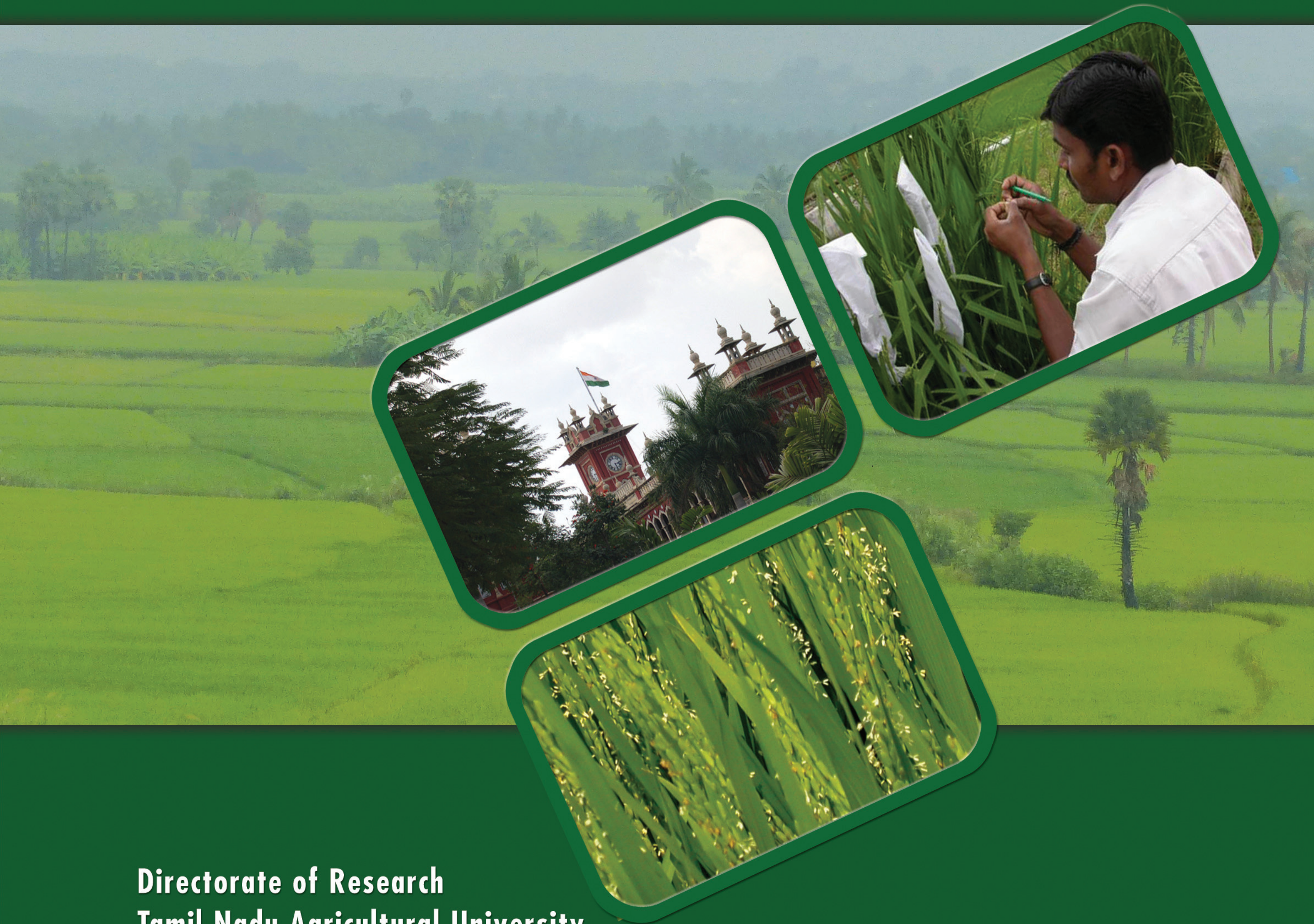
TNAU Research Agenda

Agriculture, Horticulture, Agricultural Engineering, Forestry, Home Science and Social Sciences

Research Priority Areas



Directorate of Research
Tamil Nadu Agricultural University
Coimbatore 641 003, India

2014 - 2018

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Why TNAU Research Agenda 2014-2018?

Tamil Nadu Agricultural University (TNAU) came into being in 1971 to cater to the needs of farming and student communities through its triple functions *viz.* Education, Research and Extension education. Before independence, education and extension activities were given prime importance in the then agricultural college and the significance of research was felt with the evolution of newer varieties and technologies based on strong scientific basis.

This resulted in the metamorphosis of agricultural colleges into agricultural colleges and research institutes. The earlier experimental stations established with strong extension activities were made into units responsible for accomplishing both extension and research activities. With TNAU attaining the status of one of the prominent State Agricultural Universities (SAU), it became a nerve centre for national and international research collaborations. It started getting the financial support for its research activities from various sources besides the State Government. The earlier research activities were carried out as per the time based Research Agenda formulation drawn by several visionaries. But it was considered more generic as it was meant for improving the quality of food and feed produced for feeding the people and cattle only. Considering the fluidic environment prevalent now owing to the changes in climate, TNAU needs a research agenda which is very specific, time bound and goal oriented.

A well articulated and institutionalized agricultural research agenda can assist all contributors and intended beneficiaries to visualize the link between research and community needs, system outcomes and development. All these days, much of TNAU's success in satisfying the needs of its clients is due to the results obtained from the research projects sponsored by various funding agencies. Considering the man power and capacity of the scientists at the disposal of TNAU, it is the right time for TNAU to evolve a university wide research agenda of its own apart from the tailor made programmes of external funding agencies. In developing and preparing such an agenda, all the "Research Administrators" must take into account the following

- to exploit the research expertise of scientists and students
- to look into the relevant research publications and documents of the past
- to consider state and national development priorities
- to discuss, prioritize and implement the lessons for improving the process of making the agenda
- to consider and align research activities having similar goals and
- to consider research and funding platforms established by the "State and Central Government Plan Period"

K. Ramasamy
Vice-Chancellor

Indian Agriculture has made rapid strides during the past four decades. From a production level of 55 million tonnes of food grains in the early fifties, India has produced over 260 million tonnes during 2013-14 with more than 70 million tonnes as buffer stock in our godowns at the national level. Tamil Nadu with a record production of 96.41 lakh tonnes of food grains in the year 2011-12 has fetched the “Krishi Karman Award” from the Government of India through its “National Food Security Mission” (NFSM). During 2013-14, 36.69 lakh ha were covered under food grain crops in Tamil Nadu with a production of 120 lakh tonnes (as per 4th Advance Estimate). Considering the possibilities and converting them into realities, it has been programmed to achieve 145 and 170 lakh tonnes of food grain production at the end of 2014-15 and 2015-16 respectively. Substantial increases in production have also been realized in the case of non-cereals, commercial crops, animals, fisheries and forest products. The green revolution ushered in a new scientific era in India and has given agricultural science respectability and achievement consciousness. However, increasing population pressure of humans and animals, shrinking land and water resources available for agriculture, problems of soil, water and environmental degradation, mushroom growth of small and marginal farmers and lagging dry land agriculture pose challenges to the agricultural scientists.

In the developmental dynamics, technological changes are inevitable and agricultural research and technology generation has become highly competitive both in domestic and international environment due to changes happening since 1990s. Privatization is considered as an alternative to public research to make research more relevant, meaningful and efficient. Research resource is in short supply and hence an optimal allocation of this scarce resource is of crucial importance. Further, in view of globalization, changes in cropping pattern, infrastructural and institutional facilities are bound to take place. Policy analysis aiming at allocation of research resources among commodities and regions has to consider the present realities and make an objective assessment of probable changes in the future so that a near optimal allocation is possible and the research becomes the mainspring board of development. The research achievements in agriculture in the coming years will, to a large extent, determine the pace of economic development and the management of socioeconomic crises in rural India. Agriculture is the state subject and the role of the state in hastening the process of agricultural research and development hardly needs any emphasis.

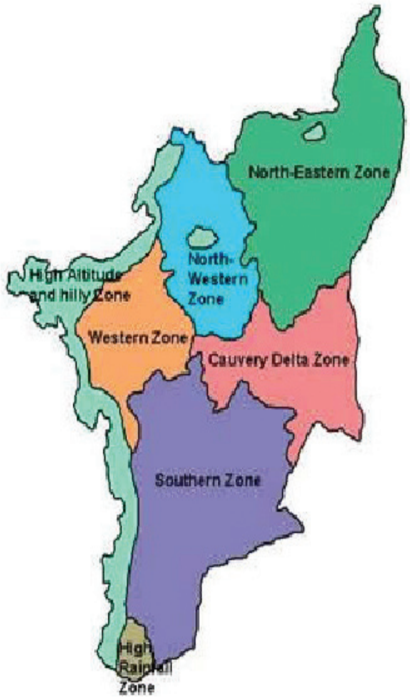
The Tamil Nadu Agricultural University (TNAU) came into existence on June1, 1971 as the seventh state agricultural university (SAU) and now remains as the top most one among SAUs. It is functioning in an effective manner so as to deliver the maximum benefit to the state and to its farmers through its agenda in the areas of education, research and extension education. TNAU is taking care of formulating its programme of activities in teaching, research and extension education which are closely related to the needs of the state and its developmental plans covering both long and short term needs of the state. Planning for the future of the university is therefore not only a challenging task but fascinating one which needs imagination, broad thinking and advance action. This requires periodical explorations of problems of agriculture in the widest sense of the term by reorienting its education, research and extension education and a team of experts to guide, stimulate and monitor the work of the University towards coordinated and purposive action.

The challenging agricultural scenario around the world in terms of production and consumption of food grains and processed foods has opened up ample opportunities for international agriculture and trade participation. This is practically an unexploited area in agriculture today. The emerging agribusiness requires agricultural scientists/technicians in the field of agriculture, horticulture, forestry, agricultural engineering and home science to satisfy the needs of the stakeholders. In developing countries like India, capital will continue to be scarce whereas human resource and knowledge will be abundant. Substituting knowledge for capital will have to be carefully exploited wherever possible.

Is TNAU addressing itself to the ongoing and upcoming problems in the field? Is the existing organizational structure capable of meeting the challenges? Does our agricultural researchers aware of new scientific opportunities to be in the forefront of research? Has TNAU given due attention on 'futurology' in terms of reorientation of research, restructuring of existing curricula and preparing the needed man power to face the problems in coming years. To answer the above questions, agricultural research system of TNAU needs pertinent, reliable information on people, finance and facilities in order to effectively manage its research programmes. To aid the decision making process, information systems and data bases are necessary. At present, these are very poorly organised. This network could be established and engaged to institute online agricultural research information network and develop research monitoring system including personnel and equipment usage across the university to exploit the research facilities by both scientists and students of TNAU.

Tamil Nadu is one of the 31 states and 5 union terititories of India having its position in the southernmost part of the Indian Peninsula. It is bounded by the Eastern Ghats on the north, by the Nilgiris, the Anamalai Hills and Kerala on the west, by the Bay of Bengal in the east, and by the Indian Ocean on the south. Tamil Nadu is the eleventh largest state in India by area. The land area has been classified into seven agro-climatic zones based on soil characteristics, rainfall distribution, irrigation pattern, cropping pattern and other ecological and social characteristics. The following are the seven agro-climatic zones of the State

1) North Eastern zone
2) North Western zone
3) Western zone
4) Cauvery delta zone
5) Southern zone
6) High rainfall zone and
7) Hill and high altitude zone



Zone	Name	Districts	Altitude (m)	Annual rainfall (mm)	Annual PET (mm)
1	North Eastern zone	Kancheepuram, Thiruvarur, Cuddalore, Villupuram, Vellore, Thiruvannamalai	100--200	1105	1700
2	North Western zone	Dharmapuri, Salem, Nammakkal	200-600	875	1727
3	Western zone	Erode, Coimbatore, Thiruppur, Karur (part), Namakkal (part), Dindigul (part), Theni (part)	200-600	715	1622
4	Cauvery delta zone	Tiruchi, Peram-balur, Pudukottai, Thanjavur, Nagapattinam, Thiruvarur, Cuddalore (part)	100-200	984	1932
5	Southern zone	Madurai, Sivagangai, Ramanathapuram, Virudhunagar, Thirunelveli, Thoothukudi	100-600	857	1825
6	High rainfall zone	Kanyakumari	100-2000	1420	1816
7	Hill and high alti-tude zone	The Nilgiris, Kodaikkanal	2000	2124	1213

(Source : Department of Land resources, Govt. of Tamil Nadu document available in the http://dolr.nic.in/dolr/downloads/spsp/TAMILNADU%20STATE%20PERSPECTIVE%20&%20STRATEGIC%20PLAN.pdf)

Rainfall and Crops cultivated

1. North Eastern zone

The North Eastern zone is prone to frequent cyclonic damage. In this zone, 352 mm rainfall normally received during Southwest monsoon season is more adequate and therefore length of growing season accounts to 200 days. Hence, rainfed crops are successfully cultivated in this zone. Groundnut is the most widely cultivated rainfed crop in this zone. Other crops like sesame, sorghum, pearl millet and rainfed rice are also cultivated.

2. North Western zone

.he North Western zone receives 400mm of rainfall through southwest monsoon. Mean maximum temperature ranges from 30°C to 37°C and mean minimum temperature from 19°C to 25.5°C. Length of growing season in this zone is 180 days. Crops such as finger millet, sorghum, groundnut, horse gram, sugarcane, cotton, tapioca and vegetables are widely grown in this zone. Groundnut, sorghum, finger millet, sesame and small millets are grown as rainfed crops.

3. Western zone

The Western zone receives a mean annual rainfall of 715 mm in 45 rainy days of which 49 per cent is received during northeast monsoon season. Mean maximum temperature during April month is 35°C and during January month is 30°C. Mean minimum temperature ranges from 19°C to 24°C. Rice, sugarcane and banana are grown under wetland condition whereas sorghum, groundnut, small millets and pulses are grown as rainfed crops in red soils and cotton, sorghum, bengal gram and sunflower are the rainfed crops in black soils.

4. Cauvery Delta zone

Annually, a mean rainfall of 984 mm is received in the Cauvery delta zone of which more than 50 per cent is received through Northeast monsoon rains. The predominant crop of this zone is rice. Other crops such as sugarcane and banana are also successfully cultivated in this zone. Sorghum and groundnut are raised as rainfed crops in uplands.

5. Southern zone

The Southern zone receives a mean annual rainfall of 857 mm in 43 rainy days, of which 400 mm is received through Northeast monsoon rains. The monthly mean maximum temperature ranges from 28°C to 38.5°C and monthly mean minimum temperature ranges from 21°C to 27.5°C. Important crops of this zone are rice, cotton, millets, sugarcane, sunflower, coriander and bengal gram. Sorghum, cotton and sunflower are cultivated as rainfed crops during Northeast monsoon season.

6. High rainfall zone

The High rainfall zone receives a mean annual rainfall of 1420mm in 64 rainy days. On an average 533, 527, 312 and 47 mm rainfall is received during southwest monsoon, northeast monsoon, summer and winter seasons, respectively, Monthly mean maximum temperature ranges from 28°C to 33°C and monthly mean minimum temperature from 22°C to 26.5°C. Rice is the predominantly grown crop in this zone. Widely cultivated rainfed crop is tapioca. Plantation crops like coconut, rubber, pepper, and cardamom are widely cultivated in this zone. Coconut- arecanut-tapioca is the predominant multi-storeyed cropping system in this zone.

7. Hill and high altitude zone

This zone covers the Nilgiris, Kodaikanal, Shevroy, Elagir Javadhi, Kollimalai, Pachamalai, Yercaud, Anamalais, Palani and Podhigaimalai. This zone covers an area of 2,549 sq.kms. The area under cultivation is 73,689 hectares which is only 28.9 per cent of the total geographical, area of the zone. Furthermore, only 0.84 per cent of the total cultivated area is the irrigated area i.e., 621 hectares. The annual normal rainfall is 2124 mm. There are no dams for irrigation in this zone since there are no major rivers. Paddy and groundnut are cultivated relatively in less extent. The major crops are tea, coffee and vegetables. Forest area is 1,50,139 hectares which is 58.9 per cent of the total geographical area of the zone.

Nature of Soils

The predominant soils of Tamil Nadu are Entisols, Inceptisols, Alfisols, Ultisols, and Vertisols

1) Entisols

They cover an area of 18,28,978 ha and distributed in Nilgiris, North Arcot, Erode, Pudukottai, Pasumpon Muturamalingam, Ramanathapuram, South Arcot, Salem, Trichy, Thirunelveli, Thanjavur, Coimbatore, Chengalput, Dharmapuri, Kanyakumari and Kamaraj districts. River alluvium, coastal alluvium and eroded soils are included. They are poor in nitrogen, phosphorus and organic matter but rich in potassium and lime. The River alluvium is used for the cultivation of wetland crops like paddy, sugarcane and banana and Coastal alluvium is used for casuarina plantations. The eroded areas are used for the development of pastures.

2) Inceptisols

They are distributed in all the districts of Tamil Nadu and cover an area of 22,10,685 ha. Moderately deep red, brown and black soils are included under this category. They are poor in nitrogen, phosphorus, potassium and lime. These soils are used for cultivation sorghum, groundnut, maize, onion, tobacco and chillies.

3) Alfisols

They cover an area of 31,43,312 ha and are distributed in all the districts except in the hill ranges. They are very deep, reddish in colour and have a well developed sub surface horizon. They are utilized for cultivation of millets and pulses under dryland conditions and groundnut, cotton , maize, sugarcane and paddy under irrigated conditions.

4) Ultisols

They cover an area of 36,499 ha and are distributed in Salem, Dharmapuri and Nilgiris districts. They are poor in bases. Phosphorus is largely unavailable due to fixation in the soils as iron and aluminium phosphates. They are used for the cultivation of coffee, tea, cocoa, cold vegetable etc.,

5) Vertisols

They cover an area of 17,91,575 ha and are distributed in all districts except in Nilgiris and Kanyakumari districts. They are very deep, clayey, calcareous and poorly drained. They developed cracks during summer, poor in OM, N and P but fairly well supplied in potassium and lime. Free calcium carbonate is present in the form of canker. Cotton, sorghum and pulses are grown under rainfed conditions. Under irrigated conditions, paddy and cotton are grown.

