EXPERT SYSTEMS FOR AGRICULTURE

Presentation in Faculty Meet at
Tamil Nadu Agriculture University, Coimbatore

BY

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21 February 2014

A GLIMPSE OF GREAT SCIENTISTS OF ANCIENT INDIA

ARYABHATT (476 AD)
ASTRONOMER & MATHEMATICIAN
First to proclaim that the earth is round & rotates on its axis

Calculation of Π (Pi) to 3.1416 and sine table in trigonometry.

BHASKARACHARYA II
(1114-1183 AD)
GENIUS IN ALGEBRA
First to discover gravity, 500 years before Sir Isaac Newton.

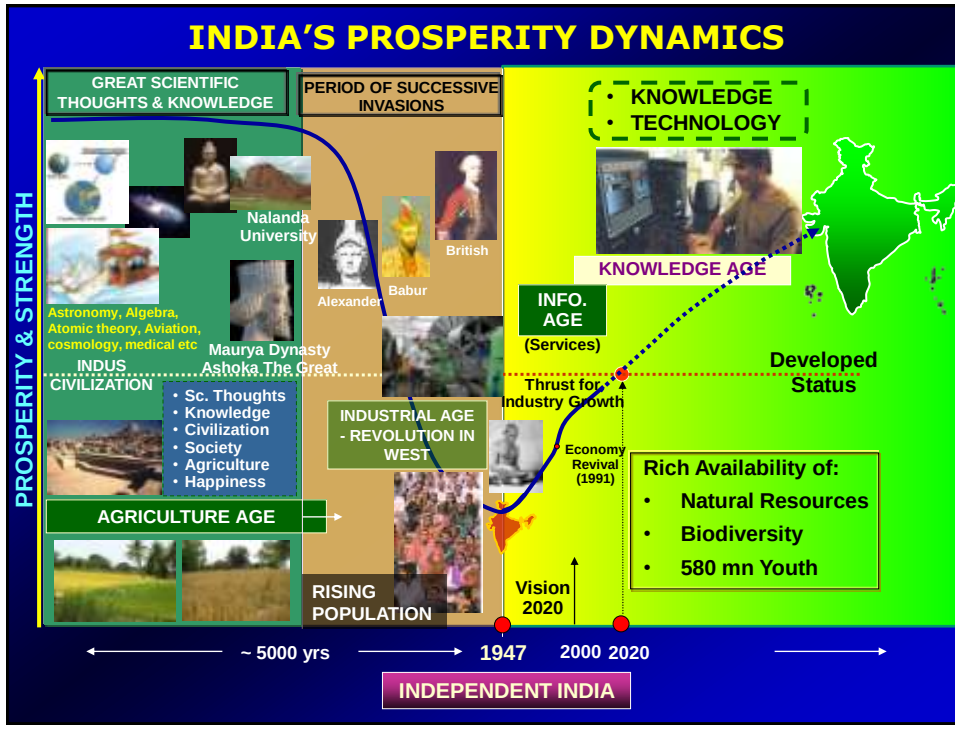
ACHARYA KANAD (600 BC)
FOUNDER OF ATOMIC THEORY
Said "Every object of creation is made of atoms which in turn connect with each other to form molecules".

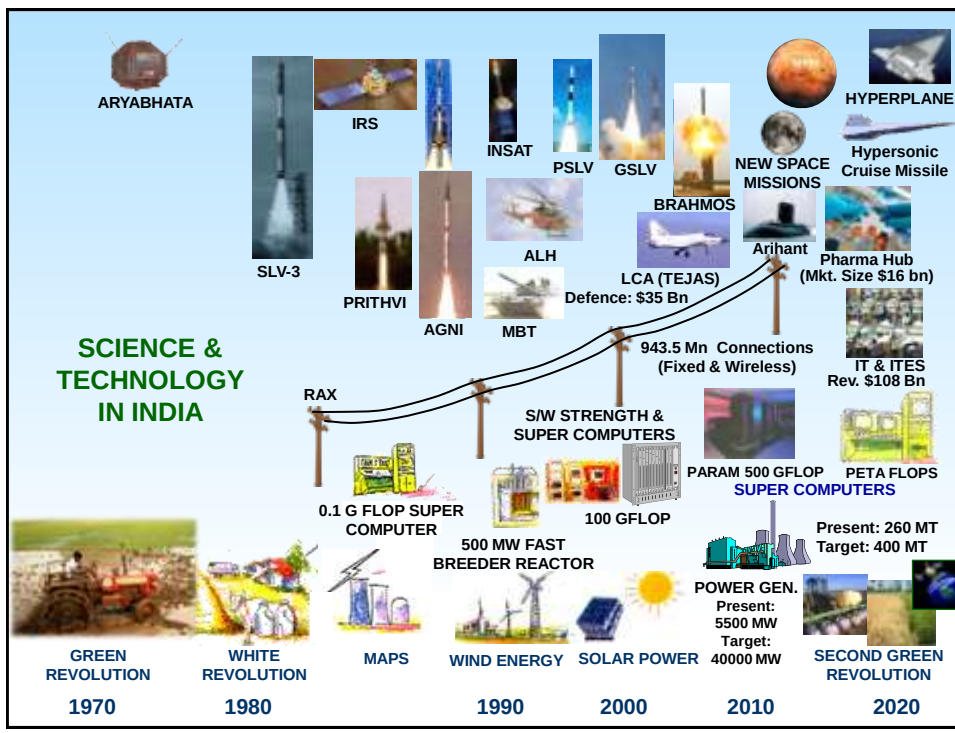
ACHARYA SUSHRUT (600 BC)
FATHER OF PLASTIC SURGERY
Performed Rhinoplasty (restoration of a damaged nose); prescribed treatment for 12 types of fractures & 6 types of dislocations.

