INFORMATION TECHNOLOGY RESEARCH ACADEMY (ITRA)

(A Division of Media Lab Asia)

and

INDIAN COUNCIL OF AGRICULTURAL RESEARCH (ICAR)

Request for Proposals

in

IT BASED TRANSFORMATIONS IN INDIAN AGRICULTURE AND FOOD

(Focus Area 2014.ITX.2)

Version: 1.0

Any updates to this RFP will be posted at http://itra.medialabasia.in/?p=2189. The proposing teams are responsible for visiting this site for keeping current.
The teams may also post any queries and find answers at this site.

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Abbreviations

Sr. No	Abbreviation/ Terms	Definition
1	Ag&Food	Agriculture and Food (the terms *Agriculture and Food*, *Ag&Food,* and *Agriculture* will be used interchangeably, referring to *Agriculture and Food,* unless the context makes it clear otherwise.)
2	Translator	An organization or individual focused on transferring the results of the team's work to the field
3	IIs	ITRA Institutions –institutions of the research groups that form the teams
4	Pyralet	2-layered pyramid of research groups from different institutions
5	DP	Dual Pyralet: Two interacting pyralets, one formed by IT institutions and the other by Ag&Food institutions
6	EOI	Expression of Interest
7	Mentors	World class experts, including scientists, technologists, industrialists, as central players and an integral part of the team, who will mentor the rest of the team from the proposal stage through the actual activities including planning, publications, these supervision, general professional guidance, and outreach
8	ICAR	Indian Council of Agricultural Research.
9	IPs	Interacting Pyramids – A set of pyramids forming a team working together on different parts of the same problem
10	IT	Information and Communication Technologies and Electronics (ICTE)
11	IT-in-X	IT applied to solve problems in an application domain X
12	*ITRA-Ag&Food*	*IT Based Transformations in Indian Agriculture & Food* – the IT-in-X focus area targeted by this RFP
13	*ITRA-Mobile*	*Mobile Computing, Networking and Applications* - an IT focus area of ITRA
14	*ITRA-Water*	*IT based Innovations in Water Resources Sustainability* - an IT-in-X focus area of ITRA
15	KVKs	Krishi Vigyan Kendras
16	Lead PI	Principal Investigator of the Lead Institutions of a pyralet

17	LINP	Lead Institutions Pair – one from the IT pyralet and one from the Ag&Food pyralet
18	LIN	Lead Institution of a pyralet
19	PINP	Partner Institutes Pair – the pair of closely interacting partner institutions, one from the IT pyralet and one from the Ag&Food pyralet
20	PIN	Partner Institution
21	PI	Principal Investigator – lead of the group from one institution in the pyralet
22	RFP	Request for Proposals
23	SFM	Strategy Formulation Meeting

Executive Summary

Information Technology Research Academy (ITRA) is a National Programme aimed at building a national resource for advancing the quality and quantity of R&D in Information and Communications Technologies and Electronics (IT) and its applications at a steadily growing number of academic and research institutions, while strengthening academic culture of IT based problem solving and societal development. ITRA is currently operating as a Division of Media Lab Asia, a Section-25 not-for-profit organization of Department of Electronics and Information Technology, Govt. of India.

Focus Areas with societal relevance are chosen for nurturing research and to begin the pursuit of a selected focus area, Strategy Formulation Meetings (SFM) are held to identify and discuss different aspects of the area. Well known researchers and applications experts in the focus area, from India and abroad, are invited to the meeting. Subsequently collaborative projects are taken up in the selected focus areas. ITRA uses a pyramid model of increasing the number of partner institutions. Each institution learns from its LIN located at the next higher level, while it simultaneously helps improve the quality of its own PIN at the level immediately below.

ITRA has initially taken up two focus areas, viz., "Mobile Computing, Networking and Applications (*ITRA-Mobile*)" and "IT based Innovations in Water Resources Sustainability (*ITRA-Water*)". In *ITRA-Mobile*, 9 team projects consisting of 33 institutions have been initiated. Similarly, in *ITRA-Water*, 5 team projects consisting of 20 institutions have been initiated so far. The anticipated number of PhD students in the system for these two focus areas after 3 years will be around 200.

