Rural Biotechnology: Alternate and Ultimate Approaches for Rural Development in India

Chellapandi Paulchamy
Department of Bioinformatics, School of Life Sciences, Bharathidasan University,
Tiruchirappalli-620024, Tamilnadu, India
Email: pchellapandi@gmail.com

Introduction:

Biotechnology provides a great potential for a new technological revolution in industrial and agricultural sectors in the next decade. The ultimate success of biotechnology is dependent on advances in and support for the associated and engineering sciences. Short cuts, empiricism and superficial attention to any single discipline are likely to lead to poor performance and expensive failures. A key factor in all such attempts has been an integrated effort by biologists and engineers with a clear understanding to achieve the target. Often, the problems of translating scientific research into commercial practices and rural development have been under estimated and a link has been missing from the liaison between biologists and authorized managers. Such a situation requires either a new breed of technologically competent entrepreneurs or alternately an alert professional society to provide a common platform to biotechnologists, industrial managers and government agencies.

India is fortunate to have a very large resource base for biotechnology "take off" in terms of renewable raw materials and trained workers. We require many technical and commercial criteria to achieve success in translation. These include development of an efficient process technology package through scale-up studies starting from shake flask level along with inputs from molecular biology, optimization of unit operation, protection of technology packages by IPR and issues related to practice on a commercial scale with low cost when using recombinant organisms (Banerjee et al, 2001). Unfortunately, biotechnology is still in the process of early development and does not possess a sharp and easily defined form. Only in the last fifteen years has progress been made by microbiologists and genetic engineers, and we are hopeful of solving many problems of the present day specially energy and food crises to cater for the need of a growing population in the world. Rural biotechnology is the integrated use of biochemistry, microbiology and engineering sciences to achieve technological application of the capabilities of micro-organisms and cultured tissues /cells for rural development. An integrated knowledge of this field is afoot to bring a potential development in the rural population in which an inter relationship is needed as an essential support between rural people and biotechnologists/industrialists/extension agencies. In this article, we discuss how different biotechnological advancements are necessary for model development of the rural economy, rural health and rural society. We also describe a specific role for biotechnological processes and products and their wide utilization in Indian villages.

R & D of biotechnology in India:

Academic researchers who receive government funds usually conduct basic research. The objective of applied research is to gain the knowledge needed to supply a recognized and specific need, through a product or process. Our research and development organizations will have to acquire the resilience to introduce and adapt the latest technologies in production processes and to pay more attention to improving the quality and design of our products to stay globally competitive (Research Profile of Biotechnology Activities in India-A Directory, 1993). Though we have rich bio-diversity, it could not be over exploited as feedstock in biotech industry. The infrastructure costs will have to born by the government and the conversion and utilization should be left for entrepreneurs to work out the economics. The need to keep abreast with the latest information on advances and developments in biotechnology has become imperative for rapid progress in research and manufacturing applications. To fulfill this growing need, DBT (Department of Biotechnology) has established, as a part of its national infrastructure facilities, the biotechnology information system (BTIS) as a distributed database and network organization to provide an integrated information resource on all aspects of biotechnology. Research and development of different laboratories in India with useful rural aspects including fields of research, projects, infrastructure, techniques, processes, patents, and education and training facilities (Research Profile of Biotechnology Activities in India-A Directory, 1993) are listed in Table 1. Conceivably, this information table may be

helpful for people who have interest to develop economy through biotechnological advantages. Farmers can also collect more information for freshly introduced processes and or marketed products from appropriate institute.

Animal biotechnology on rural development:
Biotechnologists have improved many products and processes by modern techniques including gene cloning, microprocessor controlled bioreactors, and immobilization. More than twenty ten dollars worth of products of recombinant DNA technology is already on the market. 1000 millions dollars of biotechnological agro-products have sold in world. This forecasts sale will be 2300 millions dollars as estimated by Consulting Resource Corporation. Bio-products will be emerging out from laboratory to society through a proper commercialization by appropriate industrialists (Banerjee et al, 2001). India has attained a good position on developing many recombinant products, however, unlike western countries India did not commercialize those products at all to reach to the poor society to date. DNA finger printing is becoming a common practice in forensics. India is third most country in the world to implement this technology. Limited knowledge of genetic disorders, gene therapy, and outbreaks of diseases in rural community and the cost effective of these biotechnological products are considerable bottlenecks in India. Animal biotechnologists replaced many traditional techniques to improve live stock productivity and to overcome increasing poverty (Purohit, 1999). Embryo transfers, *in vitro* fertilization, stem cell culture and transgenic animals are outcome technologies of animal biotechnology. A real availability of such advancement will only promote farmers' income in the next decade.