ACHARYA BHARADWAJ (800 BC)
PIONEER OF AVIATION TECH.
Designed and described about the techniques in aviation technology

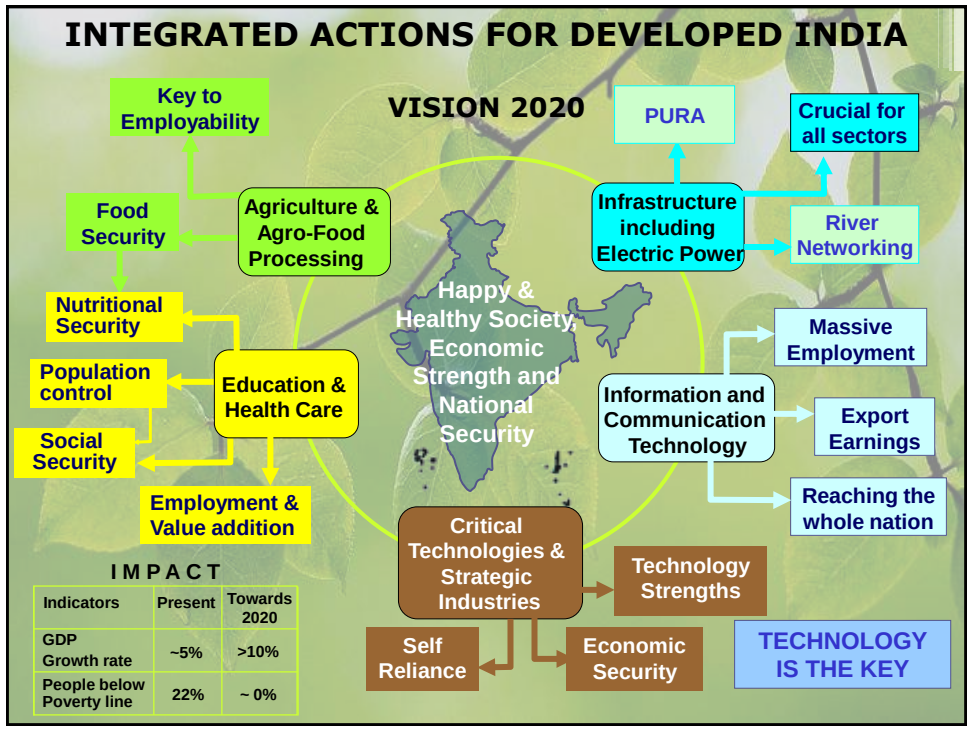
ACHARYA KAPIL (3000 BC)
FATHER OF COSMOLOGY
Given concept of transformation of energy

Source: Indian Institute of Scientific Heritage, Trivandrum, www.iish.com


INDIA'S PROSPERITY DYNAMICS
PROSPERITY & STRENGTH
GREAT SCIENTIFIC THOUGHTS & KNOWLEDGE
PERIOD OF SUCCESSIVE INVASIONS
• KNOWLEDGE
• TECHNOLOGY
Nalanda University
British
Alexander
Babur
KNOWLEDGE AGE
Astronomy, Algebra, Atomic theory, Aviation, cosmology, medical etc
INFO. AGE
(Services)
Maurya Dynasty
Ashoka The Great
INDUS CIVILIZATION
Developed Status
Thrust for Industry Growth
• Sc. Thoughts
• Knowledge
• Civilization
• Society
• Agriculture
• Happiness
INDUSTRIAL AGE - REVOLUTION IN WEST
Economy Revival (1991)
Rich Availability of:
• Natural Resources
• Biodiversity
• 580 mn Youth
AGRICULTURE AGE
RISING POPULATION
Vision 2020
~ 5000 yrs
1947
2000 2020
INDEPENDENT INDIA


ARYABHATA
IRS
INSAT
PSLV
GSLV
HYPERPLANE
Hypersonic Cruise Missile
NEW SPACE MISSIONS
BRAHMOS
Arihant
Pharma Hub (Mkt. Size $16 bn)
SLV-3
ALH
LCA (TEJAS)
Defence: $35 Bn
PRITHVI
AGNI
MBT
SCIENCE & TECHNOLOGY IN INDIA
943.5 Mn Connections (Fixed & Wireless)
IT & ITES Rev. $108 Bn
RAX
S/W STRENGTH & SUPER COMPUTERS
PARAM 500 GFLOP
PETA FLOPS
SUPER COMPUTERS
0.1 G FLOP SUPER COMPUTER
100 GFLOP
Present: 260 MT
Target: 400 MT
500 MW FAST BREEDER REACTOR
POWER GEN.
Present: 5500 MW
Target: 40000 MW
GREEN REVOLUTION
WHITE REVOLUTION
MAPS
WIND ENERGY
SOLAR POWER
SECOND GREEN REVOLUTION
1970
1980
1990
2000
2010
2020

INTEGRATED ACTIONS FOR DEVELOPED INDIA



IMPACT

Indicators	Present	Towards 2020
GDP Growth rate	~5%	>10%
People below Poverty line	22%	~ 0%

GREEN REVOLUTION

C. SUBRAMANIAM

- VISIONARY LEADERSHIP FOR INDIA'S SELF-SUFFICIENCY IN FOOD GRAINS
- TWO MAJOR OBJECTIVES:
  - INTRODUCE S&T IN AGRICULTURE
  - ESTABLISH PRICING POLICY TO MOTIVATE FARMERS FOR ENHANCING PRODUCTION
- REORGANISTION OF AGRI. RESEARCH IN COUNTRY

OBJECTIVES

- CONTINUED EXPANSION OF FARMING AREAS
- DOUBLE CROPPING EXISTING FARMLAND
- USING SEEDS WITH IMPROVED GENETICS

- HIGH YIELD, CROSS-BREED WHEAT & RICE VARIETIES DEVELOPED
- HIGH PRODUCTIVITY OF GRAINS

NOBEL LAUREATE
PROF. NORMAN E BORLAUG

M.S. SWAMINATHAN

LEADERS

AGRICULTURE MISSION

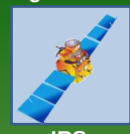
FIRST GREEN REVOLUTION

- SEED
- FERTILISERS
- WATER MANAGEMENT
- TRAINING FARMERS
- CULTIVATION MANAGEMENT
- HARVEST & POST HARVEST
- OUTPUT = GRAIN (TARGET: 230 MT PER ANNUM)

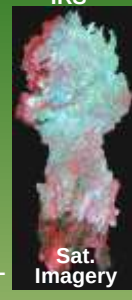
PRODN.: 260 MT

RP-5 CHANNEL BIHAR (TIFAC)

Large Farming



IRS



Sat. Imagery

SECOND GREEN REVOLUTION

- SOIL CHARECTERISATION
- MATCHING THE SEED
- FERTILISER MANAGEMENT
- WATER MANAGEMENT
- CULTIVATION
- POST HARVESTING (SILOS)
- GRAIN PRODUCTION TARGET(2020) 400 MT PER ANNUM
- FOOD PROCESSING (Value Addition)
- MARKETTING

INCREASED USE OF S&T

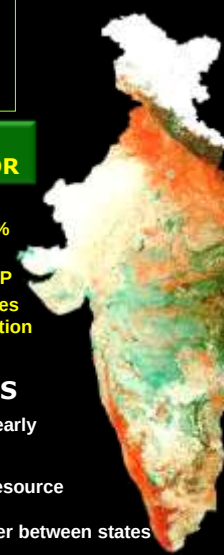
Space Perspectives:
- Efficient Land and Water Resources Management
- Empowering People for Sustainable Development

AMBIENCE IN AGRICULTURE SECTOR

Sector status in India
- Means of living for almost 58% employment in the country
- Accounts 14.5% of India's GDP
- Arable land of 158 Mn. Hectares with a total food grain production of 260 million tonnes.

