswing owing to an aging global population and growing health consciousness, with herbal and botanical supplements being increasingly adopted as natural alternatives for hormone replacement therapy; prostate health; brain health and cognitive function; and joint and connective tissue health.

The global herbal medicine market is forecasted to grow to US$ 93.15 billion by 2015. The market is dominated by the United States andEurope,followed by the Asia-Pacific region. India and China are growing at the highest pace with an expected CAGR of 10.7% till 2015.[19] The largest segment in this market is 'multi herbs' followed by soy and specialty herbs. Globally, both multinational companies and smaller firms manufacture herbal medicines. Key players include Nutraceutical International Corp., Arizona Natural Products, Amerifit Brands, Inc., Nord APS, Blackmores Ltd., Imperial Ginseng., Ricola USA Inc., Nature's Answer, etc.

India, having one of the richest repositories of herbal medicines with almost 25,000 effective plant-based formulations[20], has the potential to tap this growing market. A key factor that supports the growth of this industry is India's rich biodiversity-the country has more than 4,500 plant species, a number ofwhich are exported from India, as seen in Exhibit 24.

Table 8.3

Exhibit 24: Herbs exported from India

Botanical names	Parts used
Acorus calamus	Rhizome
Argemone Mexicana	Fruit
Curcuma amada	Rhizome
Curcuma longa	Rhizome
Curcuma aromatic	Wild turmeric
Cassia lanceolata	Leaves
Glycyrrhiza glabra	Root
Withania somnifera	Vegetable rennet
Myrica nagi	Leaf
Piper longum	Fruit

[18] Ernst & Young,"The glorious metamorphosis-Compelling reasons for doing clinical research in India", 2009
[19]Global Industry Analysts, January 2011
[20]Verma Sheetal and Singh S.P., "Current and future status of herbal medicines", Veterinary World Vol.1, No.11, November 2008: 347-350

Table 8.3

Botanical names	Parts used
Rubia cordifolia	Madder root
Symplocos racemosa	Bark
Swertia chirata	Whole plant
Terminalia chebula	Bark and seed
Zingiber officinale	Rhizome
Wedelia calendula	Leaf and root

Source: "Current and future status of herbal medicines", Veterinary World, Vol. 1, No. 11, November 2008

Herbal medicine offers opportunity not only for exports but also for the domestic market. Indian herbal medicine market is estimated at US$ 1 billion (2008), however, significantly below that of China, which is estimated at US$ 6 billion[20].The key Indian players in this industry are Dabur India Ltd, Sri Baidyanath Ayurvedic Bhawan Ltd., Zandu Pharmaceutical Works, The Himalaya Drug Company, and Charak Pharmaceuticals.

- **Nutraceuticals**

Nutraceuticals are natural chemical compounds possessing medicinal properties, which improve health and/or prevent diseases. These are sold in the form of capsules, powders, pills etc. These compounds help in preventing hypertension, diabetes, arthritis, insomnia, constipation and also reduce the risk of heart diseases or cancer. They are classified either on the basis of medicinal use or the type of ingredients.

We have addressed it in the Chapter-7. Such huge earnings and the employment generated which in turn create economic growth, will be a great incentive to preserve our biodiversity.

Another area for India ~~Future~~ could be Nutraceuticals, which are natural chemical compounds possessing medicinal properties. These are supplements to improve health, to prevent diseases etc. They are sold as tablets, capsules, powders etc. (See Table 8.4)

See Table 8.4

These are broadly categorised as functional food (eg. probiotics), functional beverages

medicine market is estimated at US$ 1 billion (2008), however, significantly below that of China, which is estimated at US$ 6 billion[20].The key Indian players in this industry are Dabur India Ltd, Sri Baidyanath Ayurvedic Bhawan Ltd., Zandu Pharmaceutical Works, The Himalaya Drug Company, and Charak Pharmaceuticals.

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Exhibit 25: Classification of nutraceutical compounds

Based on ingredients	Based on medicinal use
• Antioxidants, carotenoids	• Bone and joint health
• Dairy-based ingredients	• Cancer risk reduction
• Fibres and carbohydrates	• Cardiovascular health and diabetes
• Minerals	• Cognitive and mental function
• Nutritional lipids and oils	• Energy and endurance
• Phytochemicals, plant extracts	• Eye health
• Probiotics and prebiotics	• Immune system
• Proteins, peptides, amino acids	• Maternal and infant health
• Soy-based ingredients	• Respiratory health
• Vitamins and premixes	• Skin health
	• Weight management

Source: "Nutraceuticals – Critical supplement for building a healthy India", Ernst & Young FICCI, September 2009

Typically, nutraceuticals fall into one of three categories: *functional foods*, such as probiotic foods, *functional beverages*, which include sports and energy drinks, glucose powders, and fortified juices, and *dietary supplements*, such as vitamins, minerals, macronutrients, antioxidants, tonics and herbal extracts.