TNAU Research Centres

Though TNAU is located in Coimbatore, its presence spread with 14 colleges offering 13 undergraduate degree programmes, 40 postgraduate degree programmes and 26 doctoral programmes for the benefit of students belonging to Tamil Nadu as well as other states.

In addition, 13 Technical Directorates, 37 research stations for agro-technology development and 14 Krishi Vigyan Kendras for out reach programmes are functioning under it. A total of 63 ICAR funded All India Coordinated Research Programmes (AICRP) are in operation at various centres of TNAU including Colleges. TNAU strives hard to have an inclusive growth of agriculture in the state by introducing impeccable agro-technologies and improved delivery system with immaculate plans for the well being of the farming community. These agro-technologies are evolved and evaluated at the following research centres distributed across Tamil Nadu.

Colleges

1. Agricultural College and Research Institute, Coimbatore
2. Agricultural College and Research Institute, Madurai
3. Agricultural College and Research Institute, Killikulam
4. Anbil Dharmalingam Agricultural College and Research Institute, Tiruchy
5. Agricultural College and Research Institute, Vazhavachanur
6. Agricultural College and Research Institute, Kudumiyanmalai
7. Agricultural College and Research Institute, Echankottai
8. Horticultural College and Research Institute, Coimbatore
9. Horticultural College and Research Institute, Periyakulam
10. Horticultural College and Research Institute for Women, Trichy
11. Forest College and Research Institute, Mettuppalayam
12. College of Agricultural Engineering and Research Institute, Coimbatore
13. College Agricultural Engineering and Research Institute, Kumulur
14. Home Science College and Research Institute, Madurai

Technical Directorates

1. Directorate of Research
2. Directorate of Extension Education
3. Centre for Plant Breeding and Genetics
4. Centre for Plant Molecular Biology
5. Centre for Crop Management
6. Centre for Natural Resource Management

7. Centre for Plant Protection Studies
8. Water Technology Centre
9. Seed Centre
10. Centre for Agricultural and Rural Development Studies
11. Directorate of Planning and Monitoring
12. Directorate of Agri-Business Development
13. Directorate of Open and Distance Learning

Regional Research Stations

1. Regional Research Station, Aruppukottai
2. Regional Research Station, Paiyur
3. Regional Research Station, Vridhachalam
4. Tamil Nadu Rice Research Institute, Aduthurai

Agricultural Research Stations

1. Agricultural Research Station, Bhavanisagar
2. Agricultural Research Station, Kovilpatti
3. Agricultural Research Station, Paramakudi
4. Agricultural Research Station, Thirupathisaram
5. Agricultural Research Station, Vaigaidam
6. Agricultural Research Station, Virinjipuram
7. Centre of Excellence in Millets, Athiyanthal
8. Coastal Saline Research Centre, Ramanathapuram
9. Cotton Research Station, Srivilliputhur
10. Cotton Research. Station, Perambalur
11. Dryland Agrl. Research Station, Chettinadu
12. Hybrid Rice Evaluation Centre, Gudalur
13. Maize Research Station, Vagarai
14. National Pulses Research Centre, Vamban
15. Oilseed Research Station, Tindivanam
16. Rice Research Station, Ambasamudram
17. Rice Research Station, Tirur
18. Soil and Water Management Research Institute, Thanjavur
19. Sugarcane Research Station, Cuddalore
20. Sugarcane Research Station, Melalathur
21. Sugarcane Research Station, Sirugamani
22. Tapioca and Castor Research Station, Yethapur

Horticultural Research Stations

1. Coconut Research Station, Aliyarnagar
2. Coconut Research Station, Veppankulam
3. Vegetable Research Station, Palur
4. Oilpalm Research Station, Pattukottai
5. Grapes Research Station, Theni
6. Horticultural Research Station, Pechiparai
7. Horticultural Research Station, Thadiyankudisai
8. Floricultural Research Station, Thovalai
9. Horticultural Research Station, Yercaud
10. Horticultural Research Station, Kodaikanal
11. Horticultural Research Station, Ooty

Krishi Vigyan Kendras

1. Krishi Vigyan Kendra, Tindivanam
2. Krishi Vigyan Kendra, Aruppukottai
3. Krishi Vigyan Kendra, Virinjipuram
4. Krishi Vigyan Kendra, Pechiparai
5. Krishi Vigyan Kendra, Vridhachalam
6. Krishi Vigyan Kendra, Ramanathapuram
7. Krishi Vigyan Kendra, Pudukkottai
8. Krishi Vigyan Kendra, Sikkal
9. Krishi Vigyan Kendra, Madurai
10. Krishi Vigyan Kendra, Sandhiyur
11. Krishi Vigyan Kendra, Needamangalam
12. Krishi Vigyan Kendra, Sirugamani
13. Krishi Vigyan Kendra, Tirur
14. Krishi Vigyan Kendra, Papparappatti

TNAU's stand in the global arena is based on newer technologies and innovations generated, groomed scholars with a thirst for research and scientific spirit and agility among the farmers in acquiring and adopting the technologies. Its research is oriented towards developing time tested, cost effective, eco-friendly and sustainable technologies for the upliftment of farmers.

The long term and short term agenda for education, research and extension education are decided by the three supreme bodies under the chairmanship of Vice-Chancellor *viz*. Academic Council, Research Council and Extension Council respectively. The research agenda are decided based on the holistic dissection of the outcome from three annual meetings *viz*, Research Council Meeting, Annual Crop Scientists' Meet and Scientific Workers' Conference. The roles of all the three components are given below. All the three are interconnected which have two-way flow of information for shaping up the Research agenda, setting up the time line and technical programme for rolling out the fine tuned technologies to the Agriculture Department officials for its widespread adoption by the farmers.

Research Council

Research Council of TNAU has the following members

Vice-Chancellor	Chairman
Director of Research	Member Secretary
Registrar	Member
All University Officers	Member
Five Heads of Departments (nominated by Vice-Chancellor)	Member
Government of Tamil Nadu officials	
Director of Agriculture	Member
Director of Horticulture and Plantation Crops	Member
Director of Agricultural Marketing	Member
Director of Seed Certification	Member
Chief Engineer (Agricultural Engineering)	Member
Chief Engineer (River Valley Project)	Member
Five outside experts (Approved by Government on recommendation from the University)	Member

Research Council: Mandate

The mandate of Research Council includes three main roles

1. Advising the University on research policy and supporting its faculty in making contributions to their disciplines and the wider world,
2. Taking a leadership role to create an enabling environment in which research will flourish and enrich teaching and learning at TNAU and
3. Encouraging and valuing all forms of faculty research and scholarly activity.

This Council helps in technology development and its scientific protection for the betterment of farming community. The annual meeting of Research Council is conducted during February-March of every year to finalize the new research agenda, mid-term corrections, if any, of current agenda and evaluate the progress of ongoing research.

Crop Scientists' Meet

Crop Scientists' Meets are conducted during April/May to review the annual progress of research work of each of the scientist based on pre-review conducted by the respective Technical Directors during October/November which coincides with half yearly completion of the research projects. In general, the annual review processes are carried out by making the scientists to present their progress of work. From 2014 onwards, themes are identified for each of the research component to avoid redundancies and mismatch in the research activities in various centres. For each component, a Team leader is identified for a group of scientists to solve specific issues. This exercise helps in identifying the gaps in the university research and facilitates the formation of "teams" for specific tasks. The research priorities identified for each of the discipline is listed as Research Priority Area (RPA) which contains specific issues pertinent to that RPA. Each of these issues will be addressed by the Teams to be formulated across the disciplines as per the requirement. Thus TNAU plans to achieve majority of the RPAs enlisted in a definite period of time.

Besides, the outcome of the discussions held during various crop scientists' meet is grouped under three categories *viz.*, **For adoption, For on farm testing and For information.** The outcome from a project (a culture/technology/farm implement) which has been recommended for consideration and release in the concerned scientist meet would be rigorously scrutinized by the University Variety/Technology Release Screening Committee (UVTRSC) as per the guidelines stipulated under the chairmanship of Vice-Chancellor. Thus shortlisted cultures passing the requirements will be placed for consideration and release by the State Variety Release Committee (SVRC) headed by the Agricultural Production Commissioner and Secretary, Government of Tamil Nadu. The accepted cultures by SVRC will be released as varieties in the subsequent year and the information about these varieties will be included in the "For Adoption" category.

Cultures that are in the advanced stage of testing would qualify under the category "For On farm testing" and others would be categorized under "For information". Thus, the entire spectrum of research being undertaken in the University in the preceding year is informed to the line Department officials during the Scientific Workers' Conference.

Scientific Workers' Conference

The conduct of Scientific Workers' Conference is an annual activity wherein the evolvers of the technologies share their achievements with the elevators/deliverers of the technologies (Extension Officials of the Department of Agriculture) to the farmers. During this meeting, scientists get the feedback on their released technologies and also field problems to reorient their research.

TNAU Research: Background

For the past one and a half decade, research activities of TNAU are under the umbrella of any one of the following groups which are being monitored so far through a decentralized monitoring system.

AICRP schemes: TNAU is identified as a coordinating centre for more than 60 AICRP (All India Coordinated Research Projects) schemes cutting across the disciplines including the Home Science.

Every year, the Project Coordinator/Project Director chalks out a tailor made technical programme to the scientists identified to work under the AICRP schemes and are coordinated and monitored by the Directorate of Research. Because of the decentralized research monitoring, the redundancy in the technical programme to be implemented at TNAU centres under AICRP with that of the University mandated RPAs could not be assessed and avoided. Hence, the Directorate of Research closely monitors the research activities of scientists working under AICRP schemes as per their Annual Technical Programme to avoid duplications.

Externally Funded Schemes: TNAU scientists propose projects to funding agencies at national level such as ICAR, BARC, DBT and DST and get individual oriented research projects in a competitive manner based on their specialization. Earlier, these projects were proposed independently through the Technical Directorates and monitored. At present, the proposals for these projects are presented at the Directorate of Research to a committee and then sent for the approval of the Vice-chancellor. After the approval of the Vice-Chancellor, the proposals are forwarded to the respective funding agencies. The scrutiny at the Directorate of Research helps in shaping up the proposals as per expectations and nearly 80-90 per cent of the project proposals thus scrutinized have won the approval of the funding agencies.

Research Support from Foreign Sources: Foreign Universities and CGIAR centres such as IRRI, ICRISAT and IFPRI, IDRC, Canada are also supporting the research activities in the form of research schemes. The individual scientists based on their contact with the scientists of funding origin handle these projects at their Technical Directorates. These projects need the MoU between TNAU and respective funding institutes. For entering into MoU/ MoA/Letter of Agreement (LoA), proposal initiated by the individual scientist will be scrutinized at the concerned Directorate and then at the Directorate of Research and vetted by the Law section and Trade and Intellectual Property Section before getting approved. Such approved binding documents are signed by the Registrar, TNAU on behalf of the University.

The other source of funding is from philanthropic agencies such as Ford, Bill and Melinda Gates and Rockefeller Foundations. Scores of TNAU scientists got their advanced trainings in their field of specializations through the fellowships from these agencies and it made them get national and international recognition. In the recent past, the Rockefeller Foundation's International Rice Biotechnology Programme made a serious impact on the transformation of TNAU research agenda rice research.

Research Support from Agencies/Trust: The other form of research support is from Government agencies like NABARD, ATMA etc. and Private firms. These projects are operated based on an understanding to solve the problems perceived by the sponsors.

Product Testing: Various companies approach the TNAU for testing their products for their efficacy and field performance. The products include pesticides, fertilizer formulations, growth regulators, varieties and hybrids and are tested on cost basis. Some of these companies are approaching TNAU for specific reasons such as registration of their products. Since this type of testing does not support any research *per se* of TNAU, unless recommended by the Technical Director, this work is generally discouraged.

Extension Oriented Projects supported by the Government: Another component influencing the researchers is the extension-oriented projects such as NADP, IAMWARM and Seed Production. The main purpose of these projects is to reach the farmers with the latest technologies which normally the line department officials are expected to do.

State Plan Schemes: Until last year, many of the colleges and stations were provided with budget from State Plan Schemes for specific purposes. There were plan schemes for specific research work with salary component for the scientists. Many of the newer initiatives were made possible during early 1970s and 1980s only through this type of scheme. These schemes have been now merged with the Non Plan schemes of the University during 2013-14 and form the integral part of the research to be undertaken by various units.

University Research Projects: Many University Research Projects (URP) are spin off from the above listed categories. To avoid redundancy and for having relevance to the RPAs identified, scientists being placed in the University schemes have been advised to propose new research projects satisfying the State mandates and the identified RPAs.

Though research at TNAU is being taken in various forms at different levels, all the research schemes being operated are goal centric, self driven and cost effective. TNAU research agenda is planned in such a way that it takes care of the feedbacks received from the department officials, builds up the platform by having the discussions during the research council meeting for arriving at logical conclusions and for its effective implementation through strategic project formulation utilizing the scientific manpower of the university. The entire gamut of research activities is coordinated by the Directorate of Research with the following objectives.

Roles and Responsibilities of Directorate of Research

- Formulating the Institutional Research Agenda for the specified period based on the inputs received from the Technical Directors/Deans
- Seeking financial support from the State/Central Government for running the core research projects
- Establishing the infrastructure facilities for doing basic and applied research involving the students and researchers
- Coordinating and monitoring TNAU core projects and other externally funded projects for effective implementation
- Safeguarding the Intellectual Property Rights (IPR) of all the researchers (both scientists and students) by evolving suitable rules and regulations
- Taking steps for having intra and inter-institutional research collaborations by identifying the right group of scientists on both ends
- Establishing Centralized Monitoring System of all the research projects of TNAU and documentation of research data accessible to all the researchers
- Providing financial support through a separate research grant for the university core projects
- Evolving clear cut procedures for proposing research projects and formulating strategies for generating money from the technologies evolved
- Evolving procedures for reporting the research outputs in the form of publications and media reports

- Coordinating the conduct of certain sponsored Congress, Conference, Seminar, Symposium, Discussion groups, Expert committee discussions on identified topics for arriving at implementable outcomes, and
- Conducting Research Council Meeting, Scientists Meet and Scientific Workers' Conference to deliberate the progress of on-going research activities of TNAU.

Technical Directors and Research Monitoring

Considering the difficulties identified in coordinating and monitoring the research activities of TNAU, it is felt that the defined role of Technical Directors/Deans is very important under the single umbrella of Directorate of Research. Hence a decision was taken at the meeting held on 9.6.2014 to involve the following Technical Directors/Deans for specific areas of research in TNAU. The Directorate of Research will remain as the Central Coordinating and Monitoring Unit for TNAU research activities.

Area	Technical Director/Dean
Agriculture	
Crop Improvement	Director (CPBG)
Biotechnology	Director (CPMB)
Crop Management	Director (CM)
Water Technology	Director (WTC)
Soil Health Management	Special Officer (NRM)
Crop Protection	Director (CPPS)
Seed Science	Special Officer (seeds)

Horticulture	
Crop Improvement	Dean (HCRI) and Director (CPBG)
Crop Management	Dean (HCRI) and Director (CM)
Water Technology	Director (WTC)
Soil Health Management	Special Officer (NRM)
Crop Protection	Director (CPPS)
Seed Science	Special Officer (Seeds)
Agricultural Engineering	Dean (AEC&RI), Coimbatore
Forestry	Dean (FC&RI), Mettuppalayam
Home Science	Dean (HC&RI), Madurai
Social Sciences	Director (CARDS)

Role of Technical Directors/Deans

- The Technical Directors are responsible for evolving the research agenda specific to their directorates of TNAU so that TNAU can have the core projects, otherwise known as University Research Projects (URPs).

- They are expected to motivate the scientists under their control to evolve research projects that can cover the needs of the Tamil Nadu farmers instead of accepting the technologies from the national and international stream.
- They should guide the scientists under their control to develop projects for which the State/ Central Governments can be approached for exclusive funding.
- They should identify any duplication/deviation of research activities and rectify them by continuous monitoring and evaluation.
- They are expected to evolve a monitoring system for multi-locational trials, adoptive research trials and on-farm trials of advanced breeding materials and technologies.
- They are responsible for monitoring the research activities of post graduates/scholars at their directorates.
- They are responsible for establishing at least one centralized laboratory common to all workers in their Directorates besides the satellite laboratories accessible only to the specific project workers.
- They should also facilitate clear-cut research priorities for each of their departments instead of allowing every department to do what it wants. They should encourage collaborations instead of crossing boundaries.

Institutional Committees and their roles

For executing the various commitments to attain the expectations in research, the scientists of TNAU are guided by certain committees. These committees which are functioning at the different Directorates are constituted for specific purposes and meet under the chairman at specified periods.

Project Proposal Scrutinizing Committee (PPSC)

In research, proposing the projects to the funding agency is the prime task to be accomplished. In this connection, upon receiving the call for proposals from different sponsoring agencies, the Directorate of Research communicates the same to all scientists through intranet of TNAU seeking the response of relevant scientist. The project proposal received from the scientist through proper channel is assessed by the PPSC functioning under the chairmanship of Director of Research. This committee scrutinizes the proposals for its technical feasibility, operational modalities, matching the expectations of the sponsors without sacrifying the mandate of the University, competency of the scientist(s), etc. and recommends the proposal for approval of the Vice-Chancellor. Upon approval, the University Officer concerned submits the required copies of the proposals either online / offline.

Thus implemented project would certainly result in an outcome which can either be publishable / patentable. A Publication Peer Review Cell (PPRC) which has been already constituted at the Directorate of Research looks for the modalities and ethics behind the publication that had emanated from the research undertaken in accordance with the recent guidelines communicated by ICAR. This cell needs to be strengthened for its activities in the near future.