PROBLEM AREAS

- Shrinking of arable land to nearly 100 mn hectares by 2020
- Scarce availability of water resource
  - Monsoon failing
  - Disputes in sharing of water between states
- Migration of people to cities, looking for job opportunities commensurate with education, Govt. schemes providing free food & other facilities – led to shortage of labour in the farm sector
- Excessive Use of Pesticides leading health hazards

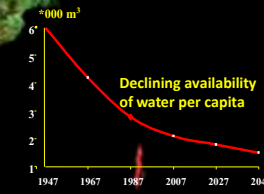


700 M. Indians depend on Natural Resources for their Livelihood and Marketable Surplus

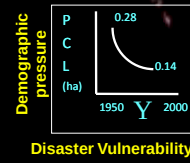
Loss to 4.5% of the GDP due to Degradation of Natural Resources

India's Annual Soil Loss 5334 Mt

Forest: 64 M ha
Closed forest : 11%
Flora / Fauna : 46000 (7.0%)
81000 (6.5%)

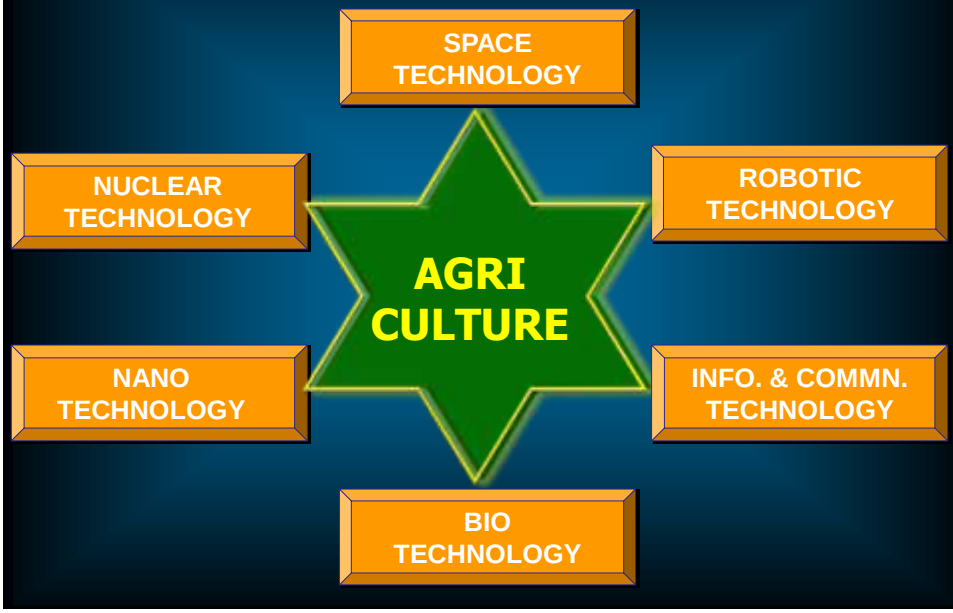


Depletion of ground water table
Glacier retreat >10 meters/ year



Disaster Vulnerability

CONTRIBUTION OF SCIENCE & TECHNOLOGY FOR AGRICULTURE DEVELOPMENT

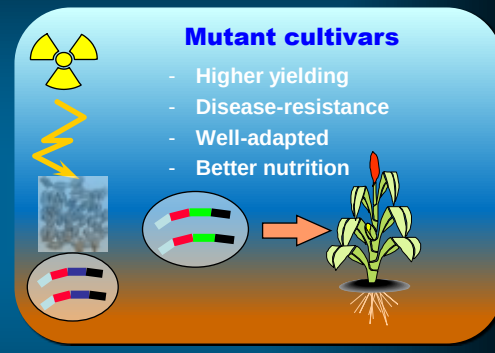


NUCLEAR TECHNOLOGY FOR AGRICULTURE

Plant Breeding & Genetics

by Mutation Techniques

- Induced mutation is useful for crop improvement
- Spontaneous mutation rate is $1\times10^{-8} \sim 1\times10^{-5}$
- No introduction of foreign hereditary material into induced mutants

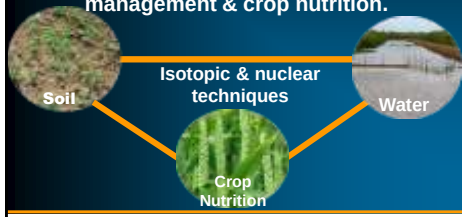


NO HEALTH HAZARD

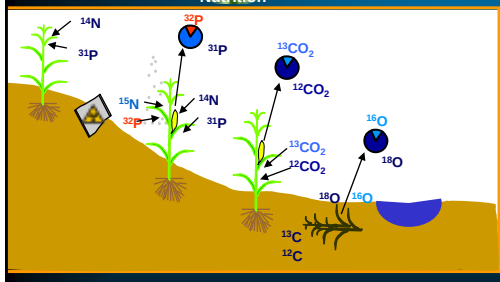
NUCLEAR TECHNOLOGY FOR AGRICULTURE

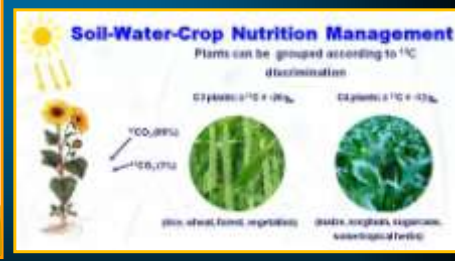
Soil & Water Management & Crop Nutrition

Both stable and radioactive isotopes used as tracers in soil and water management & crop nutrition.