In partnership with ICAR, ITRA conducted a SFM in Delhi in March 2013 to develop a roadmap for its new focus area "IT based Transformations in Indian Agriculture and Food (*ITRA-Ag&Food*)". SFM identified the following five topics as presenting the major challenges: crop production; soil, water and weather; agriculture education and extension; marketing and agribusiness; and livestock and fisheries. For the detailed SFM report, please see http://itra.medialabasia.in/?p=1104 To address the challenges mentioned in the report, ITRA seeks high quality proposals by teams of researchers from the disciplines of at least Ag&Food and IT.

A team may consist of researchers from academic and research institutions, including agriculture universities, ICAR research institutes, IT research institutes, or any institution connected with IT and/or agriculture, and with any other disciplines as/if needed; and field-level experts from extension agencies such as Krishi Vigyan Kendras, extension wings of agriculture universities, NGOs, trusts, state agriculture departments, and industries connected with IT and agriculture. The nodes of the pyramid (i.e. academic institutions or Government Supported Research Laboratories) called as ITRA Institutions (IIs), will closely collaborate with non-academic institutions, such as research labs, industry, Government organizations and NGOs, the latter typically adding or extending the capabilities of the IIs in translating their R&D into societal impact, e.g., through technology transfer to industry, startups, etc. Each team must include Mentors who have agreed to be involved in the project. An Mentor is a renowned expert from world class scientists, technologists, industrialists, etc., as central players and an integral part of the team, who will mentor the rest of the team from the proposal stage through the actual activities, including planning, publications, these supervision, and general professional guidance.

To maximize the likelihood of a match with ITRA expectations, a two-stage process will be used for teams to efficiently develop proposals. In the first stage, a brief Expression of Interest (EOI) statement will be submitted by the lead institution of a team. This will help ITRA arrive at a preliminary assessment of the proposed effort and provide any feedback that may help improve the chances of eventual acceptability of any full proposal that follows. Those teams with acceptable EOIs will be invited to submit a full proposal. ITRA may provide inputs about potentially useful

groupings among the selected teams. The second stage will be submission of a full proposal. The information required in the EOI will be a small part of the full proposal.

ITRA will proactively and continuously work with the IIs to identify the needs and opportunities for achieving greater efficiency. ITRA will arrange for the necessary resources and mechanisms and pyramid-wide access to them. Achievements by teams will be recognized through a variety of awards: starting from the quality of their proposals; to quality work done at the level of individuals, institutions and teams; at different stages during the work; with respect to all four ITRA quality metrics mentioned earlier.

ITRA plans to select about 5-10 multi-institution teams, at an average funding of about Rs. 1 Cr per institution for 3 years.

IT BASED TRANSFORMATIONS IN INDIAN AGRICULTURE AND FOOD

1. About ITRA

IT Research Academy (ITRA) is a National Programme initiated by Department of Electronics and Information Technology (DeitY), Ministry of Communications and Information Technology (MCIT), Government of India, to help build a national resource for advancing the quality and quantity of R&D in Information and Communications Technologies and Electronics (ICTE, or IT for short) and its applications, in IT and related institutions across India. ITRA is currently operating as a Division of Media Lab Asia (MLAsia), a Section-25 not-for-profit organization of DeitY.

The core areas of IT lie in various engineering disciplines, notably computer science and engineering, and electrical engineering, although applications may come from almost any discipline in, and importantly, beyond engineering. ITRA focuses on strengthening the nation's competitiveness by expanding the R&D base in IT, especially by leveraging the large IT education sector and IT users such as government, industry and other organizations. The enhanced IT R&D capacity created through ITRA will impact the overall ecosystem of Information Technology, to be reflected in the numbers of research groups and labs created, new research areas initiated, scale of PhD graduations, new curricula, innovative solutions to industrial and societal problems, strong linkages among R&D groups, etc.

The main objective of ITRA is to increase the national R&D capacity, both quantitatively and qualitatively. This will be accomplished by:

- Building R&D Groups
- Networking the Groups to solving a common problem through strong teamwork
- Building strong connections between the groups, and Industry and Society
- Facilitating mentoring by renowned experts from Industry, Academia, etc.
- Fostering international collaboration
- Attracting students to PhD
- Attracting new faculty to ITRA teams
- Producing high quality PhDs for Industry, R&D labs and Academic Institutions
- Enhancing societal problem solving skills
- Facilitating technology transfer
- Rewarding performance of students, faculty, and the rest of the teams

Details about ITRA can be seen at http://itra.medialabasia.in/.