Other type of outcome from the research project would be those that can be registered / protected / patented. Separate committees are functioning to satisfy the requirements under these categories.

Patent Technical Committee (PTC)

The outcome of the project that can be patented on behalf of the University is decided by this committee which is headed by the Vice-Chancellor with selected University Officers as members and Professor and Head, Dept. of Trade and Intellectual Property as its Member Secretary. The technologies that qualify for patenting are identified during the discussions held in the concerned crop scientists' meet and the scientist is advised to submit the proposal for consideration by the University on having discussion with the officials of Dept. of Trade and Intellectual Property. On having several rounds of discussions, the proposal is shaped up and is being presented before the PTC by the scientist for its novelty, uniqueness, need for its patency, scientific validity etc. On having discussions, the committee recommends the technology for provisional filing / revision and resubmission to the PTC / non consideration. Once approved, the Dept. of Trade and Intellectual Property takes care of the filing and other associated works.

Institutional Germplasm Identification and Exchange Committee (IGIEC)

Certain outcome from the plant breeding related projects cannot be either published or patented. Instead, the outcome in the form of elite lines / pre bred materials is suggested for either protection with Plant Variety Protection & Farmers' Right Authority (PPV & FRA) / registratration with National Bureau of Plant Genetic Resources (NBPGR). This process is facilitated by this committee constituted under the chairmanship of Vice-Chancellor with Director, Centre for Plant Breeding and Genetics (CPBG) as permanent member, other selected University Officers and Professor and Head, Dept. of Plant Genetic Resources (PGR) as Member Secretary. Member Secretary facilitate the scientist for getting their lines either registered or protected with the concerned agency after having a deliberation. For having a single window system in the University for monitoring the inflow / outflow of genetic resources, Professor and Head, Dept. of PGR is identified to coordinate the exchanges with the prior permission of the IGIEC.

Institutional Bio-safety Committee (IBSC)

In India, GMOs and products thereof are regulated as per the "Rules for the manufacture, use/ import/export and storage of hazardous microorganisms/ genetically engineered organisms or cells, 1989" (Rules, 1989) notified by the Ministry of Environment and Forests (MoEF), Government of India under the Environment (Protection) Act (1986). These rules are implemented by Ministry of Environment and Forests, the Department of Biotechnology (DBT), Ministry of Science and Technology and the State Governments through the six competent authorities notified under the Rules. One of them is Institutional Bio-safety Committee (IBSC) which operates directly from the premises of the institution and is responsible for proper implementation of bio-safety rules, regulations and guidelines. The IBSC of Tamil Nadu Agricultural University is functioning since 1995 and the committee meets at least twice a year to approve and monitor all research programmes involving rDNA work. Following is the composition of the IBSC.

- Head of the organization (Chairperson)
- Three or more scientists engaged in rDNA work or molecular biology
- One outside expert
- Medical Officer – Bio-safety Officer
- A nominee of DBT.

IBSC reviews all recombinant DNA research carried out in TNAU depending upon the category of experiments. IBSC records the information provided by project investigators, gives permission before start of the experiments or forwards it to RCGM for approval as per the Recombinant DNA Safety Guidelines, 1990 of DBT. Exchange of materials developed through rDNA (such as seeds of transgenic plants) needs approval of the IBSC.

Need for TNAU Research Agenda

TNAU focuses mainly on science and technology, but it also recognizes that agricultural systems rely on the interconnectedness of many different elements. The global challenge of food security has many dimensions, only some of which are amenable for change through science and innovation. Research explorations in agricultural system have to be made on four major components *viz*. crop improvement, crop and water management, soil health management and crop protection. Strong base in all the above components is very vital for the sustained growth and development in agricultural production system across the state. TNAU from its inception remains as a forerunner in serving the framers of Tamil Nadu by exploiting all possible resources and support from national and international funding agencies. However, TNAU, an institution involved in public service should transform from the state of seeking support to "in and of itself sate" to maintain its uniqueness among the state agricultural universities. This needs a strong research agenda that will facilitate solving the problems of farmers in all the agro-climatic zones of Tamil Nadu. All these years, TNAU has no such exclusive research agenda and many of the activities are based on the agenda of the funding agencies at national and international level. Considering the capacity of the TNAU scientists and the research system established over all these years TNAU has to come out with its own research agenda having clear-cut research priority areas with a purpose, mission and vision for specific periods.

Purpose

- To transform lives of farmers through broad based quality education offered in agriculture and technology including horticulture, agricultural engineering, home science and forestry.
- To provide need based technologies to the stake holders which will sustain environments and economies locally, regionally, and globally.

Mission

- To educate students and communities in ways that enable their future success at the regional and global levels.
- To develop new knowledge and technologies for the benefit of farmers and other stake holders.
- To provide our state with research institutions of national and international standing, offering the most demanding and rigorous education to the most promising students.

Vision

- To become the most important driver in nation's economy and the world's top university in agricultural technology.

TNAU's stand in the global arena is based on the newer technologies and innovations generated, groomed scholars with a thirst in research having scientific spirit and agility among the farmers in acquiring and adopting the technologies. Basically, sound research can meet all the above requirements. TNAU's research is centered towards developing time tested, cost effective, eco friendly and sustainable technologies for the upliftment of farmers of Tamil Nadu. With the primary goal of doubling the agricultural productivity and trebling the farmer's income, TNAU has identified the following research priorities, which are to be set as Research Agenda of TNAU 2014-18.

Research Priority Areas

Setting research priorities in specific areas acts as a driver of change that will influence the future of TNAU. The set research priorities should solve the challenges of providing food, energy, water and other human needs of growing population and rising consumer demands. In addition the research priorities should encompass the following components so that TNAU will have its strength to achieve the set goals in the areas of crop improvement, crop and water management, soil health management and crop protection.

- Promoting teaching and learning through interdisciplinary programmes to achieve academic excellence.
- Attracting Rural Youth towards Agriculture (ARYA)and making them as highly competitive graduates for national and international scenario.
- Enhancing the opportunities for better capacity building of the faculty and scholars.
- Focusing researchonthe changing needs of the society due to globalization, technological advancements and growing emphasis on value addition.
- Targeting higher productivity per unit of arable land and water resources through precision farming and better post-harvest management of produces.
- Evolving crop production strategies to counteract monsoon failure and seasonal droughts.
- Exploiting Information and Communication Technology (ICT) revolution to have a socially relevant system of better education, research and extension in agriculture.

Research Priority Areas (RPA)

1. Agriculture

Crop Improvement

Crop improvement through breeding remained as an art of genetic enrichment, genetic improvement and genetic enhancement by nomadic farmers just to yield more. The advent of classical and modern tools starting from simple genetic models to genomic tools changed the practice of art into science. This led to the simultaneous improvement of positive traits and removal of negative traits in crop plants with enhanced yield and improved quality as envisaged by the consumers and stakeholders. Developing newer varieties/hybrids is a continuum, which revolves around employing breeding tools and redefining the breeding strategies for achieving the goal. An amalgamation of the works related to Plant Breeding, Genetics, Biotechnology, Crop Physiology and Seed science would definitely pave a way in the isolation of newer genotypes having tailored traits. In the improvement of agricultural crops, major research priority areas should focus on conservation and characterization of the germplasm, evolving crop varieties with enhanced yield and specific duration to suit the mega-environments of each crop and improved quality of the produce.To reach these goals the tools to be used and strategies to be followed are almost the same irrespective of crops.

Crop Genetics and Breeding

RPA 1: Conservation and characterization of germplasm in major food crops

Conservation and characterization of available genetic resources in major food crops facilitate the breeders to identify the right parental materials for the improvement of specific traits in their practical plant breeding. The activities of conservation and characterization have a set of procedures, which vary from crop to crop and are to be practiced by the concerned plant breeder and the curator. Mere curation of genetic resources will not serve any purpose unless the materials are properly evaluated and maintained. These activities need a detailed planning among the crop breeders and the conservation specialists. Many of the landraces in major crops such as rice, sorghum and millets are yet to be characterized for their potential. The germplasm materials of major food crops available in TNAU need greater attention for their characterization and utilization so that the materials can be better exploited for gene identification for specific traits.

- Maintaining available plant genetic resources without loss of viability and genetic purity by way of conserving them under controlled conditions.
- Characterization, evaluation and documentation of genetic resources with accurate passport data for their better utilization in practical plant breedingand promote their use.
- Developing information network for the exchange of plant genetic resources within and between institutions.

RPA2: Breeding for crop duration and yield

The need to accelerate breeding for increased yield potential and better adaptation to varying climatic conditions is an issue of increasing urgency. Crop varieties with specific duration are to be evolved so that the farmers can use the right variety to the prevailing mega-environments. Further, there is an urgent need to synthesize crop varieties suitable for better management considering the practice of men to machines.

- Evolving dynamic crop varieties of rice, millets, pulses and oilseeds for mega-environments of each crop.
- Employing classical plant breeding tools in arriving at ideotypes with enhanced yield, nutrient and water use efficiency.
- Developing genotypes of pulses and oilseeds fitting for rice fallow situation with marginalized irrigation.
- Diversifying the male sterile sources and identifying newer sources for the synthesis of hybrids in major food crops.
- Breeding dual purpose (food and fodder) crop varieties of millets and pulses.
- Evolving compact and synchronized maturing varieties suitable for mechanical picking in crops like cotton, pulses and sesame.
- Evolving suitable varieties/hybridsin redgram and castor for varying cropping systems.

RPA3: Breeding for quality improvement

Crop breeding to improve quality traits – to enhancelevels of desirable macro-and micronutrients in the seed, reduce levels of undesirablequality factors and modify chemical composition to develop new uses for crops andcrop components is a priority area from the point of view of consumers. In recent times, the quality of crop produce is preferred over increased yield, since the crop produce with improved quality fetches better income to the producer. Increased life style associated diseases in humans and resulting food habit changes make the people to go for crop produces with nutritional and therapeutic values.

- Breeding rice varieties with increased levels of micronutrients (Iron and Zinc).
- Breeding varieties in rice and minor millets for their therapeutic values.
- Breeding fine grain rice varieties with better quality attributes suitable for export.
- Evolving varieties of grain pulses with high protein levels and lesser anti-nutritional properties.
- Developing table purpose groundnut and sesame varieties
- Breeding sunflower hybrids with increased oil content and quality.

RPA4: Breeding for resistance to biotic stresses

Productivity of crops grown for human consumption is at risk due to the incidence of insect pests and pathogens. Crop losses due to these biotic stresses can be substantialand may be prevented, or reduced, by evolving crop varieties with increased levels of resistance to them. Breeding crop varieties resistant to biotic stresses can be a major component of the integrated pest management in agricultural crops.

- Identifying the resistance sources in major crops (rice, millets, pulses, oilseeds and cotton) and understanding the genetics of host plant resistance for major insect pests and diseases.

- Breeding rice varieties with resistance to stemborer, brown planthopper and blast, bacterial leaf blight and false smut diseases.
- Evolving sorghum varieties with resistance to mite and ear head midge and grain mould and false smut diseases.
- Development of redgram varieties resistant to podborers and sterility mosaic disease.
- Evolution of black gram and green gram varieties with resistance to Yellow Mosaic Virus (YMV)

RPA5: Breeding for resistance to abiotic stresses and improved Resource Use Efficiency (RUE)

Crop losses due to abiotic stresses are very extensive causing lower agricultural production. In recent years, intensive research has been taken up to understand the influence of abiotic stresses such as drought, salinity and heat. Plant behaviour to the above stresses has been explored in major food crops such as rice, maize and sorghum. This understanding facilitates the plant breeders to evolve crop varieties with tolerance to drought, salinity and heat. The matrix of various abiotic stresses prevalent during the crop growth influences the resource (nutrient, water and light) use efficiency. Evolving crop varieties with better RUE under varying soil and climatic conditions remains as one of the priorities of plant breeders.

- Evolving rice varieties with improved tolerance to abiotic stresses such as drought, salinity and heat.
- Understanding the Nutrient Use Efficiency (NUE) for major nutrients *viz*. nitrogen and phosphorus in rice and maize by evaluating improved varieties and landraces.
- Evaluating and understanding the heat tolerance and photosynthetic efficiency in rice and minor millets.

RPA 6: Genetics, Cytogenetics and Molecular Breeding and Genetic Enhancement

Genetic enhancement of food crops by the introgression of specific traits is one of the routine practices in crop breeding. Exploitation of classical tools of genetics and cytogeneticsin practical plant breeding is well established in major crops like rice, sorghum and maize. Understanding the inheritance of specific traits and trait introgression through backcross breeding is a routine procedure in plant breeding.Cytogenetic studies conducted in major food crops facilitated identification of addition/ substitution lines for further exploitation. The development and availability of molecular tools speeds up the process of introgression of specific genes controlling the trait interest without altering the background of the elite variety. Moreover, specific genes are introgressed to superior genotypes of crops from outside the boundary of those crops. The processes of gene identification and introgression in major crops can be achieved by the joint efforts of plant breeders and biotechnologists.

- Understanding the genetic nature of target traits to plan the trait improvement in specific crops.
- Exploring the possibility of exploiting wild relatives for trait introgression to the cultivated crops.
- Molecular breeding in crop varieties for biotic and abiotic stresses.
- Molecular breeding for value addition in food and feed crops.

- Exploiting Marker Assisted Selection (MAS) in major food crops.

RPA 7: Evaluation of pre-breeding stocks and post release monitoring of varieties

Crop breeding programmes are to be systematic and structured to change the genetic composition of materials based on performance criteria before and after breeding. Evaluation of pre-breeding materials is very essential since the breeding objectives are influenced by a wide range of factors and are dependent on the needs and priorities of the farmers and consumers. Proper monitoring and evaluation of pre-breeding materials decides suitability and adaptability of the elite genotypes evolved for release to the farmers. Likewise, the post-release maintenance and monitoring of varieties should be taken care of for deciding future plant breeding plan in all the crops.

- Evaluating the potential of tailored genotypes for the traits of interest.
- Utilization of thepotential pre-breeding stocks in the evolution of varieties/hybrids.
- Maintenance breeding and seed increase to satisfy the requirement of farmers and seed producers.
- Post release monitoring of varieties/hybrids for their integrity and performance.

Crop Biotechnology

RPA 1:Evolving molecular and biotechnological tools, processes and products

Biotechnological tools are better exploited to understand the extent of genetic variability in major crops. The techniques of gene cloning and genetic transformation facilitated the incorporation of new genes to the background genotypes to have additional variability for the trait of interest. The advancements in the fields of high throughput sequencing, genotyping, transcriptomics, proteomics, metabolomics, ionomics, genetic engineering, RNAi technology andgenomeediting technologies have opened the door to exciting new approaches and applications for developingimproved genetic stocks for specific traits.

- Developing newer molecular tools, processes and products for developing genotypes with enhanced efficiency and productivity
- Developing improved genotypes for yield and agronomic traits using newer molecular tools
- Understanding molecular mechanisms of stress resistance through Omics-technologies
- Assessingtheimpact of biotechnology products

RPA 2: Bio-prospecting and tissue culture

Tamil Nadu with its diverse flora and fauna, should map, document and monitor its biological diversity and utilize these resources for isolation of bio-molecules and genes leading tosustainable product development. Large amount of genetic resources remain under-exploited which need to be profiled for their biochemical/medicinal properties. Perennial crops with long life cycle are usually heterozygous, possessing self-incompatibility mechanisms and inbreeding depression, which restrict the production of homozygous individuals. In this context, inbreds, which are to be used as parents for hybrid development, can be developed by producing doubled haploid plants through anther or ovule culture. As tree crops are generally recalcitrant to in vitro culture, micro-propagation methods are required for large scale propagation.

- Biochemical profiling of nutritionally/medicinally important native genetic resources
- Identification, isolation and *in silico* analysis of novel bio-molecules/genes from under exploited indigenous plants and microbes
- Micro-propagation of tree and horticultural crops
- Development of doubled haploids plants as source of inbreds for hybrid development in major food grain and vegetable crops.

RPA 3: Genomics and bioinformatics for gene identification and molecular evolution

Many species of plants and microbes endemic to Tamil Nadu have not been characterized and their potential utility undiscovered. Sequencing native plant species and identifying useful traits/ genes will improve medical and agricultural applications. Small millets, mostly native to our country possesses high level of stress tolerance, photosynthetic- and nutrient use efficiency. However, the genes associated with those traits are unknown. These genetic resources could be exploited to improve major crops such as rice. The volume of genomic information available to the biological community is continuously increasing and diversifying which demands construction of specific databases to congregate the individual requirements of the diverse research communities to a particular subject and to provide in-depth information.

- Molecular diversity in plants and associated organisms
- Whole genome sequencing of native crops and beneficial micro-organisms
- Unraveling the genome and allele mining
- Development of databases for agricultural crops and new bioinformatics tools for genome analysis
- DNA fingerprinting of varieties of major crops of Tamil Nadu.

Crop Management

Crop management is a pragmatic approach to the production of crops. Unlike crop protection, which focuses on control of pests and diseases, crop management includes more components in managing crops from seed to seed. Its aim is to achieve maximum yield at farm level by reducing the gap between potential yield and farm yield. Besides the crop oriented technologies, crop management includes management of environmental (water and weather) and social factors influencing crop production also. Over a period of time, the focus on crop production has moved from yield to quality and safety, and then to sustainability. This results in new challenges for farmers and growers during each season and warrants identification of mega-environments for each crop so that specific crop management components can be evolved and introduced to realise maximum yield.

Agronomy

RPA 1: Evolving integrated weed management (IWM) technologies for enhanced yield in major crops

Currently, weed control strategies involve herbicide applications and/or mechanical disturbance (tillage). Although these strategies have been successful in increasing farm labour efficiency and crop productivity, concerns regarding the economic and environmental impacts of these practices including development of herbicide resistance have generated interest in identifying alternative weed management approaches. An integrated approach to weed management (IWM) can be used to develop agricultural systems that are less dependent on herbicides and tillage.