- Enhance the efficient and sustainable use of soil-water-nutrient resources.
- Quantify Biological Nitrogen Fixation.
- Minimize effects of soil erosion and degradation.
- Enhance water use efficiency by crops.





NO HEALTH HAZARD

NUCLEAR TECHNOLOGY FOR AGRICULTURE

Food Irradiation

- Food irradiation is the treatment of food by ionizing radiation
- Isotopic techniques are employed to monitor foods for contamination with agrochemicals
  - optimizing sample preparation by radioisotopes
  - detecting contaminant by electron capture detector

- Gamma Rays
- Electron Beams
- X-rays

NO HEALTH HAZARD

INDIA'S SPACE PROFILE

Space is the potential resource for the development of India

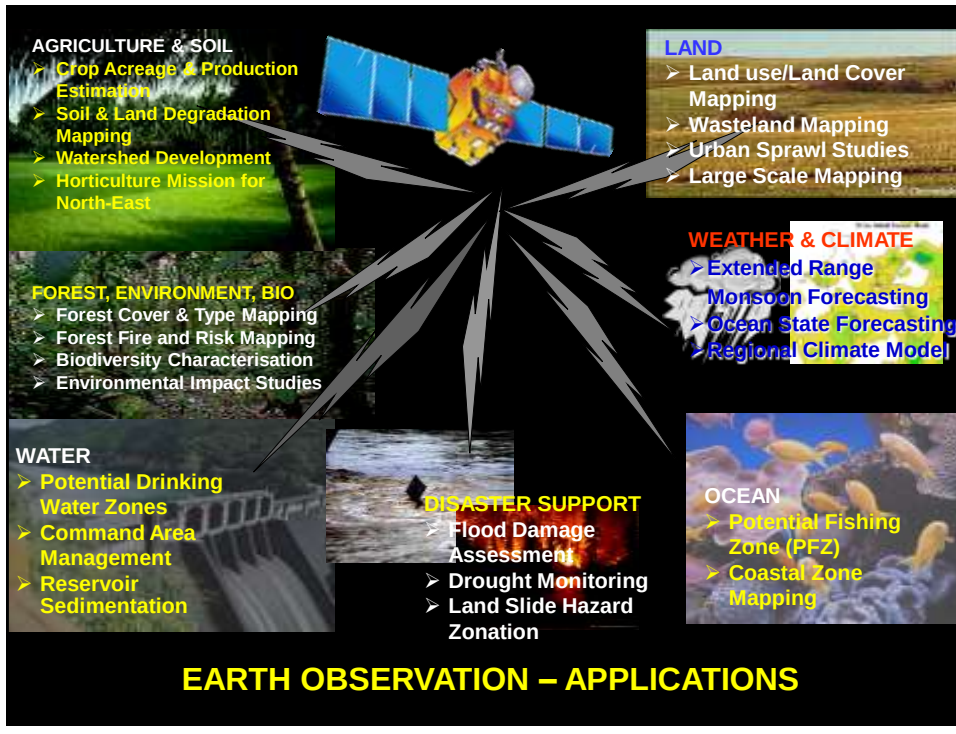

Dr. Sarabhai


Prof. Dhawan

REMOTE SENSING

INSAT SATELLITES

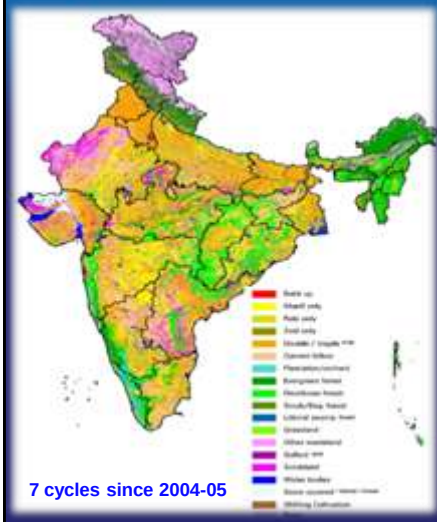
- Self-Reliance in launch vehicles & satellites
- Space Tech. applns. for national development
- Satellite Recovery capability for re-entry mission
- Cost effective launch vehicle service
- Capability to launch multiple satellites
- Global competitive space power



EARTH OBSERVATION – APPLICATIONS

NATURAL RESOURCES CENSUS

Geospatial Information on natural resources and depiction of changes on a periodical basis



7 cycles since 2004-05

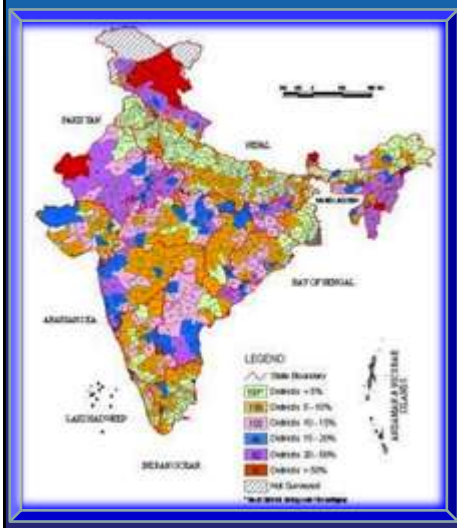
- Mapping at 1:250,000 scale using 56 m resolution IRS-AWiFS data (7 Cycles)
- Mapping at 1:50,000 scale using 23 m resolution IRS-LISS3 data (1 cycle).

At 1:50,000 scale using IRS-LISS 3

- National level Land-use/ Land cover inventory
- Geomorphology and lineament mapping
- Snow & Glaciers mapping
- Land degradation mapping
- Wetlands mapping
- Soil mapping

WASTELAND INVENTORY AND CHANGE ANALYSIS

Mutli-temporal Wastelands inventory using Remote Sensing and Geospatial technology



Sl.no	Year	Area (M.Ha)	%TGA*
1	2000	63.85	20.17
2	2004	55.27	17.45
3	2006	47.22	14.91
4	2009	46.73	14.76

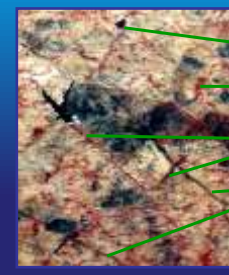
** TGA: Total Geographic Area*

Image at T1

Image at T2

Geospatial Information on Groundwater & Recharge

(Rajiv Gandhi National Drinking Water Mission)