(e.g. energy drinks) and dietary supplements (e.g. vitamins, antioxidants etc.

Those who want to dig deep may refer to the TIFAC-ICC report which is rich with information, written in simple terms.

We will pick up ~~some~~ a few of the elements to cover in some detail in the later chapter 13, emerging Technologies and Enterprises.

Here would like to point out that this emerging areas in which Indian industries are fortunately present to some degree, is highly knowledge intensive. It requires

Go to 389A

several new skill sets and different ways of working. It will require new forms of Industry – Academia collaboration. Presently our academia are far removed from manufacturing and global laboratory practices. Also they are slow to respond. One has to work 24×7 to make products in this competitive world.

The skill set is not just for technicians and assistants alone; but also for the researchers, research managers. The later group requires a lot of unlearning in terms of their work culture and learn new globally competitive industrial work culture. Industries too ~~world~~ world need newer

(Go to 389B)

work styles and mindsets right from the Board Room to middle management to factory floors to marketing.

These may require new testing infrastructure for which Govt may have to help in money terms. Existing Govt systems of funding and the work culture of those departments may need a drastic reorientation.

If we do so, India can become one of the top leaders in Knowledge Chemicals in about a decade.

SPECIALITY CHEMICALS

The third major sector is Speciality chemicals which support many other vital sectors. These Speciality Chemicals are: Water treatment chemicals, catalysts, construction chemicals, adhesives and sealants, colourants, textile chemicals, leather chemicals, paper chemicals, plastic additives, oil field chemicals foundry chemicals, electronics chemicals, paints and coatings, personal care ingredients, pharmaceutical excipients, and food additives to name the major products in the Indian Speciality chemical industry.

In this sector there is an excellent report by TIFAC - ICC

with a title "Indian Chemical Industry: Technology Imperatives and Business Opportunities for Specialty Chemicals" (2014). This study was ~~supported~~ assisted by ICRA Management Consulting Services Ltd ICMCS, New Delhi.

Each of the above listed chemicals such as Water treatment chemcals etc are dealt with in detail and compared to global status. Patent trends are also given.

We need to ~~look at~~ cover here the sections on Skill Gap and Technology Road Map to highlight action areas.

~~To~~ The skill gap is focussed and short & we reproduce the full quote from the report:

"Accordingly - - - years

See Attached Sheet 391A & reproduce the

p. 144 //

office devoted to managing technology transfer and staffed with legal and technical experts. In addition to patent management, Technology Transfer Offices (TTOs) in some institutes are often engaged in marketing the technology, finding potential partners, and securing funds. As of June 2004, there were 119 IPR related offices in Japanese universities, either TTOs or IP headquarters. As of 2005, 30 TTOs were in operation in China. In addition, there were more than 70 university science parks recognized by the Government.

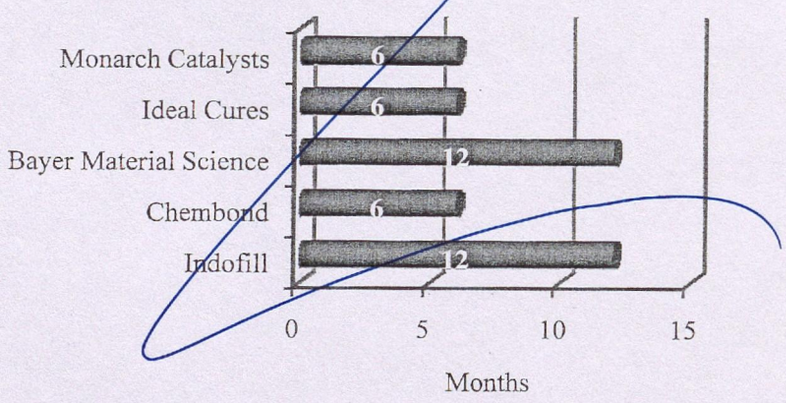
4.5.Skill gap

According to inputs received during the primary survey, the Industry is impacted by skill gap in the area of practical knowledge.It has been pointed out by respondents during the primary survey that the new entrants in the industry, while have theoretical knowledge of chemistry and other relevant subjects, often do not have adequate practical knowledge of operating laboratory equipment. Strong theoretical background coupled with adequate practical knowledge of operating machines and laboratory equipment is the need by the industry. Following are the areas which have been mentioned as areas of skill gap by the respondents during our primary survey:

- Skills to operate machines
- Knowledge of operating laboratory equipment
- Adhere to safety aspects in conducting lab work
- Knowledge of compliance to processes
- Technical knowledge of Good Laboratory Practices (GLP)

Lack of industry-academia interactions, lack of adequate infrastructure in some academic institutions and un-updated curricula have been sighted as some of the reasons for new entrants having inadequate practical knowledge. As a result, majority of the companies impart in-house technical training to the new joiners, as detailed in Exhibit 83 which operates like a 'finishing school'.