- Evaluation of conservation agricultural practices on weed shift, herbicide behaviour, soil properties, productivity and profitability of crops
- Developing integrated weed management practices for crops and cropping systems
- Evolving suitable weed management strategies for non-cropped situations including aquatic weeds.

RPA 2: Nutrient Management for maximizing resource use efficiency

Intensification of research on nutrient management is an urgent necessity to optimize nutrient inputs in crop production and minimize their environmental effects. Nutrients that are not effectively utilized by crops have the potential to leach into groundwater or enter nearby surface waters via overland runoff or subsurface agricultural drainage systems leading to their pollution.. The key to effective crop nutrient management is developing and following a yearly plan based on experiments to determine the nutrient needs of crops

- Determining the requirement of major nutrients for major agricultural crops under varied agro-climatic conditions.
- Evaluating different nutrient placement methods to increase the efficiency of nutrient uptake.
- Developing/fine tuning nutrient application by determining nutrient application rates, methods and timing to ensure nutrients use efficiently.

- Enhancing nutrient use efficiency through integration of different sources of nutrients for crops and cropping systems

RPA 3: Yield Maximization through improved production systems

Yield maximization in agriculture is the fore most component considering shrinking land area and the increasing demand for food and fodder production. This can be achieved at farm level by practicing use of improved seeds of crop varieties and adoption of improved farm management practices.Besides the above components, possibilities for introducing mechanization at every possible stage of crop growth should be explored.

- Demonstrating the importance of improved seeds and sowing methods for better crop establishment and yield.
- Evolving critical farm management techniques for each crop and evaluating the potential of such techniques under different agro-climatic conditions.
- Introduction of appropriate mechanization for major crop management techniques and exploring possibilities of its large scale adoption by farmers.

RPA 4: Evolving suitable cropping pattern for specific situations

The yearly sequence and spatial distribution of crops in different areas is not constant and hence there are many cropping patterns. The significance of following a specific cropping pattern is to achieve maximum benefit from it. Though there are different cropping patterns practiced by the farmers based on their experience, the scientific validation is required to suggest specific cropping pattern to different areas.

- Identifying and evaluating potential cropping patterns to be followed for major crops in different agro-climatic zones.
- Determining the factors influencing the specific cropping pattern to identify the benefits/risks of following that cropping pattern.

RPA 5: Water Management practices under normal and water scarcity conditions

The agricultural sector accounts for over 90 per cent of global water demand. Therefore, if water management issues are to be addressed the foremost component is reduced withdrawals by reducing return flows to facilitate increased crop production, Managing evapo-transpiration, irrigation scheduling and irrigation optimization, integrated watershed management and improved water distribution system are some of the major components to be considered for effective water management under normal and water scarcity conditions.

- Determining irrigation scheduling for optimum water usage and maximum water use efficiency in major crops.
- Assessing the water use efficiency in different crops involving complex set of genotypes to identify right genotype(s) for specific environment.
- Identifying new irrigation strategies/methods for increased water use efficiency.

- Standardizing fertigation methods for macro-and micronutrients for major crops through optimum water usage.

RPA 6: Augmenting crop production in dry land agriculture

Crop production in marginal areas without irrigation facilities contributes substantially to food production utilising available rainfall. Management of rain-water remains as the key to success in dry land agriculture. An integrated approach for the management of rain water consists of increasing moisture storage in the soil, optimum use of this moisture through efficient cropping systems, harvesting a portion of the runoff water for “life saving” irrigation, and reorienting the concepts and organization of irrigation, including that from tanks, to enhance productivity per unit of rain water.

- Mapping the land area wherein rainfed agriculture is the only possibility and prioritization of rainfed areas in Tamil Nadu.
- Identification of crops suited to available rainfall and soil fertility
- Managing soil fertility and available water resources for maximizing the crop production.
- Exploring possibilities for introducing conservation agriculture in selected dryland areas.

RPA 7: Integrated Farming System (IFS) for livelihood security

Integrated farming system (IFS) denotes a more integrated approach to farming than the existing monoculture approaches. It refers to agricultural systems that integrate livestock and crop production for the benefit of small and marginal farmers. There are several models which have revolutionized conventional farming of livestock, aquaculture, horticulture, agro-industry and allied activities. The IFS approach introduces a change in the farming techniques to maximise production in the cropping pattern with optimal utilization of resources.

- Evolving and evaluating suitable IFS models for different agro-climatic zones of Tamil Nadu.
- Determining comparative economics of different farming systems/enterprises to recommend right model for each zone.
- Identifying a perfect model for adoption by studying the strength and

Agro-climatology

RPA 1: Weather and climate proofing and forecasting for improved crop production

Climate change may have positive impacts on agricultural productivity by extending the geographical suitability of agriculture in some cold or high altitude areas of the world. However, the agriculture sector is vulnerable to changes in temperature, rainfall, sea level, and the frequency and intensity of extreme weather events resulting in adverse effects on crop growing conditions, agricultural productivity and the suitability of crops in different agro-ecological zones. This warrants research activities related to impact assessment, vulnerability assessment, and adaptation assessment due to the changes in climate.

- Monitoring and modeling climate change impacts on water resources vis-a-vis major agricultural crops and developing location specific adaptation options

- Capturing the benefits of integrated climate/weather forecast information for farm decision making

RPA 2: Yield gap analysis and identification of causes for yield gaps in major crops

The yield gap of a crop grown in a certain location and cropping system is defined as the difference between the yield under optimum management (potential yield) and the average yield achieved by farmers under varying conditions of soil, water and other components of crop production. Changing climate and its impact on crop production is very severe and there is an immediate need to understand the components responsible creating the gap between the potential and average yield .

- Understanding production potentials and yield gaps in intensive production areas of major food crops.
- Establishing simulated crop yield potential using various basic data of soil, water and weather parameters.
- Quantifying yield gaps in rainfed cropping systems in Tamil Nadu.

Organic Farming

RPA 1: Developing organic farming systems and quantifying resources and their use efficiency

As natural resources become increasingly scarce, the transition to a more resource-efficient farming system must be a top priority for the coming years and it can be organic farming which involves reduced resource use and increased resource recycling. The organic farming practices are expected to build healthy soil by increasing soil stability and organic matter content. This ensures improved soil biodiversity and efficient use and recycling of essential elements *viz.,* nitrogen, phosphorus and potassium. Organic farming is expected to preserve water quality by abstaining from using synthetic fertilizers and engaging in effective management of water sources.

- Identifying crop varieties amenable for better resources use efficiency under organic farming conditions.
- Developing crop specific package of practices to sustain the quality and quantity of the crop varieties identified for organic farming.
- Assessing the impact of organic farming on soil health, resource (nutrients and water) use efficiency and biodiversity.
- Developing technologies for rapid composting of organic wastes for resource recycling.
- Identifying and validating Indigenous Technologies and Knowledge for large scale adoption.

Crop Physiology

RPA 1: Physiological interventions for breaking yield ceiling in food crops by increasing photosynthetic efficiency

Evolving crop varieties for high yield is mostly based on defect elimination and selection for yield. Involving these two components in the evolution of crop varieties need plants with model characteristics known to influence photosynthesis, growth and development of phenological traits and grain production. An optimized ideotype of any crop plant will make minimum demand on resources per unit of dry matter produced because of having higher photosynthetic efficiency and translocation rate of photosynthate from source to sink.

- Identifying techniques related to monitor photosynthesis related parameters (phenological, morphological and physiological) in plants.
- Understanding the photosynthetic properties of model crops in cereals and pulses under varied stress conditions and temperatures in relation to biomass production.

RPA 2: Understanding the physiology of root system and environment interaction

Physiological research activities in plant system predominantly focus on above ground parameters of plants. Understanding on the root system and its interaction with edaphic factors is very limited. Considering the effects of global climate change resulting in the extremes of drought, salinity heat and erratic rainfall understanding on the root traits will play a major role in the development of new crop varieties suitable for the changing climate. There is an urgent need for identifying root traits for normal and infertile soils.

- Identifying root traits contributing to plant productivity in major food crops like rice and redgram.
- Exploring the role of plant growth promoting rhizobacteria in root system functioning.
- Identification of root traits and signaling influencing the acquisition of mineral elements

Seed Science and Technology

RPA 1: Pre and post harvest problems associated with seeds and their management

Seed is the most vital and crucial input for crop production and producing quality seeds remains as the one of the ways to increase the productivity of crops. During seed production, the produced seed is expected to be affected by several problems and among them some of them are inherent with seeds either before harvest or after harvest. The major problems before harvest include, seed set and development, pre-harvest sprouting and pre-harvest shattering. The major problems after the harvest are seed dormancy and seed germination. Understanding the biology behind the above is very important in crop production.

- Understanding the biological and environmental factors responsible for improper seed set and development, pre-harvest sprouting and pre-harvest shattering of seeds.
- Identifying the factors causing seed dormancy and seed germination and exploring their biological origin.

RPA 2: Seed quality enhancement economically important crops

The demand for quality-enhanced seeds of improved varieties is growing at an amazing phase worldwide. Since seed is the basic unit of agriculture, it fetches much importance in cultivation than other inputs though the cost on seed is cheap. Advances in science and development of seed industry expect every single unit of seed to be germinable with vigour. However, seed is the biological entity, which undergoes deterioration even when it is in the mother plant after attaining the physiological maturity stage and subsequently results with heterogeneity in quality of the harvested seeds. Hence, value addition and management techniques are essential for the basic inputs to derive, to benefit out of all other allied inputs.

- Development of seed quality enhancement techniques for economically important crops
- Seed quality enhancement through priming, pelleting and hardening
- Development of integrated seed treatments suitable for mechanized sowing for economically important crops.

RPA 3: Seed quality maintenance during production, storage and distribution.

Seed production is a systemic and scientific approach on mass multiplication of reproductive materials with assured quality. The seeds should be genetically and physically pure and should have physiological soundness in terms of viability, vigour and seed health. Seed production system needs specialized and technical skills and is influenced by many factors. Seed quality is influenced during production, storage and distribution. Seeds undergo deterioration during storage and distribution. Thus quality maintenance is a vital component seed distribution chain.

- Standardization of improvised seed production techniques for new varieties of economically important crops.
- Standardization of hybrid seed production techniques for economically important crops.
- Standardization of field and seed standards for all the seed crops.
- Exploring the biological and environmental factors responsible for seed quality deterioration during production, storage and distribution.
- Evolving suitable methods for maintaining the seed quality and genetic purity in the seed production chain.

Soil Health Management

Soil Science

RPA 1: Soil fertility Assessment and Improvement

To meet the basic needs, human kind is degrading the natural resources through unscientific exploitation, causing environmental problems like land degradation, droughts and floods and calls for a scientific approach in development and management of resources at various levels. A soil resource inventory provides all potentialities and limitations of soils for its effective exploitation. It also provides adequate information in terms of land form, terrain, vegetation as well as characteristics of soils which can be utilized for lands resources management and development. Rational utilization of land resources can be achieved by optimizing its use, which demands evaluation land for alternative land use, ensuring its wise use.

- Differential crop response to various nutrients and assessing stage specific nutrient use efficiency

- Geospatial delineation and assessment of major and micronutrients and sulphur status in soils of Tamil Nadu
- Delineation of magnesium status of major cotton growing soils and management of magnesium for cotton.

RPA 2: Innovative approaches for Nutrient Management

Varied agro-climatic conditions make it possible to grow a wide variety of crops all the year around. However, their average yield is low due to unbalanced fertilizer use, continuous use and sub-optimal doses of nutrients in an unbalanced proportion led to serve depletion of nutrient reserves in soils, causing multiple nutrient deficiencies and decline in crop productivity. The integrated plant nutrient supply, envisaging conjunctive use it fertilizers and other nutrient sources of organic or biological origin is an ideal approach to maintain soil health, increase productivity and reduce cost of cultivation.

- IPNS recommendation for irrigated and rainfed crops including fertigation.
- Developing Rapid Test Kit for estimating leaf nitrogen concentration in sugarcane
- Enhancing fertilizer use efficiency through Nutriseed Pack technology
- Management of nutrient deficiencies for major crops
- Fertilizer scheduling for hybrid maize under high density planting
- Development and evaluation of specialty fertilizers
- Radiotracer studies for nutrient optimization

RPA 3: Soil carbon management for sustaining soil health

Soil Organic Carbon (SOC) plays a critical role in sustaining crop productivity and provide options for improving soil fertility, thus ensuring food security by imparting physical environments to soil, improving chemical properties of soil and nutrient availability. There is a strong interest in the SOC pools and the associated fluxes because of their significance to the global C cycle and their impacts on green house gases and crop production.

- Use of sugarcane trash biochar for carbon sequestration and improving sugarcane productivity
- Developing strategies for organic matter build up in different agro- ecosystems through crop residue management
- Soil organic carbon: Assessment and forecasting under continuous fertilization
- Developing strategies for organic matter build up in different agro-ecosystems through organic sources viz. Biochar, GM, GLM and crop residues

RPA 4: Enhancement of quality of crops

Nutrient deficiencies pertain mainly to protein and micro nutrients like zinc, selenium and iodine. An adequate and diverse diet, comprising fruits, vegetables and cereals, is the best solution for good on nutrition, both in terms of energy requirement and micronutrient needs. Introducing biofertilizer stable crops with increased nutritious content can therefore have a big impact, as the strategy relies on improving an already existing food supply.

- Biofortification of micronutrients in cereals, millets and pulses

RPA 5: Degraded soils and poor quality water management

Soil degradation is the decline in soil quality caused by its improper use, usually for agricultural, pastural, industrial or urban purposes. It is a serious global problem and encompasses physical, chemical and biological degradation. The ground water in arid, semi-arid and coastal regions are it poor quality due to excessive salt concentration and high Sodium Adsorption Ratio (SAR) and Residual Sodium Carbonate (RSC) values. Scarcity of good quality of water forces the farmers to use poor quality irrigation water knowing fully well that quality and yield of crops are continuously decreased. Suitable holistic management practices should be developed for degraded soils and poor quality irrigation water for the sustainable agriculture.

- Foliar fertilization of silicon for mitigating the biotic and abiotic stress in rice
- Evaluation of suitable foliar crop stress mitigants for enhancing rainfed groundnut productivity
- Assessment of problem soils, poor quality water and their management
- Assessment of phosphorus utilization and response of redgram cultivars to P in alkaline/ calcareous soils
- Bioremediation of degraded sodic and saline sodic soils.

Agricultural Microbiology

RPA 1: Exploiting microbial biodiversity for enhancing agricultural productivity

Monitoring the changes in soil biological properties due to any nutrient managements or agronomical practices is essential as these may affect the productivity and sustainability of soil. The soil biological variables include soil microbial biomass, counts and diversity, enzyme activities, nutrient transforming biochemical processes and some recalcitrant molecules accumulation serve as indicator of nutrient management.Exploring the microbiome of drought adopted natural plants (wild or indigenous nature) would yield better drought mitigating strains, which can be further exploited for agricultural crops. The rhizospheremicrobiome had not only influenced the plant health and fitness, but also serves as source of nutrient flow to soil pool. The positive feedback through beneficial microbes supply high amount of soluble carbon, conserve available moisture through biofilms and provide available nutrient pools in the soil throughout the crop growth. Additionally, the oxido-reductive potential changes in the root regions release several bound nutrients (especially P, Zn, Mn) to the soil solution. Hence, the beneficial interaction between plant and rhizospheremicrobiome had an added benefit to enrich the soil and thereby the fertility sustainability.

- Microbiome analysis of different agro-climatic soils of Tamil Nadu for long-term fertility sustainability and biorestoration.
- Microbial diversity of drought adopted indigenous plant species for abiotic stress mitigation.

- Plant associated microbiome for enhanced plant growth and yield of agricultural crops
- Exploration of soil microbial diversity wealth through metagenomics approach for novel microbial genes and products for agricultural and industrial applications

RPA 2: Microbes mediated biofuel production from biomass

Lignocellulose is the most abundant carbohydrate source in nature and represents an ideal renewable energy source. To efficiently deconstruct recalcitrant plant biomass to fermentable sugars in industrial processes, biocatalysts of higher performance and lower cost are required. Thermostable enzymes have significant advantages for improving the conversion rate of biomass, typically have a higher specific activity and higher stability, allowing for extended hydrolysis times and decreasing the amount of enzyme needed for saccharification. Hence, our efforts to improve depolymerization of polymeric sugars with high specific activities and relatively low levels of end-product inhibition thereby we can aim for enhanced conversion of sugars to fuels and chemicals. The major bottleneck with algal biofuel production is the huge cost of biomass production whatsoever the method (indoor/outdoor). Strategies to identify carbon and nutrient sources from wastes (flue gas, waste water, brackish water, etc) pave the way for sustainability.

- Biomass derived fuels and chemicals
- Lipid Storing Capacity of Algal isolates of the Pristine Forest and Marine Ecosystem and Establishment of a Repository

RPA 3: Development and evaluation of microbial bio-inoculants

Use of plant growth promoting rhizobacterial bio-inoculants for the benefits of agriculture is gaining world-wide importance and acceptance and appears to be the trend for the future. However, the potential of the bio-inoculants is under-utilized due to several reasons like inferior quality, less-competitiveness, poor-colonizing ability in crops and poor-survival in the soil ecosystems. Several measures are being under investigations to improve the inoculant-mediated benefits to the crops. One such attempt is proposed in the present project to use stage-specific inoculants to improve the inoculant-derived benefits to the crops. The under-lying principle of stage-specific inoculant technology is to introduce the necessary microbial inoculant specific to the growth stage of the crop so as to maximize the colonization and efficiency for maximum yield. In order to obtain maximum benefit from the inoculated strains and to prolong their colonization throughout the cropping period, it is believed that inoculating appropriate strain specifically needed stage of the crop would be more useful than a single inoculation at the time of sowing.