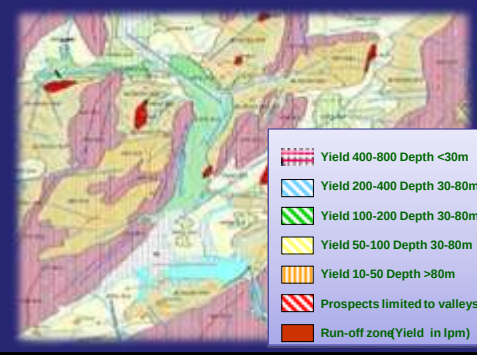


Hydrologic information
(Surface water bodies)

G.W. exploitation
(Ground water irrigated area)

Conduits for G. W. movement
(Fracture /Lineament)

Barriers for G. W. movement
(Dolerite dyke)



- 20 States completed; work is in progress in 15 states and UTs.
- 2,80,000+ Bore wells drilled with 93% success rate
- 9,050 + Recharge structures constructed

India Water Resource Information System

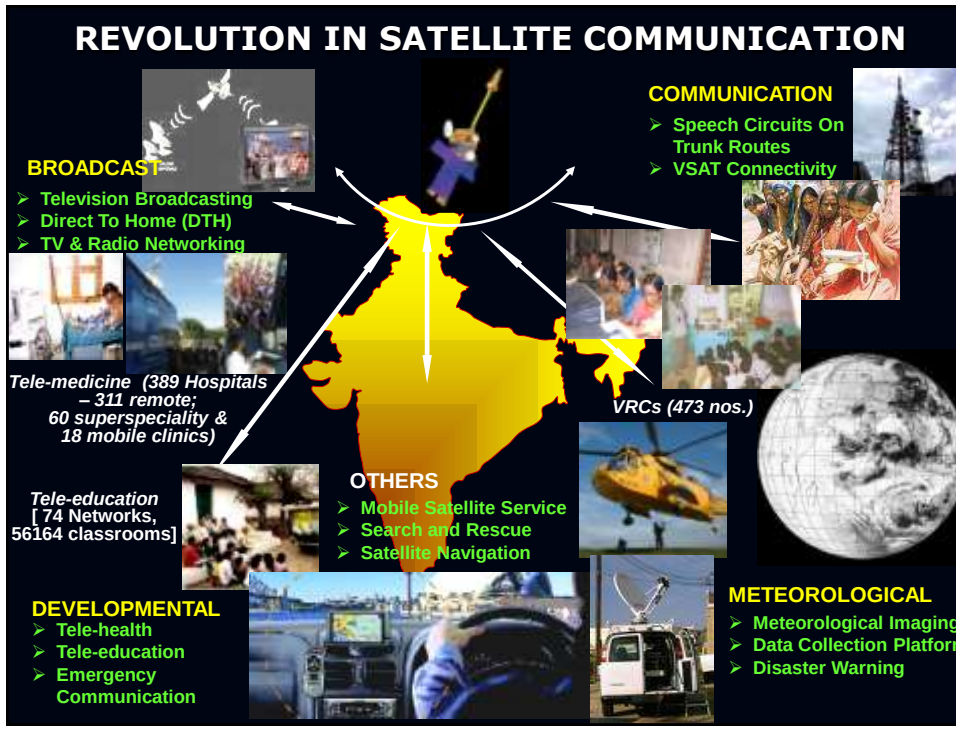
India-WRIS WebGIS

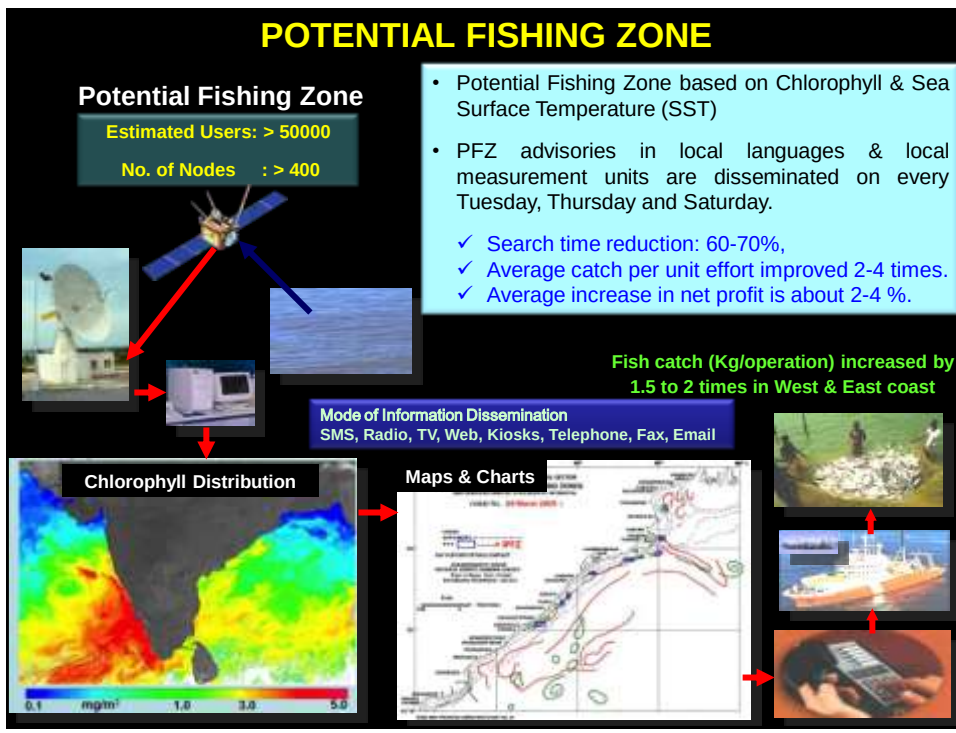
Geo-Visualization & Processed data

Joint effort of ISRO & CWC

- **Joint effort of ISRO and Central Water Commission.**
- Single Window solution for all water resources data and information.
- India-WRIS (Ver 2.0) with 12 major info systems having 108 spatial layers released on March 22, 2012.
- Basin-wise reports and Watershed atlas of the country

- The Beta version with some of the important databases launched on December 7, 2010.
- Capacity building of CWC official has also been undertaken