Exhibit 83: Technical training to new joiners (months)



Source: Primary survey

Technology Road Map:

There is a declining growth in demand in the developed markets; demand has shifted to China, India and other emerging countries. As per TIFAC – ICC report, escalating raw-material costs, new competition from emerging economies (from India's regional players, China and Middle East) and expansion of scope of commodity and diversified players are leading to shrinking margins.

The report further states that "in this evolving scenario

of Specialty Chemicals industry, India offers several growth opportunities such as exports, product outsourcing hub, ~~R&D~~ research outsourcing hub, ex. India's cost advantage is a key driver governing outsourcing and contract research and manufacturing services (CRAMS) in the country. Foreign companies are shifting their manufacturing base to India mainly due to well educated pool of scientists, chemical engineers, and low labour and

and equipment costs.

Further, ~~multi~~ multinationals are viewing smaller Indian companies as providers of their specialty chemical requirements."

The report further states that "Emerging trends in Specialty Chemical Industry indicate a new focus on technology; New development in end-user industries such as nanotechnology, biotechnology etc are offering new

opportunities in several areas such as electronics, food, textiles etc, however, success in this area demands technological competence to develop new products and customised applications".

~~Lat~~ The report further lists the technology gaps or limitations of the Indian specialty chemical industry:

- Heavy reliance on imports
- Problems for raw materials
- Compliance to environmental regulations guidelines.
- Limited focus on research

– Limited collaboration between industry and academia.

Regarding the last point, our experience shows that most of the problems are due to the organisation of our national laboratories and academic system. Their governance does not demand delivery ~~of goods to~~ to industry or to actual life-situations. They are often in their ~~ivory~~ ivory towers!

The actions required by Govt are:

– Providing financial assistance ~~for~~ acquiring global technology

- Attaining self-sufficiency in raw material: Several details steps are given in the report
- Focussed research projects: an approach is given in the report.
- Developing herbal products for specialty applications: ~~Detail~~ Some details are given

When Dr. Kalam was Principal Scientific Adviser to Govt of India and Rajan as Scientific Secretary during 2000-2001, ~~that~~ one of the first task, was to create a detailed action plan

for Herbal Products through
a Task force ~~under~~ with the
~~Dg~~ leadership for Smt.
~~Leela~~ Leela Poonawalla
The trouble in our country
is the extremely slow action!!

- Developing Centres of
Exallence for identification
of Specality Chemicals Industry
Again the Centres of
Relvence and Exallence (CORE)
the scheme specially launched by
Dr Kalam as PSA & Chairman TIFAC
~~for~~ slowed down after he & Rajan

left. We can easily
convey about 200 colleges
in India for this work, with
low investment and also
thereby creating skilled
~~manpo~~ human resources

We need to ~~to~~ take
up this sector as a Mission.
India can achieve a lot

BIO PROCESS AND BIO PRODUCTS

In one sense these
can be covered under Chemical
industry, as they belong here.
However we are going to
cover them in Chapter 13, emerging

areas to which also they belong. To give a glimpse of what they are we mention a few products: ~~Bioe~~

- Bioethanol: ~~ethanol~~ ethanol from biomass, bacterial ethanol, bio conversion of cellulose etc
- Biochemicals: chemicals produced from Bio mass
  - Bio-oil
  - Bio-hydrogen
  - Industrial Enzymes for bioethanol

These are again areas in which India can excel because India has a lot of arable lands.

and good weather, water, if we use right technologies for agriculture, forestry, biomass production etc. Advanced technologies will increase soil productivity, plant growth etc, ~~thus~~ thus ~~produ~~ giving lots of ~~land~~ land area freed from the current agricultural products: grain, fruits, vegetables, cotton, ~~etc.~~ sugarcane etc.

CONCLUSION

On the whole Chemical Industry in India is poised for a major growth if we take care of the items highlighted here and in the

TIFAC-ICC reports. It is not without competition. China is a major competitor. Other ~~~~ emerging countries make a dent too. One of the major problem for India is availability of quality ~~and~~ reliable and reasonably priced ~~to inexpensive~~ electricity; water; and road/~~rail~~ rail/ port/ship infrastructure. There has to be abroad upgradation. Some of Chemical industry currently are being "shaken out" in the global competition. ~~White~~ Those

which are obsolete need to be upgraded or abandoned. But those which are good or have potential to be better and best need support in terms of policies, enabling infrastructure and skilled human resources. National laboratories and academia funded by GOI need to be speedily oriented to one Mission

"INDIA AS A CHEMICAL AND BIOTECHNOLOGY INDUSTRY HUB OF THE WORLD"

in all the sectors touched upon here. It is possible to achieve within one decade.