- Development and evaluation of stage-specific microbial inoculants for rice
- Development of high density spore inoculum of Arbuscular Mycorrhiza through Root Organ Culture
- Developing microbial consortium for nutrient management
- Standardizing various technologies of application of microbial inoculants for enhanced productivity
- Physiological and molecular property of microbial strains

- Manipulation of rhizosphere microbial dynamics
- Stress alleviation through deploying microbial systems

RPA 4: Value addition

Due to a ground water overexploitation by more than 100% in the Salem and Namakkal districts, the groundwater declines continuously. Water shortage and environmental impacts caused by waste waters have motivated Sago factory owners to channel about 30% of their waste waters through biogas plants to reduce the organic loads and for gaining methane that is converted into heat and electrical energy for granulating starch. For overcoming water shortage, further purification for process reuse/safe disposal steps besides biomethanation are urgently needed. Hence, a process for improving the purification efficiency of sago waste waters for irrigation purpose has to be developed through addition of N amendments to the inflowing waste waters of biogas plants and by Spirulina cultivation in the biomethanated waste waters under HRAP system. The Spirulina biomass produced can be used as feed supplement for poultry birds in the poultry farms, which is a major venture in this area.

- Improving biomethanation and bioremediation efficiency of cassava sago effluent for safe recycling
- Recycling and extraction of value added products from wastes

Environmental Sciences

RPA 1: Bioremediation of polluted soils

Bioremediation is a natural process which relies on bacteria, fungi, and plants to alter contaminants as these organisms carry out their normal life functions. Metabolic processes of these organisms are capable of using chemical contaminants as an energy source, rendering the contaminants harmless or less toxic products in most cases. This paper summarizes the general processes of bioremediation within the soil environment, focusing on biodegradation of petroleum hydrocarbons. The effect of soil conditions on rate of biodegradation of hydrocarbons is addressed. Further, limitations and potential of both ***ex situ*** and ***in situ*** bioremediation as viable alternatives to conventional remediation are explained and addressed.

- Bioremediation of tannery and dyeing industrial wastewater polluted agricultural lands for crop cultivation
- Restoration of sewage water contaminated agricultural lands through rhizo-remediation
- Establishing repository of effective microbial cultures for bioremediation and sharing the culture collections to research and development activities of other organizations

RPA 2: Wastewater treatment and recycling

Satisfactory disposal of wastewater, whether by surface, subsurface methods or dilution, is dependent on its treatment prior to disposal. Adequate treatment is necessary to prevent contamination of receiving waters to a degree which might interfere with their best or intended use, whether it be for water supply, recreation, or any other required purpose. Wastewater treatment consists of applying known technology to improve or upgrade the quality of a wastewater and subsequent recycling or reuse.

- Advanced treatment technologies for removal of pollutants in wastewater
- Development of anaerobic consortium for maximizing energy recovery from wastewater through advanced anaerobic digestion
- Exploring the possibilities of extracting economic products from industrial wastewater and recycling of treated wastewater for crop production

RPA 3: Integrated Solid Waste Management

Integrated Solid Waste Management (ISWM) is a comprehensive waste prevention, recycling, composting, and disposal program. An effective ISWM system considers how to prevent, recycle, and manage solid waste in ways that most effectively protect human health and the environment. ISWM involves evaluating local needs and conditions, and then selecting and combining the most appropriate waste management activities for those conditions.

- Development of microbial consortium for rapid composting of different organic waste
- Management of biosolids through nutrient extraction
- Developing a nutrient rich potting medium from solid waste for urban horticulture

RPA 4: Air Pollution Monitoring and Mitigation

Air pollution is now the world's largest single environmental health risk and can cause a variety of environmental effects also on ecosystem and cultural heritage. Well-known pollution sources (e.g., traffic, biomass burning) and new drivers (e.g., new sources, fast urban development) bring new challenges. Aerosol particulate matter (PM), together with gases (e.g., NO x, PAH, VOCs, and SO 2), is the main pollutant responsible for atmospheric pollution and its effects. In this context, a detailed chemical characterization of particulate matter is needed to identify pollution sources and assess the environmental impact. Different kinds of environments are monitored starting from typically highly polluted urban environments, coming to background and remote sites. Monitoring air quality both indoor and outdoor is essential in order to evaluate negative effects on human health and to design the most efficient measures for a sustainable development.

- Assesment and mitigation of air pollutants emanating from municipal waste dumpingsites
- Developing odour mitigating strategies in industrial corridor
- Climate change impact on emission of Green House Gases from rice ecosystemsand its mitigation strategies

Remote Sensing and Geographical Information System

RPA 1: Hyper-spectral remote sensing applications

Estimates of foliar biochemical such as the levels of chlorophyll and nitrogen provide indicators of plant productivity, stress and availability of nutrients. Direct field techniques for estimating these attributes require frequent destructive sampling. Such techniques are difficult, labour intensive, time consuming and costly. They can hardly be extended to large areas. However, estimates of biochemical and biophysical parameters over large areas may be obtained using remote sensing. The existing remote sensors have limited application because of the low spectral resolution. Hyperspectral imaging is a new technique for obtaining reflectance spectrum in each position of a large array of spatial grid. The narrow spectral channels enable the detection of small spectral features. These spectral features provide an insight in to the biochemical and biophysical characteristics of vegetation, especially leaf. The biotic and abiotic stress can be detected by analyzing reflectance spectrum much earlier to the appearance of visible symptoms. This offers a great scope for correcting the nutrient deficiency or moisture stress before the crop reach an irrevocable stage of stress. Thus by considering the advantages of the hyperspectral remote sensing, the following theme is identified for investigation.

- Application of hyperspectral remote sensing technique for monitoring crop nutrients, moisture stress and assessing pest damage

RPA 2: Drought monitoring applications

Ground based drought monitoring suffers from the sparse observations. Satellite remote sensing provides grid based data and the coarsest of which is 29km x 29km. The periodicity of much of this data set varies from once in three hours to daily or available on alternate days. Some special products are generated as 8-day-composites. Almost all the above data are freely available on the internet. The global coverage, intense observation and high frequency of the satellite data as well as the availability of historical data help closely follow the crop water status. Drought can be identified by analyzing the current scenario with historical data and also by closely monitoring the progression of biomass and hence it is possible to offer timely advice on drought mitigation. Hence, it is planned to initiate research on the following themes.

- Monitoring agricultural drought using multisensor remote sensing data for Tamil Nadu
- Assessing crop water sufficiency from multisensor remote sensing data

RPA 3: Building spatial database

Information on the status and condition of natural resources like, soil, water and vegetation is highly essential for planning agricultural activities. Due to the intense cultivation and competition from other uses of these resources the degradation of natural resources is accelerated. This decreases the potential of the resource base to support high agricultural production to meet the ever growing demand from increasing population. The Indian Land Use Policy note laid out the principles upon which the land use has to be planned. These include understanding the potentials and limitations of the land resources and devising optimum land use without affecting the environment. Farmers are also demanding detailed information about their land resource, especially soil and irrigation water. Though we have assembled voluminous data on soil resource, they are not in a format suitable for integration with other data or information in a decision making environment. The geospatial technologies have solutions for such issues and have great potential to provide data in the required format and perform spatial analysis to make informed decisions. This forms the pivotal point for structuring the research activities on the following themes.

- Building spatial database and developing online applications for addressing soil health related issues
- Cadastral level soil resource information system building and development of digital map
- Mapping soil fertility, biodiversity and monitoring crop nutrients

- Land degradation and industrial pollution mapping and monitoring
- Refining agro-ecological sub-zones in Tamil Nadu

Nano-Science and Technology

RPA 1: Development of nano-based agri-inputs for precision agriculture

Nanoscale agri-inputs are envisioned that would have the capability to detect and treat diseases, nutrient deficiencies or any other maladies in crops long before symptoms were visually exhibited. “Smart Delivery Systems” for agriculture can possess timely controlled, spatially targeted, self-regulated, remotely regulated, pre-programmed, or multi-functional characteristics to avoid biological barriers to successful targeting. Smart delivery systems can monitor the effects of delivery of nutrients or bioactive molecules or any pesticide molecules. This is widely used in health sciences wherein nanaoparticles are exploited to deliver required quantities of medicine to the place of need in human system.

- Synthesis and characterization of nano-based agri-input formulation using natural / biological nano-materials
- Study of nano-agri input formulations on soil characteristics, crop nutrition and use efficiency in plant system
- Differential expression studies with conventional and nano-forms of inputs
- Nanotoxicological studies and Biosafety of Nano-products

RPA 2: Fabrication of nano-packaging to extend the shelf-life of perishables

Despite India is the second largest producer of both fruits (81.3 million tonnes) and vegetables (161 million tonnes) next to China, the per capita availability fruits and vegetables together (demand 400 g; supply 265 g) is nearly 35-40% of its demand. Such a wide gap between demand and availability is attributed to the post harvest losses which accounts for 30-35% of the production with a huge economic drain of Rs. 200,000 Crores annually (PTI September 1, 2013) owing to the absence of adequate processing, packaging and preservation facilities. In order to address a challenging issue of post harvest management of perishables in India, several strategies are being adopted with marginal success at the farm gate due to the obvious reasons such as smaller farm holding, less access to cold storage besides poor infrastructure. Under these bundle of constraints, packaging industries started exploiting innovative technologies such as nanotechnology to prevent post harvest losses. It has been reported that more than 300 commercially available nano-packaging that being used across the globe and it is expected grow exponentially in the years to come. The Department of Nano Science & Technology has a major project to address the post-harvest losses using nanotechnological approaches

- Development of ready use nano-emulsion of hexanal to extend shelf-life of fruits in the orchards and storage
- Fabrication of nano-matrices using top down approaches to fortify bioactive (hexanal) compound into the packaging material
- Encapsulation of hexanal using biodegradable polymers integrated with nano-cellulose derived from banana pseudostem

RPA 3: Early detection of diseases and pests using diagnostic kits and biosensors

Protection of the soil health and the environment requires the rapid, sensitive detection of pollutants and pathogens with molecular precision. Soil fertility evaluation is being carried out for the past sixty years with the same set of protocols which may be obsolete for the current production systems and in the context of precision farming approaches. Accurate sensors are needed for *in situ* detection, as miniaturized portable devices, and as remote sensors, for the real-time monitoring of large areas in the field. Generally speaking, a sensor is a device built to detect a specific biological or chemical compound, usually producing a digital electronic signal upon detection. Sensors are now used for the identification of toxic chemical compounds at ultra low levels (ppm and ppb) in industrial products, chemical substances, water, air and soil samples, or in biological systems. Nanosensors is believed to be used to determine nutrient, moisture and physiological status of plants that assist in taking up appropriate and timely corrective measures. Nano-particles are mini laboratories have the potential to precisely monitor temporal and seasonal changes in the soil-plant system. Nanosensors detect the availability of nutrients and water precisely which is very much essential to achieve the mission of precision agriculture.

- Assaying of target molecules for detecting the diseases
- Immobilize or conjugate the target molecules in nano-particles and interact with analytes
- Development of gadgets for detection using immune-nanotechnologial approaches
- Validation of diagnostic kits for early detection of diseases, pests and nutrient

RPA 4: Nanotoxicological Studies and Biosafety of Nano-products

Current research into the risks presented by engineered nanomaterials is rather limited. However, it is sufficient to alert us to the fact that some engineered nanomaterials do indeed behave differently to their more conventional counterparts and may present new and unusual risks. Though the nano-agri inputs are yet to hit the farm lands, laboratory studies are being taken up to assess the impact of engineered nano-particles on the physiological processes in plants. As the saying goes 'little knowledge is very dangerous', this holds good with the current status of information related to nano-toxicity. History reveals that all science advancements overcame the fear psychosis. Hence, it is too primitive to speculate the issue of nanotoxicity. Instead, nanotoxicological studies may pave ways for a wide array of avenues and opportunities to explore and address all associated issues well before nano-based processes and products hit the farm land. The Center is intended to establish a "Biosafety and Nanotoxicity Studies and evolve "Biosafety Framework" to oversee the biosafety and toxicity issues. Nano Agiculture is emerging area of interest that is expected to achieve the food and nutritional security. While carrying out such extra-ordinary endeavours, care should be taken to find undesirable properties of nano-particles if any so as to make nano-science an enabling technology in plant sciences.

- Impact of synthesized nano particles of agricultural use on soil organisms at cellular and genome levels
- Assess the relationships between accumulation potential and properties of nanoparticles in soil microflora (Toxicokinetics of nanoparticles in soil organisms)
- Life cycle studies of nano particles in soil micro environment

- Influence of nanoparticles on human cell lines
- Development of Biosafety Frame work

Crop Protection

Agricultural Entomology

RPA 1: Insect taxonomy and biology of major crop pests

Management of insect-pests in agro-ecosystem cannot be undertaken without identifying the insects. The studies of insect taxonomy and biology have great use in quarantine. The success in biological control of insect-pests also depends upon the identification of their natural enemies. Thus research will be done in the following areas.

- Identification, morphological characterization and documentation of insect pests and natural enemies of important crops (with special reference to Lepidoptera, Noctuidae, Sphingidae, Hesperidae, Geometridae, Crambidae and Acarina, Tetranychidae and Phytoseidae)

RPA 2: Biological control of insect pests

Biological control deals with managing insects using their natural enemies. Natural enemies may be parasitoids or predators. Insect pathogens such as viruses, fungi and bacteria are also used in successful biological control of insects. Biological control is the foremost technique in eco-friendly insect management. The gaps in research with respect to biological control will be addressed by carrying out the following works.

- Quality control -referral laboratory for biocontrol agents.
- Biological control of major pests of field and horticultural crops.
- Developing NPV formulation for *Spodoptera litura* and *Helicoverpa armigera.*
- Identification and mass production techniques for predators, parasitoidsand insect pathogens.

RPA 3: Insecticide toxicology studies

Despite being considered has harmful to environment, pesticides still remain to be an important means of controlling insect pests infesting crops. Hence it is essential to device methods to use them with caution. The persistence of pesticides in environment and harvested produce have to be studied. Methods to decontaminate harvested produce before consumption are essential. Continuous monitoring of pesticide residues in the environment can help in decision making regarding their use. New molecules safer to environment and more toxic to insect pests are being developed and such products have to be tested for their bioefficacy and safety to environment. Thus the following areas will be concentrated upon

- Persistence and dissipation of pesticide residues and working out safe waiting periods / pre harvest intervals for recommended pesticides on major crops by supervised trials
- Impact of processing and decontamination methods on pesticide residues
- Monitoring of insecticide resistance, its mechanism and management strategies for major pests of field and storage

- Screening for efficacy of new molecules and monitoring of pesticide residues in agricultural and horticultural food commodities

RPA 4: Integrated pest management

The concept of integrated pest management came into existence to minimize the impact of harmful pesticides on environment. Judicious integration of various pest management tools can help in achieving satisfactory pest control and at the same time minimize the environmental impacts of such measures. Pest surveillance is the essential first step in a successful pest management programme. Many IPM packages have been developed for crop pests in the last three decades. It is essential to revalidate them to suit present day context. Plant products and kairomones are areas of interest to scientists which can provide effective management of pests in eco-friendly manner. Thus research will be taken up in the following areas.

- Forewarning and forecasting pest incidence and outbreaks under changing climatic conditions.
- Revalidating available IPM packages and developing strategies by incorporating proven IPM tools against key pests of major crops.
- Use of plant based products for eco-friendly pest control and plant defense chemicals in pest management.
- Identification and formulation of kairomone molecules for key pests and testing the field efficacy for pest management.
- Rodents, mite and other non-insect pests management in various crop ecosystems.

RPA 5: Plant-pest interaction and assessing host plant resistance to major crop pests

The first step in any effective pest management is through the use of pest resistant plant varieties. Developing a resistant variety through selection and breeding programme can minimize the money spent on costly inputs such as pesticides and other control measures. Thus it is essential to screen the available germplasm for resistance to major insect pests. Chemical ecology through research on intra and interspecific semiochemicals can help in effective pest control. Hence reeaerch will be conducted in the following areas.

- Chemical ecology of host plant and its influence on insect pests and natural enemies
- Identifying resistant donors for major pests of field crops and horticultural crops for breeding programme and studying the mechanism of resistance in host plants against insect pests

RPA 6: Storage pests and their control

Insect pests cause loss of stored food grains to the tune of about 10 percent in many crops. An effective programme to manage storage pests can help in saving grains produced by the hard work of farmers. There are various methods which are promising in management of storage pests. These methods will be studied with respect to storage pests occurring in Tamil Nadu. Use of pest monitoring and controlling gadgets, modified atmospheric storage is some areas of interest that can bring about effective control. Thus following areas will be concentrated

- Assessing the causes for post harvest losses by insect pests and their mitigation through developing new devices, controlled and modified atmospheric storage, identification of attractants and grain protectants.

RPA 7: Honey bees and their economic utilization

The role of wild and domesticated pollinators in yield increase of crops if documented will be useful for recommending suitable pollinator species for each ecosystem. Pest and diseases of honeybees is a major hurdle in beekeeping and pollination. Management of bee enemies is an important area of research. Colony management and queen rearing techniques are well studied in Italian bees (*Apis mellifera*) and relatively less studied in Indian bees (*A. cerana indica*). Thus research has to be strengthened in this area. Bee forage becomes a scarcity in a certain period of the year and developing artificial food substitutes for honey bees is a priority area. Thus research work will be carried out in following areas

- Intensive studies on honey bees and other pollinators for improving crop yield in major horticultural and field crops.
- Identifying alternate food resources for Indian bee *A. cerana indica* during dearth period.
- Developing strategy for general, pest and disease management to sustain beekeeping with *A. cerana indica* and *A. mellifera.*
- Perfecting queen rearing techniques in Indian bee.

Plant Pathology

RPA 1: Identification of sources of disease resistance in crops

Host plant resistance is the major component in the management of crop diseases. Use of disease resistant plants is the ideal method to manage plant diseases, if plants of satisfactory quality and adaptation to the growing region with adequate levels of durable resistance are available. The use of disease resistant plants eliminates the need for additional efforts to reduce losses due to diseases.