REVOLUTION IN SATELLITE COMMUNICATION
BROADCAST
Television Broadcasting
Direct To Home (DTH)
TV & Radio Networking
COMMUNICATION
Speech Circuits On Trunk Routes
VSAT Connectivity
Tele-medicine (389 Hospitals – 311 remote; 60 superspeciality & 18 mobile clinics)
VRCs (473 nos.)
Tele-education [74 Networks, 56164 classrooms]
OTHERS
Mobile Satellite Service
Search and Rescue
Satellite Navigation
DEVELOPMENTAL
Tele-health
Tele-education
Emergency Communication
METEOROLOGICAL
Meteorological Imaging
Data Collection Platform
Disaster Warning


POTENTIAL FISHING ZONE
Potential Fishing Zone
Estimated Users: > 50000
No. of Nodes : > 400
Potential Fishing Zone based on Chlorophyll & Sea Surface Temperature (SST)
PFZ advisories in local languages & local measurement units are disseminated on every Tuesday, Thursday and Saturday.
Search time reduction: 60-70%,
Average catch per unit effort improved 2-4 times.
Average increase in net profit is about 2-4 %.
Fish catch (Kg/operation) increased by 1.5 to 2 times in West & East coast
Mode of Information Dissemination
SMS, Radio, TV, Web, Kiosks, Telephone, Fax, Email
Chlorophyll Distribution
Maps & Charts

DEFENCE TECH. APPLICATIONS FOR DEVELOPMENT

AGRO TECHNOLOGIES FOR HIGH ALTITUDE

ANTIOXIDANT RICH PRODUCTS

Seabuckthorn beverages


Seapricot Beverage

Jam


Herbal Tea

GREENHOUSE TECHNOLOGY


Greening of Cold Desert


Trench Technology


Vegetable Production

DEFENCE TECH. APPLICATIONS FOR DEVELOPMENT

DEFENCE INSTITUTE OF HIGH ALTITUDE RESEARCH (DIHAR)

GREENING OF LEH VALLEY

- **LARGE SCALE AFFORESTATION**

  VALLEY IS COVERED WITH SNOW IN WINTER BUT LUSH GREEN IN SUMMER

- **FRESH VEGETABLES**
  - FARMERS CO-OPERATIVES SUPPLY VEGETABLES OVER RUPEES ONE CRORE ANNUALLY TO ARMY
  - GREENING OF LEH MARKET DURING FROZEN WINTER (Greenhouse leafy vegetables)
- **SURPLUS PRODUCTION**
  - 50 % OF ARMY REQUIREMENT NOW MET LOCALLY

DEFENCE TECH. APPLICATIONS FOR DEVELOPMENT

DEFENCE INSTITUTE OF HIGH ALTITUDE RESEARCH (DIHAR)
COLD DESERT-SELF SUSTAINING VILLAGE
NANG (4000 m) LADAKH, J&K

- FRL (DRDO) AND MIN. OF RA&E AS PARTNERS USED VILLAGE CO-OPERATIVE AS A VEHICLE
- ACTIVITIES UNDERTAKEN

  Water Harvesting (3 reservoirs)
  Afforestation in 25 ha. waste land
  Potato seed Production for Leh valley Greenhouse Cultivation
  Improved Agro-technology & Machinery
- WITHIN TWO YEARS INCREASED SUSTAINABLE ANNUAL INCOME FROM Rs. 2200 TO Rs. 44OO PER FAMILY

DEFENCE TECH. APPLICATIONS FOR DEVELOPMENT

DEFENCE INSTITUTE OF BIO-ENGINEERING RESEARCH (DIBER)
PITHROGARH

- Crop improvement programme thru' molecular biotechnological tools
- Dev. of high yielding varieties/hybrids in vegetables
- Practices for undertaking vegetable cultivation in high altitude cold desert
- Green house technology for off season vegetable cultivation

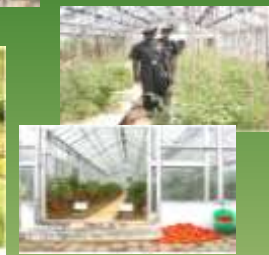
Hybrid Variety – Garlic & Tomato

Cold Tolerant Vegetables

Soilless Cultivation: Hydroponics

DIBER, Fd. Stn. Pithoragarh (5500 ft)

DIBER, Fd. Stn. Auli (9000 ft)



Green House Technology For Off Season Vegetable Cultivation

DEFENCE TECH. APPLICATIONS FOR DEVELOPMENT

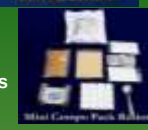
DEFENCE FOOD RESEARCH LABORATORY (DFRL)

AGRO FOOD PROCESSING

NOVEL INNOVATIONS AND TECHNOLOGIES:

- **Minimally processed vegetables in pre-cut & packaged form**
- **HTST Dehydration Technology**
- **Fungistatic Wrapper**
- **Stay fresh Chemicals for Fresh Fruits & Vegetables**
- **Micro-Encapsulated Flavours**
- **Thermal Processing of Food in Aluminium Cans**
- **Stack Encapsulation Technique**
- **Leg Operated Chapati Rolling Machine**

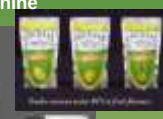
Instant Spiced Dal



Enzyme clarified Goose berry juice

Anti freeze container

Automatic Tender Coconut Water Processing System



AGRICULTURAL BIOTECHNOLOGY

Agricultural biotechnology is a collection of scientific techniques used to improve plants, animals and microorganisms.

Genetic Engineering is the introduction of a specific gene into the DNA of a plant to obtain a desired trait.

HOW IS AGRICULTURAL BIOTECHNOLOGY USED?