Agriculture biotechnology on rural development:
As a result of the green revolution, M. S. Swaminathan Research Foundation introduced a new variety of wheat, which has to be developed in favor of rural people. A number of genetic varieties including rice, sorghum, millet, maize and pulses have been developed by plant genetic engineering (Purohit, 1999). Lack of knowledge in applications among farmers and low commodity hinder the transfer of these technologies. The 'Flavr-Savr" tomato was brought about by Monsanto, a versatile biotech company, through genetic engineering. As the price is high, this product has not been well popularized yet. Dipel, a commercial name of Bt toxin, is still ignored by many rural people because it was not stable for a long period. Almost 2000 medicinal plants have been identified for herbal preparation (Purohit, 1999). Among rural people, we explore knowledge and expertise of propagation methods; biotechnological advancements can be extended and improve their economy. Nursery, on the other hand, is an efficient way to earn money in rural areas. Plant tissue culture has played a significant role in the development of ornamental and other horticulture plants. At present, several attempts have been made to improve plantation crops, tubers, species and tree plants to encourage people in hills station. KVK (Krusi Vigyan Kendra) and other relevant extension agencies and even producing industries need to have a link to rural society, in which we can promote their additional rural business. Mushroom spawn, bio-fertilizers, bio-pesticides, curd, rural cheese, buttermilk, ghee etc, are low cost products and can be sold for applying among them. A mature technology transfer can only improve the rural economy. A direct linkage from extension agencies to farmers can only develop ideal integration for rural development.

Industrial biotechnology on rural development:
Knowledge of organic farming (vermin and microbial composting) is a desired way to improve economy of farmers and it also replaces traditional chemical fertilizers usages (Rajak, 2000; Rajini Gupta, and Mukerjee, 2001). As our concern, such technology can only directly reach to rural development. Bioprocess applications constitute only a relatively small fraction of market for agricultural commodities (Purohit, 1999). The need for raw materials for bioprocesses, however, could become a major factor in commodity grain markets if bioprocesses find a place in large-scale fuel or chemical production for various carbohydrate wastes-agricultural foods, industrial or household, despite frequent claims of their availability and low cost, no economical bioprocess application have yet been found (Mukhopadhyay, 2001). A numerous fermentation products and chemicals manufacturing processes are depended on the use of agricultural commodities (Subhash Chand, and Jain, 1999). A mutual interaction between fermentation industries and farmers is desired to enhance farmers income and low durability to industrialists because supply of raw materials (straw, grains, bran, agro-wastes etc.) directly to company. To replace chemical utility in traditional leather processing, Central Leather Research Institute at Chennai explores and alerts knowledge to low-incoming people by key of

organizing programmers through extension and consulting centers. Cellulase free xylanase has commercialized in the view of hand paper mills (Tripathi, 1999). Food processing industries have discharged a huge quantity of residues as waste. Centre for Food Technological Research Institute (CFTRI), a well-known CSIR institute in India, has developed many human consuming products including Spirulina, Chlorella, single cell protein, single cell oil, mushroom, fermented products and has also developed many convenient processes for development of income in rural people (Dietrich Knarr, 1987). Because of improper sanitation and contaminated water in rural sectors, environmental biotechnologists have generated guidance for treatment of wastewater and public health (Agarwal, 1998).Society-scientists-industry relationship must be needed to technology transfer, rural health and economy in India.

Bio-energy on rural development:

Potential of agro-residues for rural households and agro-industries can be projected only other conceding present use pattern and possibility of efficient utilization, so that energy needs of present consuming communities is not disturbed (Pradeep Chaturvedi, 1995; Chellapandi, 2004). The rural communities have to be explained on need for efficient utilization of agro-residues, as that will generate income opportunities for remaining part of the year (Harvey Ross and Amy Pinkerton, 1981). Entrepreneurial development for rural industrial, either traditional or agro based, shall have to be started with involvement of enterprising industrialists. Social and development benefit derived from the indigenous provision of energy and employment shall out weigh all other consideration. Rural woman should also be put their involvement for rural development and spreading the technology transfer on rural community (Gowri Srivastava, 2003). The following integrated approaches will satisfy development of renewable sources of energy as,