2. About ICAR

Indian Council of Agricultural Research (ICAR) is an autonomous organization under the Department of Agricultural Research and Education, Ministry of Agriculture, Government of India. It is the apex body for coordinating, guiding, and managing research and education in agriculture including horticulture, fisheries, and animal sciences in the entire country. With 99 ICAR institutes and 53 agricultural universities spread across the country, ICAR is one of the largest national agricultural systems in the world. Details about ICAR can be seen at http://www.icar.org.in/.

3. IT based Transformations in Indian Agriculture and Food

ITRA seeks collaborative, multi-institutional, inter-disciplinary proposals on the use of IT to catapult the state of Agriculture & Food (Ag&Food) into a new orbit of productivity. In the sequel, the terms *Agriculture and Food*, *Ag&Food,* and *Agriculture* will be used interchangeably, referring to *Agriculture and Food,* unless the context makes it clear otherwise. IT here may be interpreted broadly as cyber-infrastructure that would help enable the desired paradigm shift in Ag&Food, by integrating into Ag&Food operations capabilities such as environment and location sensing, communication, data management, modeling, simulation and data mining. The work under this

initiative, primarily focused on inter-disciplinary R&D on current and emerging Ag&Food challenges with the necessary cross sector (e.g., among IT, Ag&Food, etc.) collaboration, will be expected to simultaneously impact educational and training modalities, demonstrate that Ag&Food are an important arena for advanced and creative IT activity with much societal returns and satisfaction, and enable a range of entrepreneurial and other outreach activities. Given that a significant fraction of the work in the Ag&Food field tends to have high degree of applicability in relatively short term, and given the scale of the field, the impact can be very significant, the proposals are expected to lay out clearly how the proposed work is going to integrate outreach activities to make a major field impact. The outreach activities include development of IT-driven Ag&Food systems designed by IT and Ag&Food experts, from government, academic, research, industrial, non-governmental and extension organizations. Another important outcome of the outreach part is economic and policy approaches conducive to the multifaceted, comprehensive and sustainable solutions targeted by the R&D work. Given two otherwise comparable proposals, the one that has a larger role for IT in it will be given preference.

The domain of Ag&Food is an old and established discipline, huge and diverse in scope. It is already being pursued in India at a commensurately large scale, in a structured manner, under the aegis of ICAR. ICAR's participation in ITRA activities in this focus area well serves the need for access to domain expertise.

In partnership with ICAR, ITRA conducted a Strategy Formulation Meeting (SFM) in Delhi to develop a roadmap for the ITRA-Ag&Food initiative. The SFM was conducted with participation of eminent researchers from IT institutions, ICAR institutes, agriculture institutions and other organizations concerned with IT and A&F. SFM identified the following five topics as presenting the major challenges: crop production; soil, water and weather; agriculture education and extension; marketing and agribusiness; and livestock and fisheries. The participants of the SFM breakout sessions were asked to identify, and rank problems/areas within a topic by the degree to which they covered the current Ag&Food challenges. Specifically, this was done by asking the session participants the following question: "Given a fixed supply of resources (human, facilities, financial,..), what percentage should be allocated to each of the (up to ten) problems you have identified?"

3.1. Summary of the SFM Report

A summary of the research problems/areas identified under each topic is provided below, in the order of decreasing priority, established first in the breakout sessions and subsequently reviewed by ICAR; each is phrased as a problem statement and what the objectives of the proposed work should be, or simply in terms of keywords that denote the area of desired activity. Note that these individual problems, etc., in general do not occur in isolation; they tend to occur in clusters. Solution to a large field problem may involve simultaneously addressing many of the individual ones. Examples of such larger problems, the kinds that are candidates for being the focus of the proposals being invited appear in the next subsection.