- Screening germplasm accessions of agricultural and horticultural crops for multiple disease resistance under natural and artificial epiphytotic conditions.
- Studying mechanisms of disease resistance in major crops and its utilization in disease management.

RPA 2: Biological control and integrated management strategies for major diseases affecting agricultural and horticultural crops

Biological control of plant diseases is eco-friendly and is a potential component of integrated disease management. Several strains of *Pseudomonas fluorescens*, *Bacillus subtilis*, *Trichoderma viride* and *T. harzianum* have been used for biological control of several plant pathogens. The fluorescent pseudomonads have been widely used for control of diseases caused by soil-borne plant pathogens. Fluorescent pseudomonads are also known to survive and multiply in the phyllosphere after application and induce disease resistance against foliar pathogens. Hence several attempts have been made to control foliar diseases with foliar applications of fluorescent pseudomonads. The fluorescent pseudomonads stimulate plant growth by secreting auxins, gibberellins and cytokinins and by suppression of deleterious microorganisms. Biocontrol agents in the phylloplane are continuously subjected to rapid and extreme variations in moisture and temperature, exposure to ultraviolet radiation, and limited nutrient availability. Hence, the introduced antagonists lose their viability within a short duration and need to be reapplied frequently. Maintenance of threshold populations of the introduced biocontrol agents on the phylloplane has remained the focus of biocontrol research.

- Isolation and characterization of native biocontrol agents, assessment of their plant growth promoting activity and biocontrol potential against major pathogens in different hot spot locations
- Identification of biomolecules associated with the suppression of plant pathogens and development of bio-formulations of promising antagonists.
- Screening of new fungicide molecules, botanicals and defense activators against major crop diseases.
- Development of integrated management strategies for newly emerging diseases of agricultural and horticultural crops and high valued crops under protected cultivation.
- Development of management strategies for post harvest diseases.
- Development of disease forecasting models for major diseases.

RPA 3: Plant disease diagnosis

Plant diseases greatly reduce agricultural productivity, and new pathogens are continuing to emerge that create new disease problems requiring novel control measures. Accurate and timely diagnosis of plant diseases are extremely important so that appropriate controls can be implemented. Detection of pathogens and identification are important for preventing the spread of disease by seeds and other propagating materials and also to implement plant quarantine regulations. Attempts to breed new crop varieties with better yields need to start with disease-free plants. Early diagnosis enables to take decisions about how and when chemicals can be used most effectively. Traditional methods of detecting plant pathogens involve the interpretation of visible symptoms followed by microscopic observations and culturing of pathogens in the laboratory. It requires skill and expertise. Furthermore, culturing of plant pathogens take several days or weeks. However, the molecular- based diagnostic techniques are more rapid, sensitive and accurate than traditional methods. Diseases that are caused by microorganisms can be diagnosed by identifying a unique feature of the organism, such as its genetic material (DNA) or a protein. Immunoassays particularly the enzyme-linked immunosorbent assay (ELISA) and immunofluorescence assay (IFA) and PCR-based assay have been widely accepted as valid tools in the diagnosis of plant diseases and detection of pathogens. Antibody and DNA-based diagnostics are therefore being used to detect important fungal and bacterial pathogens.

- Development of antibodies against major pathogens and standardization of immunological methods for detection of pathogens in seeds and planting materials.
- Development of molecular methods for detection of important plant pathogens from seeds and planting materials and to trace quiescent infections of important postharvest pathogens.
- Development of biosensors for detection of pathogens and toxins.

RPA 4: Host-pathogen interactions and biotechnological interventions

Plant diseases are being controlled by agronomic practices that include crop rotation and use of agrochemicals and by breeding new varieties that contain new resistance conferring genes. The use of agrochemicals poses many dangers that include harmful effects on the ecosystem and an increase in the input cost of the farmers. Breeding of resistant crops is time consuming and has to be a continuous process as often new races of pathogens evolve and crops become susceptible. The most significant development in the area of varietal development for disease resistance is the use of the techniques of gene isolation and genetic transformation to develop transgenics resistant to diseases. Developments in genetic transformation technology have allowed the genetic modification of almost all important food crops like rice, wheat, maize, mustard, pulses and fruits. For bacteria and fungi, the majority of transgenic crops in trials express antimicrobial proteins. For viruses, RNA interference is increasingly being used.

- Unraveling the mechanism of recognition and transmission of plant viruses by specific vectors and using its to develop antiviral strategy.
- Investigating the interaction between pathogens and hosts gene products to elicit basic information on molecular mechanisms of pathogenicity.
- Analysis of diversity of pathogens and vectors in a geographical location to address epidemic problems.
- Development of genetically engineered crop plants with resistance to major pathogens

RPA 5: Development of innovative technologies and varieties for commercializing edible and medicinal mushrooms

Worldwide mushroom production technology has been emerging as million dollar industry with an annual production of about 30.24 million tonnes worth of USD 2,800 billion. India produces roughly 1,20,000 tonnes (3% of world production of mushrooms) every year. Obviously, mushroom production is the best biotechnology process for Integrated agro-waste management to uplift rural livelihood and to address protein malnutrition. Mushroom fungi are biodynamic network of knowledge and a new frontier of science fully packed with a wide array of nutraceutical, pharmaceutical and biopesticidal molecules. Any attempt to conserve fungi will have a greater stake hold in agriculture, horticulture and forestry eco-system. TNAU is the pioneer in mushroom research in India since 1940s.Over years TNAU has released several mushroom varieties and newer strains of oyster, milky, button and paddy straw mushrooms and innovative production systems. Commercial cultivation of milky mushroom and the variety APK2 has been introduced for the first time in the world from TNAU. As an outreach programme, mushroom production trainings are regularly organized at various Colleges, Research stations and KVKs of TNAU. It is a record making event that the Department of Plant Pathology, TNAU, Coimbatore offers regular One Day Mushroom Training Programme on a fixed date (5th of every month, if 5th is a holiday, the next working day) since 1988. So far 375 such programmes have been organized and more than 20,000 people have been trained. In addition, special entrepreneurship programmes, hands on training (five days duration) are also organized regularly for the benefit of farmers, farm women, SHG and youth. Through such programmes excellent impact on mushroom production technology has been created in India by TNAU.

- Conservation of macrobasidiomycetes of commercial importance and creation of a gene pool of tropical fleshy fungi.
- Introducing innovative production technologies and small scale automated mushroom production systems for edible and medicinal mushrooms.

Nematology

RPA1: Biosystematics of nematodes attacking major crops

Nematodes are considered one of the most difficult organisms to identify due to their microscopic size, morphological similarity, limited number of distinguishable taxonomic characters and overlapping morphometric measurements. The nematodes remain as excellent bio-indicators for environmental change as once they are present in a habitat and in proximity of hosts conducive to their development, they may rapidly multiply. Indigenous species that have remained in balance may emerge to pest status on agricultural crops with small changes to their habitat, either through changes in cropping practice (crop, cultivars, rotation cycle, *etc.*) or climate. Biosystematics of plant parasitic nematodes based on morphological, morphometric and molecular data will facilitate to identify the nematodes and understand their interactions with plant and other insects.

- Biosystematics and bio-ecology of key parasitic nematodes of major crops based on morphological and morphometric parameters.
- Phylogentic analysis at molecular level.
- Developing diagnostics for nematode identification

RPA 2: Integrated nematode management in agricultural and horticultural crops

Nematode management requires flexibility and must take into account species or races of nematodes, the availability of resistant or non-host plants, the cropping system and the cropping history, economics, and the climate. Integrated Nematode Management (INM) in crops is a sustainable approach for managing nematodes by combining biological, physical, and chemical tools in a way that minimizes economic, health, and environmental risks.

- Nematode management in introduced cut flowers, vegetables, poly houses and protected cultivation.
- Use of bio-inputs, botanicals, irrigation methods, cropping system approaches, highly susceptible weeds as trap crop for nematode management.
- Desiccation tolerance and influence of climatic changes in nematode behavior.
- Development of integrated nematode management measures for banana, potato, vegetables, crossandra, pulses, paddy and cotton.

Sericulture

RPA 1: Genetic diversity and silkworm breeding for enhanced silk production

The silkworm is the larva of the domesticated silkmoth. It is an economically important insect, being a primary producer of silk. Selective breeding in silkworm over years resulted in the commercial exploitation of silk production. The genetic diversity in silk moth has been exploited by adopting cross breeding to enhance the silk production. A better understanding on the genetics, breeding behavior and evolving breeding methodologies will pave ways for better exploitation of silk moth.

- Collection and conservation of silkmoth across the country and establishing the genetic diversity for silkmoth.

- Adopting selective breeding methods for enhanced silk production
- Understanding the quality parameters associated with silk fibre produced from the silkmoth.
- Evolving and evaluating suitable management practices for quality silk production.
- Integrated pest and disease management in silkmoth.
- Exploitation of serivaste by value addition.

RPA 2: Assessment of genetic diversity and mulberry breeding and managment

Mulberry (*Morus alba*) is the major feed for silkworm. Mulberry breeding over years played an important role in evolving several high yielding mulberry varieties to cater the need of the sericultural farmers.

- Collection and conservation of mulberry accessions and understanding the genetic diversity across the accessions
- Adopting suitable breeding methods for producing quality feed for silkmoth.
- Evolving suitable management practices for mulberry production
- Integrated pest and disease management practices in mulberry

2. Horticulture

Crop Improvement/Crop Management

Fruit crops

- Development and evaluation of varieties/hybrids and root stocks of fruit crops under specific agro climatic zones for yield and quality
- Breeding varieties with resistance to biotic and abiotic stresses
- Strengthened rootstock studies and standardizing innovative vegetative propagation methods for quality seedling production
- Integrated Nutrient and Water Management
- Standardization of ultra high density planting,
- Off season flower induction in manago
- Training systems for achieving higher productivity in grapes,
- Standardized pruning for sustainable productivity through effective canopy management
- Improved methodologies for enhancing the quality and shelf life
- *In vitro* mass multiplication of elite planting materials
- Optimizing production package for strawberry under plastic tunnel system
- Optimizing production package for kiwi fruit

Vegetable crops

- Breeding for high yield and quality by deploying classical tools
- Developing genotypes for pests and diseases especially in brinjal, chilli and bhendi
- Improving the quality of farm produce through breeding and biotechnological interventions
- Understanding the flowering and reproductive phenology and manipulation
- Developing photoinsensitive vegetables for all season's cultivation
- Standardizing the production systems under polyhouse
- Standardizing agro techniques for grafting in brinjal and tomato
- Standardizing the applications of growth regulators on bulbing efficiency and storage life in onion
- Developing precision farming strategies in identified crops

Floriculture and Landscaping

- Developing ideotypes for offseason flowering in jasmine
- Qualitative improvement in selected flower crops
- Strengthened loose flower / cut flower production programme
- Integrated nutrient, water and resource management
- standardizing production protocol for pot grown foliage plants
- Developing packaging and storage techniques for domestic market in loose flowers

Spices and Plantation Crops

- Developing turmeric types with high yield and curcumin content
- Evolving spices suitable for intercropping in perennial crops
- Developing coconut hybrids / varieties suited for multipurpose including fibre
- Improving the quality and yield in coriander, curry leaf and tamarind
- Standardizing agro techniques including nutrient, water and canopy management

Medicinal and aromatic crops

- Breeding *Gloriosa* and *Salacia* for yield and alkaloid content
- Breeding *Ocimum sanctum* and Palmarosa for high herbage

3. Forestry

The country's forestry area is predominantly reserved or protected for conservation and hence the scope of exploitation and utilization is not possible in the existing natural forests resulting in massive import of both domestic and industrial wood. The National Forest Policy 1988 and the Agroforestry Policy 2014 directed and guided the stake holders for promotion of agroforestry in satisfying the country's demand by deploying improved genetic resources suitable for varied utility. However, such studies are very minimal and dismally modest. Agroforestry envisages development of suitable agroforestry systems for various agroclimatic zones of the state besides conducting design and diagnosis studies on the existing agroforestry practices.

The increasing productivity of trees in plantations can be achieved through intervention of better silvicultural practices with high yielding genetic material and various silvicultural farming with appropriate pest and disease management strategies. International Union for Forestry Research on special program (IUFRO) for developing countries has prioritized silviculture and management as a higher priority than other priority areas of forestry research. Considering the wealth of trees and sustaining their health, conservation of genetic resources vis-à-vis the forest tree dependent ecosystem, utilizing forest trees productively for timber and non timber purposes etc. research priority areas have been framed.

Improvement, utilization and conservation of forest genetic resources (IUC – FGR)

RPA 1: Management of Forest Genetic Resources

Forest Genetic Resources play a vital role in enhancing the tree cover and biodiversity in the country besides meeting the domestic and industrial wood requirement. Continuous exploration, collection and assemblage of Forest Genetic Resources coupled with database development and management will help in the breeding programme besides catering the needs of stake holder's requirement.

- Pre and Post Breeding evaluation and maintenance of germplasm
- Descriptor and database development and Registration / Protection of elite types
- Networking and exchange of germplasm under approved guidelines

RPA 2: Basic and Strategic Research in FGR

Tree breeding programme envisages thorough understanding on the reproductive biology, cytogenetics and the associated physiological basis. Strengthened research through application of learned principles for improving the wood for quality and quantity, enhanced resistance / tolerance of genotypes for biotic and abiotic stresses are the need of hour. Research attempts on tree crops in this area are modest and demands vibrant studies in these areas.

- Understanding Cytogenetics and Reproductive biology, Physiology for manipulating wood quality
- Deploying biotechnological tools for genetic stock improvement
- Breeding climate resilient genotypes for enhanced wood quality and quantity
- Improvement & conservation of RET species

RPA3: Enhanced supply of elite materials and institutionalizing Consortium.

The success of any afforestation and reforestation programme depends on the availability of quality seeds and seedlings. To cater this need, establishing seed orchards, seedling standards and technologies to ensure continuous supply of quality seeds and seedlings are most important. Besides, encouraging the participation of private entrepreneurs, NGGOs, SHGs, companies by forming a consortium for improving the forest cover through quality seedlings supply is a novel approach for achieving the excellence in forestry.

- Identifying seed production area and seed orchards and standardizing mass multiplication technologies for forestry trees.
- Forming consortium to provide a platform for dialogue between institute – farmer – companies in identifying the problems and arriving at solutions.

RPA 4: Dendro Biofuels

In India, more than 100 species of forest plants-Tree Borne Oil Seeds (TBOs) have been identified as a source of fatty oils with an estimated potential of 11.3 lakh tons. There are several TBOs like Simarouba, Neem, Karanja, Mahua, Jatropha etc. They can be grown and established in marginal and semi marginal lands under varied agro climatic conditions. Development of varieties, hybrids and clones in above trees besides their testing for fitting with the agroclimatic conditions is highly essential to improve the productivity. Apart from this, cellulosic based ethanol production may also meet the part of energy demand.

- Improvement and utilization of tree borne oil seeds for biodiesel
- Wood cellulosic biomass for ethanol production

Agroforestry for sustainable livelihood

RPA 1: Enhancement of productivity through agroforestry

Agroforestry caters to the twin needs of increasing the green cover of the country besides enhancing crop productivity. It is the only pragmatic alternative to meet the target of increasing forest cover to 33 % from the present level. Well designed agroforestry systems should satisfy three basic criteria: productivity, sustainability and adaptability besides contributing to the improvement of rural welfare through a variety of direct production roles as well as a through a wide range of indirect service roles with the land use system. Growing interest is being evidenced in different parts of the state in tree cultivation which is reflected in the expansion of area under “Trees Outside Forests”. This promising trend needs to be better utilized through agroforestry which would facilitate small and marginal farmers to adopt agroforestry practices suiting their socio economic conditions.

- Developing profitable agroforestry land use systems
- Understanding perennial – annual crop’s interaction for enhanced exploitation

Silviculture management

RPA 1: Silviculture’s Productivity enhancement and conservation

Silviculture management for higher productivity is one of the core subjects of research in forest science. To this end, scientific technologies should be generated to assess various issues of productivity including soil and nutrient management, plant protection and other tending operations. Besides, issues related to improving productivity of indigenous species and its sustainable development including poverty alleviation, resource utilization and income generation for local people must also be taken care of. The over and under utilization of trees resources need to be rationalized through incorporation of multi products and services in wood production process. Focused research and productivity augmentation on site specific scale need to be taken up.

- Developing tree farming strategies for wastelands in Tamil Nadu
- Assessing under utilised and over exploited trees in farm settings and designing a practical tree continuum
- Sivicultural promotion of endangered trees

Utilization of timber and non timber forest products (NTFPS)

RPA 1: Basic and Strategic Research (BSR) for Rationale Utilization of Wood and NTFPs

The basic and strategic research envisages on the fundamental aspects of collection of database on anatomical, physical and mechanical properties of lesser known and plantation grown timbers for their improved utilisation and value addition of wood and NTFPs. At present, the fundamental research pertaining to wood and NTFPs is too meager. Hence, this BSR is devised for the development and transfer of technology in wood properties for better and appropriate end uses for conservation of natural resources with the following themes.

- Xylarium and database management
- Dendrochronology of tropical timbers
- Wood chemistry and product development

RPA 2: Value Addition and Value chain management

The demand of the wood in India is 150 million m^3 against the supply of about 50 million m^3. Since the availability of primary timber species is insufficient, it is necessary to use lesser known timber species to bridge the demand supply gap. The conservation of natural forests through rationalized utilization of available wood resources by appropriate technological intervention besides the development of wood substitution from other natural / renewable fibres is the need of the hour to address the short fall. The research on production of sawn timber, manufacturing of plywood and other allied engineered and reconstituted wood are essential to increase the productive capability of wood.

In addition, NTFP sector is one of India's largest unorganized sectors having a dependent population of about 275 million and with a business turnover of more than Rs. 6,000.00 crores per annum. NTFP contributes to about 20-40 percent of the annual income of forest dwellers. Wealth of this sector needs to be preserved as first stance and to be enhanced.