- To implement on the energy, forestry and biogas where technology development has already reached a stage which permits field application.
- To carry out field-testing and demonstration of technologies
- Bio energy plantation through private enterprises linked to its utilization needs to be promoted
- A package of incentives including low rate of soft term loans should be made available for production and conversion technologies and equipment.
- Intensive R & D should be supported to commercializing technology under different marketable site conditions.
- A package of technologies for extension should be developed to support quantum jumps of factors of two or three in one biological cycle.
- A remarkable effort should be made on biogasification for agro wastes and composting of urban waste

The future effect of bio-energy utilization in the country would lead to improvement in income generation capability in the rural sector as bio-energy production in itself will be labor (Pradeep Chaturvedi, 1995).

Government guidelines and limitations:

Planning of accelerated social and economic development of India at the being of Twenty-first century cannot be simply a continuation of developed strategies of the past. The following important forces will be faced:-

- Unprecedented growth of scientific and technological knowledge and in particular the spectacular development in the field biotechnology, new products and processes are emerging at an ever-expanding pace.
- These new products and processes being the result of extensive spending on research and development, there is a worldwide pressure for deregulation and liberalization leading to removal of barrier to freer flows of trade, technology and capital across the national frontiers.
- The emergence of global knowledge intensive economy and process growth and without a significant improvement of quality of rural life, we will not be able to prevent a mature rush of surplus rural population to urban slims.
- Government plant or set of options should be integrate new information on net energy yields, food and food yields, new crops (genetically modified), pharma products, agro-products, costs, environmental impacts, effects on agricultural system and on social life of rural people.
- Patent laws of many countries, including India, contain secrecy provisions that restrict outward technology transfer for security or foreign policy reasons. On other hand, compulsory-licensing provisions forces inward technology transfer.
- Failure to exploit a patented invention in the country
- Sometimes, in the interests of free trade and regional cooperation, the requirement that an invention be worked in the country is waived

when the demand for the patented product in the country is being met by manufacturing in a cooperating country.

- Foreign exchange and investing control laws are sometimes applied to technology licensing or technical assistance agreements or to foreign investment.
- Technology transfer across national boundaries can be promoted or inhibited by export control laws and by laws governing international joint ventures and technology licensing.
- Although most companies are not yet marketing biotechnology products, legal environment surrounding, licensing, investment, and trade is already influencing the strategic decision making of companies commercializing biotechnology strategic decisions, such as negotiations on licensing, locational decisions for R & D, production, and clinical trails.
- Transfer technology laws that can be employed directly by government to control or influence access to foreign or domestic markets.
- Studies of more mature technologies only emphasize the difficulties of technology flow. Subsides (e.g. loans, grants, tax preferences) are a form of government intervention which can provide competitive advantages to domestic producers.
- Price regulation will be important to the marketing and profitability of biotechnology pharmaceuticals. Although the basic motivation for price regulation is health care cost containment, price regulation rewards manufactures for local production, local R & D, and other desired behavior.
- Government may busy products as they wish for their own consumption and target their procurement to favor local suppliers.

Public perception of genetic research and technology is a factory that could influence the rate of commercialization of biotechnology. The raising of new issues, scale, complexity, and interdependence among technologies, irreversibility of effects, strong public sensibilities about real or imagined threats to human health, and challenging of deeply held social values are predominant factors that influencing public perception of genetic research and technology (Commercial Biotechnology, An International Analysis, 1984).

Criteria required for improving rural areas:

To spread up this advance, government has encouraged research, development, demonstration, and commercialization of renewable energy technologies, convenient protocols and applications. Since growth has to be rapid, selective import of technologies a product is also considered (Commercial Biotechnology, An International Analysis, 1984). However, the experience has shown that technology imported from the industrialized countries seldom matches our needs and it requires major changes in scale and extensive adaptation to suit local conditions. We should, therefore, realize the quantity of work required and sharpness necessary to differentiate between the needs of different sources and devices and the degree of maturity of the technologies that have been developed. The most important aspect of the Indian government is the possibility of using these technologies and their products directly in the rural areas even the nature of the technological work is diverse as the possibility of arriving at their maturity. Once a product or process has adapted and recognized in field station or a research center, the information has to be processed for three different groups, these are; information for use for scientists, industrialists and academicians working in the relevant field, information necessary for extension centers or agencies, who are involved in the promotion of its wider application amongst the end users in rural area and information for those who are involved in writing about biotechnology and creating an atmosphere conductive for development and growth of rural people. Biotechnology applications can achieve its potential in rural development if it maintains the following criteria.