3.1.1. Crop Production

(1) Non-availability of adequate variety and quantities of seeds specifically suited to each of the many agro-climatic zones and crops across the country.
(2) Improving productivity of oilseed, pulses and millets. An integrated approach is required that combines genetic enhancement, resource management and protection.
(3) Realization of inherent crop yield potential, and prevention of losses from flood, drought, heat, salinity, climate variability, pathogens, pests, and diseases.
(4) Development of centralized data repositories.
(5) Dearth of expert systems, modeling, and forecasting for pests/diseases.
(6) Lack of innovative tools/gadgets for precision farming.
(7) Poor farm mechanization, automation technologies.

(8) Lack of innovative tools/gadgets for harvesting, grading, storage, etc.
(9) Poor food processing, quality and safety.
(10) Poor agro-information delivery mechanisms.
(11) Lack of integrated crop/climate/economic models for reducing yield gaps and realizing yield optimization.
(12) Absence of country wide soil maps (physical and chemical).
(13) Poor pest and disease surveillance.
Other Issues (not in priority order): (i) Crop improvement and yield enhancement. This includes prediction, identification and selection of better yielding cultivars. (ii) Acreage data for crops throughout India, to help understand crop requirements. (iii) Crop specific import/export data on seeds. (iv) Obtaining an isolated area for seed production. (v) Development of a database of growers. (vi) Dose response data for each of the nutrients used for each of the tested cultivars (whether released or unreleased) for all major crops, especially rice. (vii) Ranking of all tested cultivars/varieties by efficiency of nutrient use. (viii) Phenomics for nitrogen use efficiency in rice/other major cereals/crops. (ix) Crop yield modeling. (x) Variable rate technology. (xi) Approaches to reducing the high levels of drudgery involved in agricultural operations, shortage of agriculture labor and reluctance of youth to work in the farms, through eg., development of machinery specific to field and horticultural crops. (xii) Enhancing farm profitability. (xiv) Selection of Appropriate Crops/Cropping Systems, and Farming Systems. (xiii) Precision farming, by offering personalized advice as against general advice.

3.1.2. Soil, Water and Weather

(1) Water management.
(2) Soil nutrient management.
(3) Weather-based agriculture management.
(4) Climate change.
(5) Saline, sodic and acidic soil management.
(6) Water logging and drainage.
(7) Soil erosion and land degradation.
Other Issues (not in priority order): (i) Low organic carbon. (ii) Quantification of nutrient losses (especially, reactive nitrogen and phosphorus) from agricultural fields as pollutants in air, soil, and water. (iii) Quantification of recoverable nutrients from environment back to agriculture. (iv) Efficient watershed management. (v) Accurate climate/rainfall predictions at the village/taluqa level.

3.1.3. Agriculture, Education and Extension

(1) Multi-lingual content preparation and delivery.
(2) Coordination between research, extension and industry.
(3) Making the KVK mechanism IT-enabled to increase its effectiveness and reach a much larger group of farmers with current human resources.
(4) Lack of skills
(5) Lack of cross-trained professionals
(6) Domain specific IT tools & techniques
(7) Farm-specific advice on agronomy, fertilization, crop protection, price discovery, access to credit, seed varieties, etc., can be made easily available on mobile devices.
(8) R&D laboratory facilities.
Other Issues (not in priority order): (i) Making the right data available at the right time through the right channel. (ii) Ensure technology innovation and development is also usable by women. (iii) Develop common e-course material (unified syllabus) and protocol for its delivery across the country. (iv) Involvement of farmers in the research process, and development of best practices for the required two-way communication and getting students trained in this practice. (v) Development of content and practices to expose the rural youth to entrepreneurship. (vi) Inadequate exploitation of IT in agriculture, for example, developing IT aids to empower professionals and farmers, such as e-Kisan, requires training resources, materials, etc. in both IT and agriculture (vii) Lack of skilled

para-professionals for providing IT-enabled solutions to farmers. Offering diploma/certificate courses with custom curriculum. Development of skills to help elicit the needs of the farmers whom the solutions are meant to help. (vii) Inadequate capacity for distance learning, both in terms of reach and content. (viii) Lack of knowledge of optimum fertilization and plant protection. No advice available to a farmer for the specific crop growing in his field. No soil and leaf analysis data available in most cases. (ix) Development of pest and disease surveillance systems. (x) Weather-based agro-advisory service. (xi) Crop simulation models for climate change impact and natural resource management. (xii) New extension methods that better harness the power of IT (xii) Pest and disease management (xiii) Information management/integration (xiv) Networking of experts/institutes (xv) Lack of IT exposure to experts and farmers (xvi) Lack of availability of the right technical inputs, about production, protection, etc., at the right time.