- Reconstituted wood panels and composites development

- Characterizing wood of lesser known species for commercial utility
- Exploration, documentation , processing and value addition of NTFPs
- Developing Marketing Intelligence Systems through prospective socio economic analysis in NTFPs

Wildlife management

RPA 1: Habitat Management and understanding prey-predator relationship

Man-Animal conflict is now becoming a social menace owing to the faster urbanization and forest area reduction owing to several other reasons. In order to resolve and manage this problem, habitat analysis, habitat evaluation, corridor assessment and migration studies of wild animals have to be carried out. Studying the prey –predator relationship and the change in the behavior of animals and its population status are essential warranting research in this aspect.

- Habitat analysis and habitat evaluation
- Corridor assessment and migration studies of wild animals
- Management of man-animal conflict
- Ethology of herbivores and carnivores
- Population dynamics of herbivores and carnivores

4. Agricultural Engineering

Crop-wise mechanization

Major research achievements in agriculture engineering have been devising methodology and equipment for tillage, sowing, interculture, harvesting, threshing, soil resource conservation, on-farm water conservation and management, proper land-use, enhancement in cropping intensity. About 300 improved agricultural equipment/ technologies have been developed countrywide for various pre and post-harvest operations by human, animal, mechanical and electrical power. A total of 160 farm implements were developed and released for the betterment of farming community by TNAU alone. Modernization of rice, wheat, oil, and sugarcane milling industry had set in to some extent besides development of technology for value addition and for health and nutrition security. Research outcome indicates that increase in productivity up to 12-34 can be witnessed by adopting mechanization at appropriate point of time. Usage of seed-cum-fertilizer drill facilitates a saving in seeds (20 %), saving in fertilizer (15-20 %), enhancement in cropping intensity (5 – 22 %), increase in gross income (29-49%) of the farmers (Report of the Sub-Group on Agricultural Implements and Machinery for Formulation of 9th Five Year Plan, Govt. of India). Mechanization if attempted cropwise operationwise, it will result in an increased production.

RPA 1: Mechanization of special crops in Horticulture

Understanding the present level of mechanization in major horticultural crops in Tamil Nadu will help in devising the farm implements to suit various operations. In Horticultural crops, certain special operations like detopping of root crops like tapioca and turmeric requires special devises. For high value crops like ginger, tapioca and turmeric, planting systems have to be evolved besides attempting intercultivation.

- Development of turmeric rhizome planter
- Development of turmeric digger with plant detopping facility
- Optimization of plant/ row spacing of turmeric to suit field traffic.
- Development of systems and machinery for carrot cultivation.
- Development of systems for cutting and windrowing tapioca plant, prior to digging.
- Economical studies on vegetable crop yields when sown with drills and planters.
- Development of vegetable transplanters (semi/fully automatic)

RPA 2: Development of safe agricultural machinery

The main aim of farm mechanization is to reduce the number of labourers engaged for a field operation and the drudgery of work. The machineries developed for agricultural mechanization also needs labours to operate them. These machineries used for tillage, cultivation, inter cultivation, weeding, harvesting, transport have to be designed ergonomically fitting to the expectations with in built safety features. Most of the times, automated machines are preferred and they have to be user and gender friendly as well.

- Development of design protocol for optimal material substitution in prevailing agricultural machinery.
- Redesigning the existing machines for better human comfort and endurance of field operation.
- Incorporation of safety devices into farm tractors and machines to address the rising problem of agricultural accidents.
- Studies on safe equipments and accessories for the application of pesticide
- Studies on standards of machinery manufactured
- Addressing issues of compatibility of machines for all prime movers.

RPA 3: Mechanization of major oil seeds and pulses cultivation

Besides the wetland crops, garden land crops also requires mechanization from seed to seed. Studies are essentially required to improve the effectiveness of harvesting of oilseed and pulse crops over the present methods through mechanisation. Much impetus is to be given for executing efficient intercultural operations and harvesting in oilseeds and pulses. Evolving combine harvesters for defined crop dynamics and planting methods especially in oilseeds would definitely be a boon to oilseed farmers.

- Development of machines to combine the operation of groundnut digging and collecting.
- Reorientation of crop geometry of oil seed crops to suit development of more viable machines for inter cultivation, plant protection and harvest.
- Evolving methods and machines for inter cultivation of oil seed crops under ridges and furrows.
- Strategies for mechanization of oil seed crops under drip irrigation

RPA 4: Mechanization of hill area agriculture

Hill area agriculture is the one which need to be concentrated as it has both annual cole crops and perennial fruit crops being grown in undulating terrain. Hence it is imperative to understand the constraints in mechanization of hill area agricultural crops and ways for improving the efficiency of existing cultivation machineries in plantation crops. Similarly studies on improving the efficiency of planting machineries of root crops and solving the issues related to their harvest are of most important.

- Development of planters and diggers suitable for narrow terrace
- Development of portable power weeders suitable for narrow spacing
- Development and modifications of existing tea pluckers suitable for our conditions

RPA 5: Controlling of crop damage by animals and birds

Harvesting the matured produce without any damage is a herculean task of farmers. Many of the tuber crops, groundnut, coconut, rice are damaged by wild boar, elephant etc. and the crops like sunflower, maize are more prone to birds damage. Hence protecting the crop from animals, birds, and rodents is of paramount importance besides saving them from pest and diseases. Either solar powered or alternative powered warding off system would be a boon to the farmers.

- Studies on crop damage caused by animals and birds.
- Development of power operated animal and birds scarers.

Agricultural process engineering approaches to ensure food safety and security

Though country is producing surplus amount of food produce, majority of the times, losses are bound to happen during its transit from the production to storage to consumption point, during storage at various points and during processing for value addition. Wheat is processed for flour, refined flour, samilona, grits, and whole-wheat flour. There are 360000 wheat milling units consisting of burr mills. Roller flourmills process over 50 % of wheat production with a milling capacity of 8-10 million tones each. Modern rice mills process 65 per cent of paddy production and rest by huller / Sheller mills. The recovery of whole grains in a traditional rice mill using steel hullers for dehusking is around 52-54% whereas in modern rice mills - rubber roll shellers for dehusking operation is around 62-64% in raw and 66-68% in parboiled paddy. Dal (split pulse) milling is the 3rd largest processing industry in India after rice and wheat milling. Pulses meet 15-30% of protein requirement. Dal recovery potential is 83-85%, but at present, it is 68-70% in conventional mills and 72-78 % in modern dal mills. The mills are processing more than 10.5 million tonnes of dal..

India produces 126 Mt of fruits and 63 Mt vegetables. Almost all varieties of vegetables are grown in India (http://www.unapcaem.org/Activities%20Files/A09105thTC/PPT/in-doc.pdf). It is estimated that only 2% of the total produce is being processed in India. Fruits and vegetable processing industry is being promoted for minimization of post harvest losses.

Promoting rural agro-processing in a decentralized fashion for value addition of farm produce helps in better waste management, less transportation, and more employment in rural areas.

RPA 1: Reduction of post harvest losses

Reducing the post harvest losses would be as equal to that of producing the produce. Analysing the existing pattern of handling of farm produce, factors influencing post harvest losses will help in devising strategies for reducing the losses with improved storage techniques and packaging systems. On account of poor post harvest management, the losses in farm produce in India have been assessed to be of very high order. Various studies have estimated post production losses in food commodities to the tune of Rs. 75,000-1,00,000 crore per annum. (http://agricoop.nic.in/Farm%20 Mech.%20PDF/05024-06.pdf) It is also estimated that the extent of losses could be brought down to less than 50 per cent of the existing level on proper transfer and adoption of agro processing technology.

- To redesign handling and transportation practices of perishable commodities to minimize post harvest losses.
- Design & development of storage structures for improving the shelf life of agricultural commodities.
- Development of controlled and modified packaging systems for different agricultural commodities

RPA 2: Development of crop specific post harvest equipments

Besides harvesting the produce, proper processing, packaging and its storage plays an important role in its cost effective utilization. In this process, certain associated drudgeries like removal of seeds from tamarind, anola, dehusking in millets, threshing in vegetable crops need to be addressed.

- Design and development of millet dehusker.
- Development of onion seed thresher.
- Development of aonla seed remover.

RPA 3: Research on frontier areas of food process engineering and value addition

Agro processing could be defined as set of technoeconomic activities carried out for conservation and handling of agricultural produce and to make it usable as food, feed, fibre, fuel or industrial raw material. Hence, the scope of the agro-processing industry encompasses all operations from the stage of harvest till the material reaches the end users in the desired form, packaging, quantity, quality and price. Ancient Indian scriptures contain vivid account of the post harvest and processing practices for preservation and processing of agricultural produce for food and medicinal uses.

Agro-processing is now regarded as the sunrise sector of the Indian economy in view of its large potential for growth and likely socio economic impact specifically on employment and income generation. Some estimates suggest that in developed countries, up to 14 per cent of the total work force is engaged in agro-processing sector directly or indirectly. However, in India, only about 3 per cent of the work force finds employment in this sector revealing its underdeveloped state and vast untapped potential for employment. Properly developed, agro-processing sector can make India a major player at the global level for marketing and supply of processed food, feed and other processed products. Improvised methods of processing along with techniques to increase the bioavailability of nutrients will help in enhanced uptake and utilization.

- Design and development of continuous ohmic heating system for pasteurization of liquid egg white.
- Micro and nano encapsulation of spice oleoresins and bio-colourants.
- Non destructive quality evaluation of foods using e-nose, hyper spectral imaging, NIR techniques.
- Minimal processing of fruits and vegetables
- Process development for value addition of mushroom by retort packaging.
- Development of extruded products from minor millets

Sustainable development through renewable energy technologies

Agriculture is a major contributor to global warming through greenhouse gases (GHG) from activities such as deforestation, soil treatment and methane emissions from livestock. It is also one of the main users of fossil fuels in Western countries, thus also contributing further to GHG emissions. The cost of agricultural products is highly dependent on, and vulnerable to, fuel prices. It is therefore appropriate to assess alternative sources of energy for the future of agriculture. Necessary studies have to be undertaken to substitute the use of fossil fuels in farming with energy produced from renewable sources, such as wind, photovoltaics, hydroelectricity and biomass. Power from wind and photovoltaics has reached a level of efficiency that can compete with fossil fuels. Globally, agriculture currently consumes about 27.7 EJ (27.7 x 1018 joules) per year; of this, 8.2 EJ is provided by renewable energy. It is possible to provide about 30 EJ, using mainly photovoltaics and wind, the study suggests, and the land needed to expand these two renewable sources should be minimal (about 30,000 km2) compared to requirements of agriculture. (http://ec.europa.eu/environment/integration/research/newsalert/pdf/340na3_en.pdf).

Among various renewable sources of energy, biomass, which is produced right in the villages offers ample scope for its efficient use to carry out domestic operations, livestock raising and agro-processing activities through thermal and bio-conversion routes. During the last about two decades, fairly good number of renewable energy technologies have been developed and commercialized in the region for rural applications. It has been estimated that about 65-75 % of the total energy consumed in rural sector is for domestic activities such as a cooking and related operations, illumination, water lifting, cleaning, etc. Among domestic activities, cooking consumes around 70-80 % of the total energy consumption. Concentrating on the development of clean green energy would sustain the country on a long run

RPA 1: Harnessing of solar energy for energy sustainability

India is a country which is blessed with solar energy. However, its utilization is not upto the expectations as it can be. Planning of using solar energy to enhance the shelflife of agricultural produce, developing solar cells to meet out various operations in agriculture, enhancing the efficiency of solar drying and pumping systems, solar energy modules etc. will be of immense help in the years to come.

- Design and development of passive and active solar driers for drying agricultural produces.
- Design and development of solar-biomass hybrid drying system for continuous drying of agricultural products
- Enhancement of heat storage using phase change materials in solar thermal collectors
- Survey on the existing solar PV systems / gadgets for the performance improvement.
- Enhancing the efficiency of the existing SPV pumping system using solar tracking devices.
- Development of software protocol for design of solar dryers

RPA 2: Biomethanation of solid and liquid waste for energy production

Besides harnessing the energy from solar, wind and biomass, processing of solid and liquid wastes can yield substantial energy which can be productively used. This requires standardized technologies for recovering energy from the industrial washes, organic wastes, food wastes. In addition, it needs a simplified procedure for generation of biogas by designing suitable bioreactors. In this area, collaborative research with Israel had been thought of earlier to treat the sewage water available in the University premises and for using it for irrigation besides treating the sludge for using it as manure.

- Assessment of biogas potential of industry and institutional wastewater
- Development of a hybrid high rate reactor for paper-mill/fruit processing wastewater

- Development of high rate reactor for tannery industry /sewage wastewater
- Evolution of technology for upgrading of biogas into biomethane
- Engine performance studies using hybrid alternate fuels.
- Development of inoculum for start-up of biogas reactors
- Design and development of suitable scrubbing system for biogas produced from sago industrial wastewater

RPA 3: Thermochemical processes for energy production from biomass

Another area of energy production is the utilization of thermochemcial methods for generating energy from biomass. This process requires compacting the crop residues and utilizing them for energy production, effective technology for voluminous biomass utilization in engine applications, retrofitting the gasifiers for running diesel engines and attempting biochar production from biomass.

- Investigation on the performance of downdraft gasifier using various agro residues and briquettes as feedstocks
- Design and development of cleaning system for effective removal of tar and particulates from producer gas.
- Retrofitting of thermal gasifier with diesel engine
- Development of suitable reactor for production of biochar

RPA 4: Enhancing energy recovery through liquid biofuels

Renewable bioresources are available globally in the form of residual agricultural biomass and wastes, which can be transformed into liquid biofuels. However, the process of conversion, or chemical transformation could be very expensive and not worthwhile to use for an economical large scale commercial supply of biofuels. Hence, there is still need for much research to be done for developing an effective, economical and efficient conversion process Strengthened studies are required on first generation and second generation biofuels. There are significant technical hurdles still to clear to make production of lignocellulosic ethanol commercially competitive, but once these processes become economically viable, they could use waste products from agriculture and forestry, municipal waste, as well as new crops such as fast growing trees or grasses. Technological interventions are required to identify cost effective technologies for achieving continuous biofuel production and supply, zero – waste technologies for effective utilization of biomass, designing engines to suit different biofuels etc..

- Development of technologies for upstream processes for mass production of algae
- Biorefinary approach for generating energy and value added end products from biomass.
- Development of suitable reactors for energy production in the downstream processing of biomass/algae
- Performance evaluation and emission characteristics of duel fuel/ diesel engine with hybrid biofuels
- Process development for bioethanol production from lignocellulosic biomass
- Design and Development of bioreactor for butanol production from biomass

Land and water management engineering for maximizing the crop production

Soil and water are most precious commodity which cannot be increased in a shortest possible time. They are to be essentially conserved. . The interactions between soils, plants, and water are used in planning irrigation systems, tillage and cultivation practices, conservation buffers etc. Develop irrigation and drainage systems, methods to reduce and control erosion, methods to reduce and control pollution of streams, rivers and lakes, and developing biological systems as cleaning systems, such as biofilters to clean air or constructed wetlands to clean water are some of the technological interventions required to protect these precious commodities. Efficient water use on the farm can minimize the quantity of water used and the energy used to pump it. Research focus requires an insight into optimization of reservoir releases and aquifer withdrawals in canal delivery systems, optimizing delivery techniques, and stochastic modeling of temporally and spatially varying soil properties. Use of microirrigation is rapidly progressing in all parts of the country realizing the value of water. Focused research on pressurized irrigation with reference to hardware development and system designs for both agriculture and urban landscapes and articulated delivery will help in conserving the water..

RPA 1: Using soil less culture and nutrient film technique for protected cultivation.

Increasing pressure on land for urbanization leaves an option of vertical cultivation in a minimal area with maximized inputs. To supplement the reducing area, use of soilless culture and hydroponics are picking up. Having a better understanding on the soil- water- plant relationship of yester years will help in focusing research for a soil less culture, developing a nutrient film technique in crop cultivation and combining them for achieving greater productivity.

- Modelling plant- water relationship for soil less cultivation.
- Energy saving technologies for nutrient film technique.

RPA 2: Development of agro climate zone wise moisture conservation techniques for watersheds in dryland areas.

Attempting research on developing agro climatic zone wise moisture conservation techniques will certainly help in having a better utilization of available moisture as the annual rainfall received over the different climatic zones varies widely from about 700 mm to 2100 mm. Developing projects on watershed mapping based on priority to the agro climate zones, newer indexing calculations besides sediment yield index for prioritizing watersheds will be of importance in the present day context.

- Prioritizing the agro-climatic zones of Tamil Nadu based on watershed-priority index.
- Idendification of soil and moisture conservation technologies for watersheds of different agro-climatic zones based on various watershed-priority indices.

RPA 3: Climate change impact on land and water resources

Climate resilient agriculture is the talk of the day. Understanding the climatic parameters and its influence in the past, changes in hydrological parameters linked to land and water resources, accurate estimation of the impact of the changes in climate on land and water resources and developing indigenous models to assess the changes over the years in various crops and optimizing resource allocation accordingly will help in devising strategies for mitigating the negative effect of climate change on land and water resources.

- Identification of climate parameters affecting land and water resources.
- Modelling the effect of climate change on land and water resources

RPA 4: Reclamation of problem soils of coastal districts using drainage techniques

Another major area which warrants the attention of the scientists is the identification / isolation of problem soils and their management. In many of the areas, draining the water table beyond an extent creates problem in the soil by adding up salts. Studies are essentially required to understand whether presently available drainage techniques are suitable for our problem areas and the possibilities of using RS and GIS in identifying various problem areas and linking them with proper drainage techniques.

- Identifying the problem areas of coastal districts and suitable drainage techniques using RS and GIS.
- Preparation of drainage net work maps for problem areas of Tamil Nadu and identification of suitable reclamation measures.