- Projects funded by central government or state government (DBT, DST, CSIR and UGC etc,) need to be taken into account to convenient techniques and processes that should be reaching to rural people immediately without any alternation and with a full maturity.
- A proper assessment of agriculture production using transgenic plants or hybrid seeds and availability of waste like bio-gas, rice husks etc., will also make it possible to assess the quantity of total generated biomass and available biomass as wastes and residues for our use and industrial feed stocks for bio-products production in solid state fermentation.
- Each process and products should inform to the concerned persons whose links are directed with biotechnological practices.
- Extension agencies or concerned scientists should process the techniques, which they adapted in front of users in rural areas. They should be explaining problem or trouble shooting

at that time of operation in the view of small-scale biotechnological industry located in a village.

- Resource persons should be exploring the advantages and limitations of transgenic plants among rural people and they should be rectifying their confidence to use in the field.
- In the reason of unawareness, insufficient knowledge and proper communication with authorized persons they are refused to purchase and apply new variety of plants or seeds in their lands. They disclose their objection to purchase new products available in the market even well known bio-fertilizers and bio-pesticides. Since, it may reduce the modern development to replace their traditional processes used in the agriculture field.
- Farmers being forced off their farms because they cannot get return they need on their crops to afford to continue farming land their desire to keep grain prices as low as possible.
- Government must be linked to R & D institutions, academic institutions, industrial plants and voluntary extension agencies for the development of technology transfer to rural community.

Future development in industry:

Biotechnology has the technical breadth and depth to change the industrial community of the 21st century because of it's potential to produce substantially unlimited quantities of products never before available, products that currently scarce, products that cost substantially less than products made by existing methods of production, products those are safer than those now available are, and products made with raw materials that be more plentiful and less expensive than those now used (Commercial Biotechnology, An International Analysis,1984). The evaluation of the following 10 factors identified as potentially important in determining the future position of India and other countries in the commercialization of biotechnology.

1. Financing and tax incentives for firms
2. Government funding of basic and applied research
3. Personal availability and training

Health, safety, and environmental regulation

5. Intellectual property law
6. University/Industry/Formers relationships
7. Anti trust law
8. International technology transfers, investment, and trade
9. Government targeting policies in biotechnology
10. Public perception

Over the next several years most biotechnology products except for some vaccines will probably be replacement products for existing products. We may not be well funded and well equipped as those in advanced countries, but the quality of the people, their expertise and dedication is certainly to way less than all those who are in the developed countries (Man Mohan Singh, 2003). Although, funding agencies like DBT, CSIR, DST and UGC etc. have lunched many financial support to biotechnology society through which it will enlighten the research activities that are dramatically favored to rural society in India. Biotechnological products can flourish well in our country (Research Profile of Biotechnology Activities in India-A Directory, 1993). We allow indigenous capabilities to prosper life for rural people also. Hence, we have to plan for a progressive integration of biotechnology in the evolving rural economy. Biotechnological practices that are emerging and are expected to revolutionize the whole plant growth pattern and commercial productivity from animals and rapid, standard commercialization of bio-products from industrial sectors will have to be properly evaluated and information made available on them (Banerjee et al, 2001).

Obviously, present era belongs with biotechnology and the future humanity would largely depend on biotechnology for sustaining life and its comforts. To feed the world population, which is expected to stabilize around 8.5 billions in 2050 with less per capita water and land availability, the humankind would look up on the tool of biotechnology to meet such demand. It has created a social-ethical debate all over the world on the extent of its application in humans. Also, one cannot rule out consequential impact of biotechnological development on society. The transfer of large-scale cultivation of transgenic plants brings high risks or only benefits (Rajak, 2000). Definitely, risk is there, but its occurrence and the potency will depend on how the genetic resources made available through genetic transformation, will be used in farming. Since, transgenic research and bio-safety are imperative issue and these must be dealt with most care. An integral and mutual understanding between rural people and scientists/industrialists/voluntary agencies must be required to bring a smile on faces of the rural people. Perceptibly, it will happen if an effective attempt of biotechnology-extension centers.