3.1.4. Marketing and Agribusiness

(1) Easy Access to market to get the best price.
(2) Developing affordable equipment for quality assessment and preservation of produce.
(3) Cost of certification for traceability in accordance with Global GAP (Good Agriculture Practices
(4) Product (Crop) strategy.
(5) Development of Decision Support Systems
(6) Predicting the right price and right market for a commodity.
(7) Development of an agri-entrepreneurship aids such as databases, tools, etc.
(8) Reduction of the huge post-harvest losses.
Other Issues (not in priority order): (i) Systems possessing market intelligence that provide useful advice based on related data about, e.g., international crop status, stock levels, price-movement, etc.. (ii) Risk spreading through co-operatives and other forms of collectives. (iii) Lack of standards for many food imports. (iv) A risk management system for food imports clearance. (v) Imported food recall. (vi) Food imports profiling. (vii) Marketing of perishable agriculture products. (vii) High transaction costs. (viii) Post-harvest management. (ix) Lack of reliable and authentic baseline horticultural data. (x) Poor marketing infrastructure. (xi) Poor awareness about existing and emerging opportunities in domestic and export markets.

3.1.5. Livestock and Fisheries

(1) Efficient livestock farming systems.
(2) Information delivery and marketing.
(3) Automation of livestock, poultry and aquaculture.
(4) Integrated agri-animal-aqua farming systems.
(5) National livestock identification system
(5) Decision support system for livestock.
(6) Improving production and post-production quality.
(7) Animal identification and growth management.
(8) Capacity building of stakeholders.
(9) Management of livestock under climate and environmental variations.
Other Issues (not in priority order): (i) Inadequate capability for recording animal performance data, for use in health management and breed improvement through selective breeding. (ii) Shortage of feed and fodder resources to feed vast populations of livestock and enhance their productivity. (iii) Greenhouse gas emission from ruminants of India due to the feeding of poor quality roughage, i.e., lack of eco-friendly animal production systems. (iv) Lack of foolproof methods for animal identification resulting in poor record keeping, difficulty in the creation of a database of gene pool and disease onset patterns at the national level, problems in settlement of animal insurance, and similar other problems. (v) Animal management, precision dairy farming and performance recording systems. (vi) Animal disease surveillance system.

3.2. Examples of Problems to be Addressed by the Proposals

The problems/areas/topics listed above may not always be mutually exclusive, nor a problem/area may, by itself, constitute the complete scope of a proposal. Indeed, a typical real world challenge is a bundle of issues from multiple such problems/areas/topics. In choosing the focus of the proposal, prospective teams should give due consideration to the priorities in the problem-mix addressed by their plan. The degree of relevance to the SFM roadmap will receive a significant weight in decision making. Of course, if there are omissions or lapses in the SFM report, and a proposal involves such related issues, these may be pointed out in the proposal. Any focus, suitably justified as relevant, will be acceptable, whether or not it is included in or follows from the lists given above. Given that agriculture and food is a very practical area and one needing much help from IT, any chosen focus should be guided primarily by the feasibility of making a field impact, and realizing a significant fraction of it or a clear proof of it during the grant period itself.

An ideal proposal may have to address a mix of problems, and even disciplines. The proposed investigators will in general therefore not be limited to agriculture, engineering and IT disciplines, but may often have to suitably involve experts from other disciplines, such as various engineering disciplines, economics, biology, physical sciences, psychology, management, sociology, etc. Therefore, proposals by interdisciplinary teams are expected to be the norm. A balanced team, capable of making an impact is going to be an important yardstick in evaluating the proposals.

To make these ideas concrete, given below are examples of the types of proposal foci that are known to be very important today. Work on them would help meet some major challenges being faced in agriculture and food today. Viable solutions to them would provide a visibly large boost to the state of affairs in agriculture and food. As can be seen, many of these involve a mixture of problems/areas/topics listed in Sec.3.1, they are not mutually exclusive, and not all important ones are covered by these examples. Proposals on these example problems are the types being solicited through this RFP; all examples meet the relevance and major-impact criteria. However, since the list of examples is non-exhaustive, proposals on similar other problems, not covered here, would be considered provided the choices are well motivated and justified in the proposal.