- ✓ Genetic engineering
- ✓ Molecular markers
- ✓ Molecular diagnostics
- ✓ Vaccines
- ✓ Tissue culture

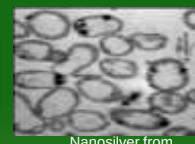
GOALS OF GENETIC ENGINEERING

- ✓ Insect resistance
- ✓ Herbicide tolerance
- ✓ Virus resistance
- ✓ Delayed fruit ripening
- ✓ Foods with improved nutritional value

Genetically Modified Seeds

NANOTECHNOLOGY IN AGRICULTURE

Eco-friendly Microbes



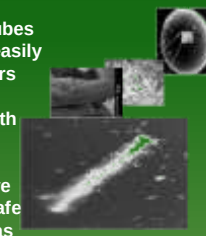
Nanosilver from Pseudomonas stutzeri

- Viable alternative to the physical and chemical methods
- Silver nanoparticles as viable bio-control Agent

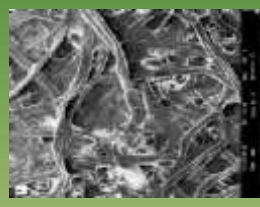
Magnetite nanoparticles

Nano-Pesticides

- Aluminosilicate nanotubes on plant surfaces are easily picked-up in insect hairs
- Filling of nanotubes with active ingredients
- Biologically more active and environmentally-safe (relatively) pesticides as nanoemulsions



Electrochemical Nano-bio Sensor for Pesticide Detection



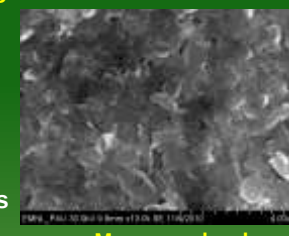
- MW CNT were deposited on the surface of membrane
- Membrane Interface Probe (MIP) material was immobilized on MWCNT layer
- Membrane resistance, potential & conductivity was measured using an electronic circuit
- Sensing was done successfully up to an 10-7 Molar concentration / soil samples

Source: Nanotechnology in Agri-Food Systems, Kalpana Sastry

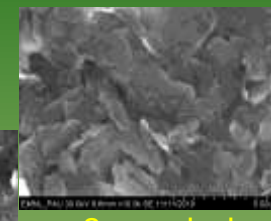
NANOTECHNOLOGY IN AGRICULTURE

Nanotechnology for Soil management

- Thermodynamically, both colloidal clays & colloidal organic matter (i.e., humus) would form complexes so as to attain stability
- One of the natural phenomena of protecting earth sys
- Humus occurs on clays on nanoscale.
- Clay bound humus can rejuvenate degraded ecosystems



Mango orchard



Guava orchard

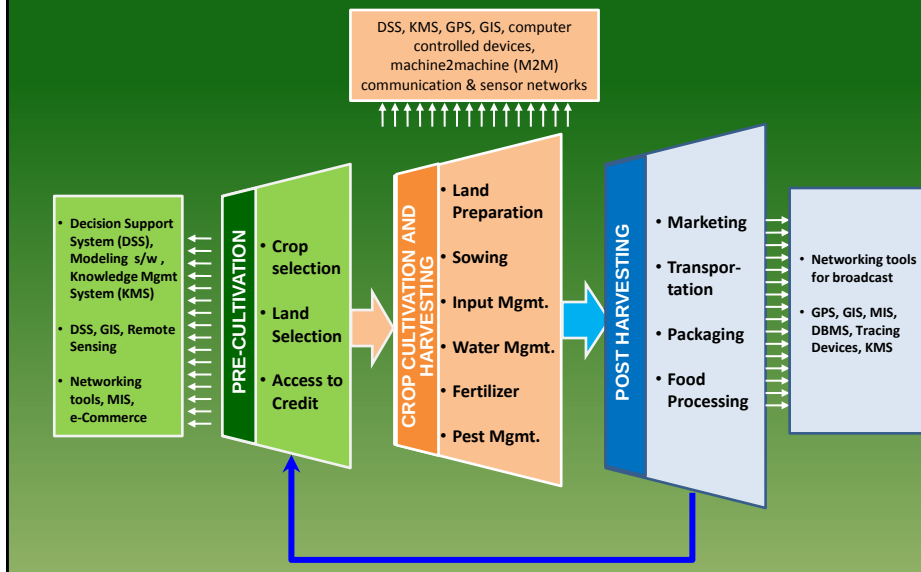
Clay-Humus Complex in soils

Organic carbon (atom %) on soil-clays of Punjab (SEM-EDS data)		
Land use	Humus Clay	Soil-Clay
Mango orchard	12.10	15.25
Guava orchard	15.60	18.90
Rice-Wheat field	9.78	11.69

Rice-Wheat field

Source: Learning to Leap: Nanotechnology's Root in Soil Science, Siddhartha S. Mukhopadhyay

ICT IN AGRICULTURE



APPLICATION OF EXPERT SYSTEM IN AGRICULTURE

- ❖ Study of Plant Pathology, Entomology, Soil condition into a framework for assessing farmer's need
- ❖ Weather and climate monitoring
- ❖ Irrigation scheduling
- ❖ Fertilizer scheduling
- ❖ Diagnosis of disorders and treatment
- ❖ Crop production and assessment
- ❖ Overall assessment of the farm
- ❖ Communication to the farmer in local language

Dynamic information system and solutions to problems

ROBOTIC TECHNOLOGY FOR AGRICULTURE

FIELD INSPECTOR

- Autonomous system requires an Autonomous Plant Inspection (API) vehicle and cameras for weed detection and mapping
- Vehicle has a height clearance of 0.6 m and track width of 1 m
- Equipped with a real time kinematics Global Positioning System (RTK-GPS)
- Operating console on the top frame for implementing agricultural operation (spraying, weeding etc.)
- Communicates with the farm control centre

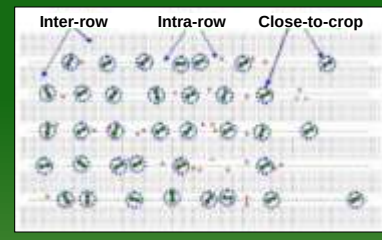
GPS APPLICATIONS

- Field preparation, Planting and Cultivation
- Fertilizing &Crop Protection
- Mapping, Scouting & Sampling
- Harvesting
- Planning and Analysis

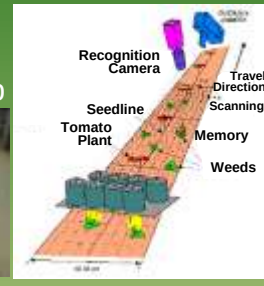
ROBOTIC TECHNOLOGY FOR AGRICULTURE

ROBOTIC WEEDING

- Robotic weeding is a novel weeding technology to reduce the amount of energy used to weed organic crops.
- Weeding operations are
  - between the rows (inter-row),
  - within the rows (intra-row); and
  - close-to-crop
- Robotic weeding
  - Tillage for intra-row and
  - Micro spray close-to-crop



Tillage for Inter-row weeding



Micro spray for close-to-crop

Source: Danish Institute of Agricultural Sciences

ROBOTIC TECHNOLOGY FOR AGRICULTURE

AUTONOMATION IN WATER MANAGEMENT & IRRIGATION

Modern automation systems comprised of five basic components:

- **Measuring and sensing equipment,**
- **Control and regulation instrumentation,**
- **Input and output devices,**
- **Communication between the different components; and**
- **Power sources**

IMPLEMENTATION OF AUTOMATION

- Time-based automatic opening and shutdown of the water.
- Opening by timer, automatic shutdown after required water delivered.
- Combined irrigation and fertilization with or without recording of the applied water and fertilizer amounts.
- Sequential activation of valves in the field
- Integrated scheduling and control of irrigation systems. Real time control thru' information received from sensors (Temp., wind, rain, soil moisture, etc.,)
- Integrated control of water sources and irrigation systems.