Conclusion:

Biotechnology is a currently emerging field in the world, and it has exploited for various kinds of

human consuming products include food products, therapeutics, vaccines, transgenic animals and plants. Biotechnological processes are developed with great extent to promote the growth of products through which it can overcome exploding population in the world. Although, biotechnological processes and products are not used efficiently among rural people because of immature technologies, generally cost effective products, government regulation during commercialization, inadequate expression of desired genes, and environmental impacts. The techniques include biomethanation, composting, and traditional fermentation processes, and some bio-products (bio-fertilizers, bio-pesticides, mushrooms, hybrid seeds and new breed of animals and fishes) are today reputable in rural society. Moreover, an integrated biotechnological approach will be helpful for improving socio-economic status of rural community in India. Though most of biotechnological processes are integrated mutually a momentous link between rural society and industrialist should be suggested. Raw materials collection, nursery and plantation, organic farming, aquaculture, biogas plants, and small scale rural industry can be handled with their support more professionally. Thus, biotechnology has potential effect on virtually all domains of human welfare, ranging from food processing, environmental protection, to human health. As a result, it now plays an important role in employment, productivity, trade, economy and the quality of human health in rural sectors.

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List of R & D laboratories and their research activities relevant to rural development in India

A. CSIR Laboratories

1. Center for Bio Chemicals, New Delhi	Human growth hormones, Immuno chemical kits Import and distribution of enzymes and fine chemicals
2. Center for Cellular & Molecular Biology, Hyderabad	Tumors therapy, DNA diagnostic kits
3. Central Drug Research Institute Lucknow	Production of genobiotics & germ-free animals Hybrid production
4. Central Food Technological Research Institute, Mysore	Enzymes & biochemicals, ethanol, fermented foods, spirulina, animal feed, food additives, flavours, crocin and sweeteners low cost byproducts as a source of protein for aquaculture feed, SCP/SCO
5. Central Institute of Medicinal and Aromatic plants, Lucknow	Propagation of medicinal and aromatic plants by somatic hybridization.
6. Central Leather Research Institute, Chennai	Development of indigenous technologies for cost effective production Diversification of the application of the enzymes in various operations in a tannery as well as in other related areas is envisaged
7. Council of Scientific & Industrial Research, Palanpur	Micro propagation of tea, bamboo and related Ornamental plants, viral free plants generation
8. Indian Institute of Chemical Technology, Hyderabad	Vaccines (Leprosy), bioactive peptides Drugs (anti-cancer), BCG
9. Institute of Microbial Technology, Chandigarh	Immunodiagnostics, plasminogen activators rifamycin
10. Industrial Toxicological Research Centre, Lucknow	Development of mixed culture for COD reduction, antioxidants
11. National Chemical Laboratory, Pune	Xylanase application in paper manufacture, RELP mapping and tagging of agronomically important genes Technology transfer on pomegranate, turmeric, ginger and sugar cane. Clonal propagation of forest frees in the field.
12. National Environmental Engineering Research Institute, Nagpur.	Restoration of environmental quality Substitutions of non-renewable resources through the application of bio-techniques. Biomethanation
13. National Institute of Oceanography, Goa	Assessment and development of culture techniques for prawn, fishes, mollusks and sea weeds to generate extra sea food.
14. Regional Research Laboratory, Jorhat	Micropropagation and in vitro tuberization of essential oil bearing plants Biogas production from water hyacinth & biomass
15. Regional Research Laboratory Thiruvananthapuram	Starch waste processing propagation of potato & sweet potato

B. ICAR Laboratories

1. Central Agricultural Research Institute, Port Blair	Development of rice with reference to salt tolerance
2. Central Soil Salinity Research Institute, Karnal	Enhanced fish production.
3. Central Institute of Brackish water Aquaculture, Chennai	Dietary requirements attractants, binders for prawn cultivation
4. Central Institute of Cotton Research,	Bio pesticides and Bio fertilizers development for