RPA 5: Enhancing Fresh water Resourcing Potential of Coastal delta tree of Tamil Nadu

This priority area is for improving the availability of fresh water through scientific interventions and by making suitable alterations in the existing structures. Scientific procedures have to be framed to prevent the run off from various agro climatic zones during excessive rainfall.

- Standardizing technologies for harvesting maximum fresh water even from a poor quality aquifer
- Altering the recharge structures for efficient percolation and analysing the potential from ground water recharge

Planning for Optimum Agricultural Production in Tamil Nadu State - A Fuzzy Goal Programming Approach

Great progress realized over the last 20 years in agriculture is not only because of the global technical and technological improvement of the production process but also the management methods and the dimension of looking agriculture as a profitable enterprise. For agriculture, and especially for field crop production, biological character is characteristic induced exclusively by biological traits of the plants, i.e. their physiological functions which cannot be influenced by the man, or if they can the influence is very moderate. (http://ageconsearch.umn.edu/bitstream/91118/2/13_Mihajlo%20The%20use_Apstract.pdf). The prediction mathematical models equally contribute to the enhanced productivity by optimizing the application and utilization of resources. This University is a pioneer in the development and utilization of models for weather prediction and forecasting, market trends of agricultural and horticultural produce and its dissemination, domestic and export market intelligence related information, pest and disease forewarning, GIS based resource inventory and fine mapping of soil nutrients etc. Amalgamating the available information will help in optimizing the utilization of resources.

For optimizing agricultural production on a holistic perspective, uncertainties may exist in many factors (e.g., weather, temperature, marketing, resources available, soil chemistry, diseases, water, mechanical engineering, biology, economy, society, policy, and ecology) and may be presented as multiple formats (e.g., fuzzy sets, probabilities, and/or interval values) (Lien and Hardaker 2001; Itoh et al. 2003; Torkamani 2005). Such uncertainties can result in interactive and dynamic complexities in terms of agricultural resources allocation over multiple contexts and could affect the related optimization processes and the generated decision schemes. Therefore, uncertainties should be considered in developing agricultural production optimization strategies

RPA 1: To work out the resource use efficiency of different crops in Tamil Nadu state

For improved productivity, enhancing the resource use efficiency is more important which can be obtained having optimized utilization of available resources. This essentially requires planning for improving the resource use in different crops. This study envisages the selection of crops to be chosen for estimating the resource use and its productivity and developing mathematical models for estimating the resource use efficiency.

- Comparison of different mathematical models in estimating resource use efficiency.

RPA 2: To develop optimum farm plans for each district regional plan for the state in a multi-objective fuzzy environment for maximizing production and profit

Optimizing resource use at farm level / block level / district level / state level definitely requires collection of voluminous data and its processing. Undertaking this type of study essentially requires planning on the information to be collected from the grass root level to the state level and the various mathematical models available and their efficiency for improving the allocation and utilization of resources.

- Inventorizing the farms in Tamil Nadu state.
- Assessing the level of available resources at farm level / block level / district level / state level for leveraging the resources
- Planning for optimum agricultural production through different mathematical programming models
- To suggest different polices and strategies for improving the allocation of land and other resources

5. Social Sciences

Agricultural Economics

RPA 1: Economics of agricultural production and farm planning

Studies on the economics of agricultural production and farm planning include the economics of optimum use of inputs, technical and allocative efficiency in agricultural production, risk management in agriculture and farm planning. Regional crop planning is one of the recent research issues in this thematic area. A major scheme on cost of cultivation of principal crops is being undertaken with full financial support from the Government of India. Data on cost of cultivation of crops are collected for all major crops and these data are used by the Government of India for fixation of minimum support prices for important crops. Comparative economic analysis of farming systems, resource use efficiency in different cropping systems and impact of modern technology on farm income and efficiency are also studied.

- Analysis of resource use efficiency and cost price relationships for the mandate crops
- Preparation of optimum farm plans under different socio-economic environments
- Structural changes in cost-price relationships in the long-term and their implications for price policy.
- Comparative economic analysis of farming systems

RPA 2: Agricultural marketing and price analysis

The Department is taking up research projects on marketing and price analysis for agricultural commodities. In recent times, a number of studies are also being undertaken on value chain analysis for major agricultural commodities. Most agricultural commodities show wide variability in their production and price levels. The major cause of market risk is price volatility. Hence market advisory services through collection, communication, dissemination of market information has been taken up to determine what to produce, how much to produce and when to sell. Further, in recent times, consumption of processed food, health food and organic products has been increasing. Hence, consumer preference and consumption pattern of these products gain importance. Studies are undertaken on these emerging issues, with a focus on the following thematic areas.

- Analyzing consumer preference and willingness to pay for organic products
- Market advisory services through price forecasting
- An Economic Analysis of Post-Harvest Losses of Major Vegetables
- Preparation of commodity reports for major crops

RPA 3: Natural resource and environmental economics

The increasing resource scarcity both in terms of quantity and quality and the long term environmental sustainability of production is one major question facing the agricultural sector. Loss of biodiversity, pollution of land and water resources from urban domestic and industrial wastes, overuse of agro-chemicals in intensive agricultural areas, water-logging and salinization are emerging as major threats to sustain agricultural productivity in the long run. In addition to sustainability problems, concern has been expressed that intensive agriculture harms the environment more generally. In particular, the rapid increase in the use of pesticides is thought to (i) harm the biodiversity by eliminating the natural enemies of pests, (ii) adversely affect the health of farmworkers and others exposed to pesticides; and (iii) contaminate ground- and surface water, harming downstream users of that water and damaging inland fisheries. There are indications that resistance to pesticides is well established among several pests. Use of agro-chemicals can also result in health problems through pollution of drinking water by residues. Hence, this thematic area proposes to conduct research on following critical issues in the future.

- Economics analysis of total value of ecosystem services
- Land use changes and its implications for agricultural production and food and nutritional security.
- Multi-objective optimization models for canal irrigated areas
- Designing economic instruments for operationalizing payment for ecosystem services
- Environmental sustainability impact of organic farming

RPA 4: Agricultural finance and crop insurance

Agricultural finance and crop insurance play a critical role in sustaining farm economy in the emerging era of increasing requirement of capital for farm investments and frequent crops failures leading to financial losses to farm economy. Demand-supply gap in agricultural credit, factors affecting the demand for credit, impact of microcredit programmes on rural poor, issues in crop insurance programme are some of the key issues addressed by the research projects undertaken in this thematic area. Farm level investments and capital formation, designing appropriate crop insurance products for different categories of farmers, and determinants of demand for institutional credit are the focus areas in this theme.

- Economics analysis of issues in crop insurance programmes
- Role of institutional credit in capital formation in agriculture
- Determinants of farm-level investments and their impact on agricultural productivity, farm income and employment

RPA 5: Impact evaluation of development projects

To achieve the developmental objectives, the Government of Tamil Nadu has been implementing various developmental programmes. Successful development projects contribute to improvements in (i) agricultural productivity; (ii) employment opportunities, particularly for marginal and landless workers; (iii) transport systems, through better farm and access roads; (iv) women's participation; and (v) institutional capabilities. Successful development projects result in the growth of both on-farm and off-farm activities. As millions of rupees have been invested on all these programmes, it is essential that these programmes generate adequate positive impacts and benefits to the society. In this context, an evaluation of various developmental programmes in the state assumes critical which would inform the policy makers for better planning. Also, there is a need to have feedback about the performance of different development programmes being implemented in the state, which will provide key inputs for the planning.

- Evaluation of agricultural development programmes implemented under the food grain mission.
- Impact assessment of rural programmes sponsored by GOI / Govt. of Tamil Nadu
- Impact Assessment of bio-fortified cereals on health, nutrition and household economy
- Rural-urban migration and its implications for agricultural production
- Rural non-farm diversification and its implications for agriculture

RPA 6: Policy advocacy

The Department of Agricultural Economics has strong linkages with policy makers at the State Government. One Professor from this Department is on deputation to the State Planning Commission, Government of Tamil Nadu to act as a liaison officer between the policy makers in the State Government and our Department. Due to our continuous engagements with policy makers at the Government of Tamil Nadu, the State Government and the State Planning Commission have sponsored a number of policy-related research projects to our Department on various issues such as Land Use Planning, Identification of strategies to increase the productivity and incomes of small and marginal farmers, Economic evaluation of major development Programmes implemented by the Government for agricultural and rural development, Study on impact of poor monsoon on agricultural performance, Identification of potential commodities from different districts for promoting value addition and export, Evaluation of watershed development projects, Problems and prospects of organic farming in Tamil Nadu, etc. These linkages bear testimony to the policy relevance of the research programmes undertaken by this Department. The following research programmes will be taken up under this them.

- Providing policy support to Government of Tamil Nadu through State organizations like Department of Agriculture, State Planning Commission, Directorate of Economics and Statistics and TAWDEVA.
- Providing policy support to the Government of India through Commission for Agriculture Costs and Prices, Planning Commission of India, National Centre for Agricultural Policy.

Agricultural Extension and Rural Sociology

RPA 1: Monitoring of adoption and impact of technology

The farming community mainly engages the State Department of Agriculture and allied Departments in dissemination of agricultural technologies for adoption. Besides, the Departments also make several interventions in the interest of agricultural development. In this context, it is important to study the extent of adoption of the recommended technologies / interventions and to assess the impact created by them so as to enable the research and extension systems to take corrective measures. Though, adoption studies are currently being carried out, they suffer on scale and spatial dimensions. Regular large-scale surveys to assess the adoption and impact of recommended technologies / interventions will help to generate valuable information for fine-tuning the research agenda and extension strategies.

- Studies on diffusion and adoption levels of new varieties / hybrids introduced by TNAU on a continual basis.
- Assessment of adoption patterns of management technologies recommended by TNAU for major crops on a continual basis.

- Studies on adoption levels of farm machinery / implements introduced by TNAU on a continual basis.
- Assessment of adoption patterns of major interventions made by the State Department of Agriculture, TNAU among the farming community on a continual basis.
- To establish an Adoption and Impact Monitoring Cell (AIMC) in TNAU to monitor adoption levels of the innovations / interventions among farmers on a continual basis and the impact that they have created on the community.

RPA 2: Extension research on ICT in agriculture

There exists a research gap in the utilization pattern of Information and Communication Technologies (ICTs) by farmers who have access to them. Some of the ICT projects have shown the way forward and continue to grow, while many of them are floundering after few years of operation. However, the variety of ICT initiatives has added lots of lessons to take future course of action. The assessment of reasons for failure or success of ICT initiatives in agricultural extension, finding out the real information needs of stakeholders, and exploring ways and means of harnessing social media for agricultural development are necessary. Besides, the contents of ICT projects also need to be monitored and validated.

- To continuously study and validate the online contents of ICT projects and offer feedback.
- To organize periodic stakeholders meets' to study their needs, suggestions and feedback for updating, designing and developing ICT tools.
- To study the comparative effectiveness of ICT in Agriculture projects being implemented by the Government, NGOs and Private organization
- To explore the possibilities for harnessing new media tools for extension work.

RPA 3: Assessment of human resource potential for agricultural development

Human resource constitutes the most critical input than any other resource necessary for sustainable agricultural growth and development. However, the rural youth show reluctance in engaging in agriculture as their occupation, which requires careful analysis. The declining agricultural labour force poses serious threat to agriculture and this trend needs to be assessed in terms of skill, availability and usage so as to develop skilled labour force. At present, the strength of agricultural graduates and diploma holders is huge and their potential should be directed towards better performance in future. The functioning of the public extension system also needs to be analysed for its accountability to different sections of farmers for sustainable agricultural development.

- Analysis of shifting pattern of rural youth and developing strategies for their retention in agriculture
- Analysis of effectiveness of organizational structure of extension system in Tamil Nadu
- Assessment of existing labour force available for agriculture and studying their migration pattern.
- Assessment of career life of agricultural graduates
- To establish an advanced extension centre for manpower planning and research in agriculture

Agricultural and Rural Management

RPA 1: Management of agribusiness and entrepreneurship

Agribusiness organizations include all business firms and entities that produce and or sell agricultural products (raw and processed) and offer services. They include Farmers Producer Organizations, agriculture input retailers, processing firms, storage facilities etc. Efficient management of these firms not only improves their performance and profit but also provide better products and services to the customers. The managerial performance of these organizations with focus on strategy, operations, market orientation, financial management, customer relations, governance, social responsibility etc., would be analyzed. Research on these aspects would throw light on the strength and weaknesses of these organizations, identify policy initiatives, capacity building programmes and networking that would be required to improve the management of these organizations and performance.

- To analyze the performance of agribusiness industries and suggest strategies and polices for agribusiness development
- Conducting studies on agribusiness organizations such as Farmers Producer Organizations (FPOs) in Tamil Nadu to identify different models, their strategy, requirements and relevant policies for better performance
- To identify the knowledge and skills required for managing agribusiness firms and designing good managerial practices
- To examine entrepreneurial growth in agribusiness and suggest strategies for promoting entrepreneurship

RPA 2: Rural organizations for agriculture: Evaluating their effectiveness

Rural organizations are institutions such as panchayats, NGOs, etc., which serve the rural community. Rural organizations work for the development of the rural community. Rural institutions play a substantial role for rural empowerment. It is essential to study the impact of these institutions on rural development. Moreover the skills required for managing these institutions may vary from managing a commercial enterprise. Knowledge on the effectiveness of rural organizations may help the policy makers in designing rural development policies. Rural population is shrinking as there is migration to urban areas for want of employment opportunities. Hence strengthening the rural organization will enrich the rural areas and generate opportunities for rural livelihood. With this background the following objectives are framed.

- To analyze the organizational effectiveness of rural institutions like panchayats
- To identify the managerial skills needed to manage rural institutions
- To assess the impact of rural organizations on rural empowerment and development
- To create entrepreneurial opportunities for rural youth

RPA 3: Supply chain management and value chain analysis

Supply chain management assumes an important role when the products are perishable and have limited shelf life. In practice, the agricultural supply chains are highly fragmented resulting in poor economic returns to all the stakeholders besides high wastage that happen during the transit of the agricultural produce from the farm to the final consumers. The trend is slowly reversing with some of the food and agribusiness industries taking a leadership role to make the supply chains more viable and active. On the other hand, the farmers are getting more organized to realize the price, quality and volume advantages of supply chains. The industries are also interested in identifying the gaps in supply and value chains for designing suitable upgradation strategies to make the chains more efficient and to produce consumer centric products for specific markets in a cost effective manner. Support from institutions and the government is a requisite for understanding the gaps that exist in the supply and value chains and implement suitable policy mechanisms in order to bridge the gaps. In view of the discussion, the following areas are identified for focused research under the theme Supply Chain Management and Value Chain Analysis.

- Identification of critical supply chain and value chain issues in food and agribusiness
- Strengthening research initiatives in lean management and Value-Upgradation
- Establishing a lead centre of Agri-food supply chain management and building database
- Institutional Governance for value chain restructuring and upgrading

Trade and Intellectual Property

RPA 1: Competitive agro export and trade

The ability to face the challenges in the international trade depends on the extent of export competitiveness of the country. Export competitiveness would be greatly influenced by many internal factors like the economies of scale, product differentiation, upgradation of production technologies and so on. The economic viability of agro export units, identification of agricultural commodities grown in Tamil Nadu, which have high export potential, production of agricultural commodities with the required quality standards as specified by the importing countries, addressing the intellectual property issues that hinder the export of agricultural commodities, and assessing the technical and non technical trade barriers in the agro exports are to be focused upon.

- Exploring competitive export potential linked agricultural products
- Identifying of export potential agricultural products in Tamil Nadu
- Comparative and competitive assessment of export oriented agro export units
- Commodity specific grades development and address of IP issues
- Assessing the impact of technical, non technical barriers and trade barriers

6. Home Science

"Agriculture and food security" and "Home Science and health" are two of our key strategic priorities. Home Science is not just to deal about the home affairs and is field of science to exploit food security provided by the agricultural science from the field into nutritional security by providing safe and healthy food at home level. Understanding the interactions between foods, its nutritional content consumer preference and acceptance requires a multidisciplinary approach. In this multidisciplinary approach, the components such as human nutritional requirements, enhancing the nutritional content of foods and reformulation of foods should be prioritized to develop processes and products to enhance safety and health benefits to humans. The other priority areas under home science include family resource management and women empowerment.

RPA 1: Food and nutrition

Good nutrition is the foundation for human health and well-being, physical and cognitive development, and economic productivity. Nutritional status is a critical indicator of overall human and economic development, as well as an essential social benefit in its own right. To reach this goal, Indian Council of Medical Research has carried out several mutli-centre extramural research activities in different areas of food safety and nutrition.

- Establishing the constituents and nutritional values of produces of food crops.
- Assessing the bio-availability of micronutrients and other constituents
- Fixing the criteria of composition of foods, beverages and their ingredients Establishing the criteria for judging the quality of food composition
- Formulation of bio-fortified food for school kids

RPA2: Nutrition and human health

The food system begins and ends with health and nutrition. This depends on agriculture and the diversity of crops grown. Although much past research and debate have focused on the impact of agriculture on nutrition, it is important to recognize that there is a two-way causal relationship. Health and nutrition may also affect agriculture and food systems. Nutritional deficiencies in humans may result in chronic diseases deterioration of health.

- Exploring the role of food and nutrition to optimize health and reduce disease risk
- Studying dietary interactions with external and internal factors to modulate phenotypic responses that influence health in humans
- Studying the dietary patterns, individual nutrients, whole and processed foods and food structures to promoting and maintaining health
- Studying the behavioural responses and attitudes toward food, nutrition and health
- Identifying the contamination of food by pathogens, toxins or other harmful substances at any stage of the food-chain and how to reduce risks to human health

RPA 3: Family resource management

The concept of family resource management is designed based on the components *viz*. management, ergonomics, energy conservation, environment, product design, marketing, space designing and communication.

- Developing guidelines for different workstations and evaluating their usage.
- Evaluating energy conservation methods at family level
- Identifying suitable product making for profit making by rural women