INCORPORATION OF ICT IN AUTOMATION SYSTEMS FACILITATES FULL EXPLOITATION OF THE POTENTIAL OF AUTOMATION.

Data Archive

Visualization

Thematic Services

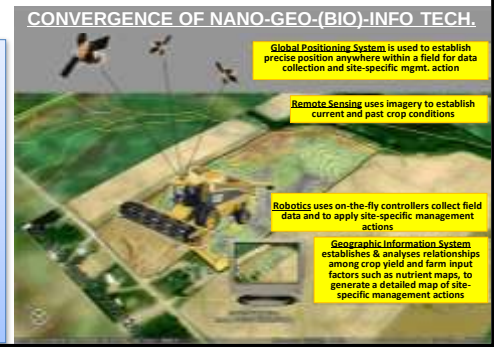
Geo-Processing

Bhuvan

– A Unique Gateway to Indian Earth observation Data & Services

- ✓ **Availability of Seamless High Resolution & Multi-Sensor Data from IRS Satellites**
- ✓ **2D and 3D Visualisation tools**
- ✓ **Rich Thematic Information**
- ✓ **Weather & Ocean Services**
- ✓ **Collaboration /Community Participation**
- ✓ **OGC Web Services**

CONVERGENCE OF NANO-GEO-(BIO)-INFO TECH.

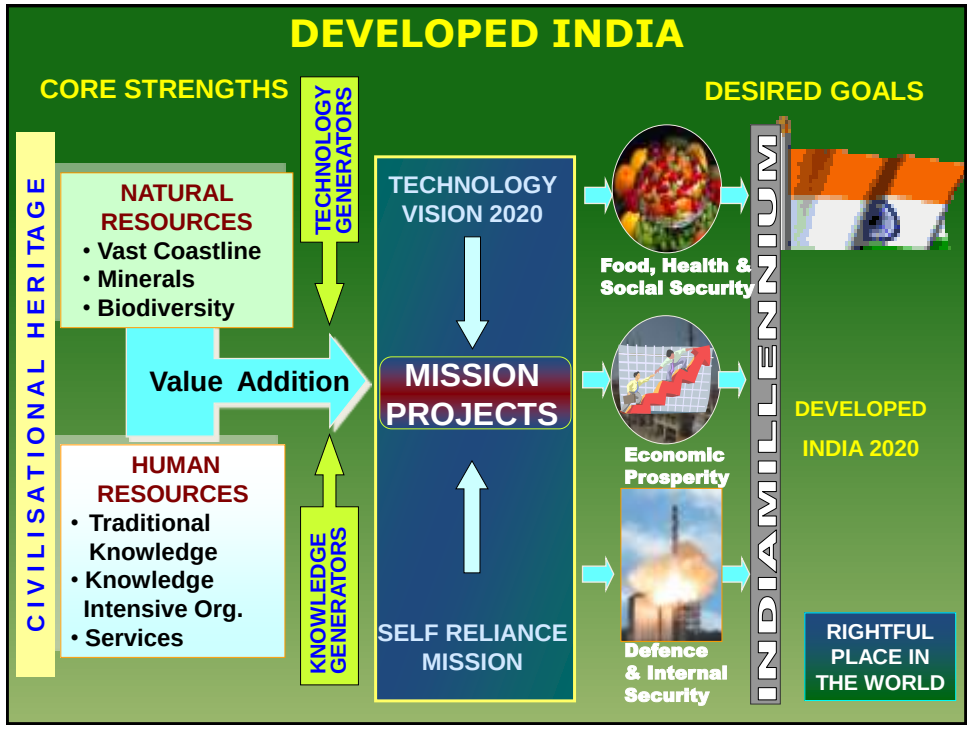


Suggested R&D Areas in Agriculture

- **Reducing Global warming**
  - Dev. of new breed of C3 plants that can absorb more CO2 in the atmosphere
- **Dev. of High Yield Varieties**
  - To focus on more quality characteristics rich in vitamins & minerals
  - Micro propagated plants for disease free
- **Radio Isotopes**
  - More R&D efforts on the usage of Radio Isotopes for diagnosing nutritional deficiency in plants & soil & application of fertilizers
- **Precision farming and Atomization**
  - More Mechanization to be resorted to for providing right quantity of water and nutrition to the crops
- **Energy Farming & Assistive technologies for farms**
  - Dev. of appropriate technologies for prodn. of energy crops economically viable.
  - R&D for power gen. thru' biomass for agriculture purpose
  - Dev. of intelligent farm machines

IDENTIFIED AREAS FOR ENHANCING AGRICULTURE SECTOR

- Needs monitoring on
  - Agricultural crop conditions
  - Weather and climate
  - Ecosystems
- Decision support for agricultural planning and policy-making
- On the basis of AI interest
  - Computational Intelligence in Agriculture and the Environment
    - Optimizing different types of bio-systems
    - Testing and fitting of quantitative models
  - Intelligent environment control for plant production systems
  - Intelligent robots in agriculture
  - An expert geographical information system for land evaluation
  - Artificial neural network for plant classification using image processing.
  - Control of green house.


DEVELOPED INDIA
CORE STRENGTHS
DESIRED GOALS
CIVILISATIONAL HERITAGE
NATURAL RESOURCES
• Vast Coastline
• Minerals
• Biodiversity
TECHNOLOGY GENERATORS
Value Addition
HUMAN RESOURCES
• Traditional Knowledge
• Knowledge Intensive Org.
• Services
KNOWLEDGE GENERATORS
TECHNOLOGY VISION 2020
MISSION PROJECTS
SELF RELIANCE MISSION
Food, Health & Social Security
Economic Prosperity
Defence & Internal Security
INDIA MILLENNIUM
DEVELOPED INDIA 2020
RIGHTFUL PLACE IN THE WORLD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