Nagpur	cotton crop Tissue culture techniques for increased cotton crop Production
5. Central Institute of Fisheries Technology, Cochin.	Development of supplementary feeds for prawn and Fish. Biogas from water hyacinth
6. Central Institute of Horticultural for Northern Plains, Lucknow	Mango & Papaya improvement
7. Central Institute for Research on Buffaloes, Hisar	Enhance the overall productivity of riverine Buffaloes in vitro fertilization techniques for rapid multiplication of superior genetic material Microbial fermentation of coarse roughages for economical feeding in growing heifers
8. Central Institute for Research on Goats, Mathura	In-vitro oocyte maturation and fertilization Cryopreservation of caprine embryos/semen
9. Central Plantation Crops Research Institute, Kasaragod	Clonal propagation of coconut, clonal multiplication of oil palm.
10. Central Potato Research Institute, Simla	Viral-free stocks using meristem-tip culture nucleus seed production for potato plantation
11. Central Research Institute for Dry land Agriculture, Hyderabad	Development of groundnut to tolerant to drought and heat shock.
12. Central Research Institute for Jute and Allied fibers, Barrack pore	Propagation of Jute plant free from pathogens
13. Central Rice Research Institute, Cuttack	New improved rice variety with desirable traits Hybrid rice
14. Central Soil & Water Conservation Research & Training Institute, Dehradun	Shoot tip culture in guava and jackfruit
15. Central Sheep and Wool Research Institute, Avikanagar	Cryopreservation of Ram semen Database management for sheep & rabbit production and diseases. Animal feed formulations
16. Central Tuber Crops Research Institute, Thiruvanthapura	Non-conventional breeding for tuber crops and animal feeds
17. Central Tobacco Research Institute, Rajahmundry	Biogas from Starch wastes Haploid breeding through anther culture
18. Directorate of Oil seeds Research, Hyderabad	Over coming the cross ability between *Ricinus Communis* (Caster) and Jatropha. Caster hybrid seed
19. Center for Research in Banana, Trichy	Propagation of disease free Banana
20. Directorate of Pulse Research, Kanpur	Propagation of pulse plants
21. Indian Agricultural Research Institute, New Delhi	Breeding for virus resistance in tomato, muskmelan, okra and brinjal, Micro propagation of ornamental plants Rhizobium inoculums development to chickpea Former extension center for knowledge regarding Bio-fertilizers and new variety of plants and seeds
22. Indian Grassland and Fodder Research, Jhansi	Propagation of C*enchrus ciliaris, Dichanthium annulatum* and P*anicum maximum*
23. Indian Institute of Horticultural Research, Bangalore	Field performance of in vitro raised mango, Jack tree, and banana. Mass cultivation of breed with good traits
24. Indian Institute of Sugar cane Research, Lucknow	Breeders seed production in sugar cane and sugar beet
25. National Bureau of Fish Genetic Resources, Allagabad	Cryopreservation of fish milt, eggs and embryos
26. National Bureau of Plant Genetic Resources, New Delhi	Cryopreservation of seeds, pollen embryos and other in vitro culture
27. National Dairy Research Institute, Karnel	Immunodiagnostic kits lactic starter culture for cheese, yogurt production. Immobilization of Rennet

	Biogas from various dairy wastes. Whey cheese, Butter and lactoferrrin In-vitro fertilization in Buffaloes & cow
28. National Research Center for Groundnut, Junagadh	Rapid multiplication of genetic stocks and hybrid bio-fertilizers development to groundnut
29. National Research Center for Species, Calicut	Rapid multiplication of elite genotypes in cardamom, black pepper, cinnamon,ginger and clove In vitro selection for resistance to soft rot & bacterial wilt in ginger
30. Vevekananda Parvatiya Krishi Anusandhan Shala, Almora.	Generation of wheat (Hybrid)
31. KVK (Kruchi vighyan Kendra)	Farmers Extension work field studies and investigation of plant pathogens and animal diseases Formers Training Programmes organized by ICAR Establishment of Biogas plant and composite pit Soil inspection and explore the know how in agricultural development Introduce the new variety of seeds, plants and embryos whichever suggested by ICAR In vitro fertilization using insemination in buffaloes and cows Supply of bio-fertilizers, bio-pesticides and other developed products by ICAR

C. ICMR Laboratories

1. Institute for Research in Reproduction, Bombay	Fertility control kit for detection of occurrence of ovulation. Family Welfare Programme. Health. Education of contraceptive acceptance in rural people Awareness about sexually transmitted diseases
2. Regional Medical Research center for Tribal, Jabalpur	Economic constraints and Health care in a Tribal Population Prevalence of diseases (Shigellosis, Filariasis, Sickle hemoglobin and pulmonary diseases) in Tribes
3. Regional Occupational Health Center, Calcutta.	Assessment of health status of the tea plantation workers and railway porters
4. Vector Control Research Center, Pondicherry	Survey of vectors transmitted diseases among urban and rural people
5. Centre for Research in Medical Vectors, Madurai.	Health status on vector control