The examples are divided into six categories, according to the nature of the technologies, etc., involved. These are presented in Sec. 3.2.1. – 3.2.6. below. They represent varying mix of problems/topics/areas listed in Sec. 3.1. Within each category, the examples are given in high to low order of perceived national priority today. As stated above, the priorities of the problems addressed by a proposal will be a significant criterion in accepting a proposal. For each example, those problems/topics/areas from Sec. 3.1 addressed by the example are indicated.

3.2.1. Imagery, GIS and Satellite based Systems

Research on imaging and satellite based systems is in its infancy. The examples of projects given below are concerned with the following topics/areas/issues listed in Sec: 3.1.5.(4); 3.1.1.(6); 3.1.1.(7); 3.1.1.(12); 3.1.1.(13); 3.1.2.(1); 3.1.2.(2); 3.1.2.(3); 3.1.2.(4); 3.1.2.(5); 3.1.2.(6); 3.1.2.(7); 3.1.1.(1); 3.1.1.(3).

(1) GIS Aided Soil, Air and Water Quality Database

There is serious need for a GIS aided, large scale (e.g., countrywide) data base of certain important characteristics of individual farms, e.g., soil, air and water quality. The database should be spatially hierarchical (should be able to provide data for regions of decreasing sizes) and dynamic (data should be updated as frequently as possible). Such a database will serve as a repository of "current" status as well as offer a historical profile for use by anyone at any time. The design parameters and maintenance of such a large database involves making many choices, which translate to the database's capabilities and limitations. Examples of parameters to be chosen include: specific database technology, data collection technology, range of spatial resolutions captured, storage capacity, update frequency, range of access rights, e.g., how much of the data is to be made available to public vs. private parties, and, of course, the available budget. What is needed is an adaptive database design that would be easy to customize by ordinary users to meet their specific needs, e.g., by choosing

values for the aforementioned parameters. The database would be initialized with what is already available with the various organizations, such as Soil Testing Labs, State and Central Agriculture Departments, ICAR Institutes, and Agriculture Universities. The contents of the database could then be continuously updated by the results generated by the various benchmarking efforts (e.g., described under "Benchmark Database of Terrain, Land Quality, and Physical and Chemical Properties of Soil" below).

(2) A Biodiversity Database from Image and Biological Information

To capture the biodiversity and changes in it over time requires continuous collection of relevant data, particularly images. The analysis of these images may yield more accurate, extensive and almost real time status of the biodiversity wealth of the country. This would require automated or at least machine-assisted computational tasks of identification, differentiation and classification. It would require close collaboration of computational and domain scientists such as biologists, image analysis experts, statisticians, mathematicians and database experts. An effort is needed to develop and deploy such a system at large scale. While the focus of the agriculture and food oriented system being sought here would be on the study of agro-biodiversity, namely on microbes, plants, animal, fish, etc., the system would be generalizable to have a broader scope, to apply to biodiversity in general. Such work will need a good amount of basic research but will immensely empower systematic efforts on maintaining and utilizing biodiversity, help enforce the rights of countries and communities to their biodiversity wealth, and help the breeders in taking decisions while making selections.

(3) Sensing Systems for Large Scale Farm Resource Management and Precision Farming

Effective management of farm resources and precision farming models for large commercial plant, animal and fish farms and communities of small farms is a challenge. The objective here is to develop the components required for an integrated ground based and satellite based management system, formed of a network of visual, geographic and other sensors integrated into a GIS. For example, in a large animal farm, the system can manage nutrition, disease diagnosis, artificial insemination and so on; and in marine fisheries, it could track fish populations, diseases and health status. For large holdings in the developed countries, advancements have been made in the field of precision farming but the challenge in India is the small size of the individual farms. There is need to build effective mechanisms to make the system community based, to serve a farm cluster instead of individual ones. Examples include real time systems for irrigation application, and image based pest and soil nutrition management. The latter, for example, could inform every farmer about the precise quantities of fertilizers and pesticides that need to be applied, or with further development, the system could make the actual applications.

(4) GIS Based Farm History Database at Panchayat Level

Knowledge of various characteristics of farms and fisheries in specific regions at panchayat level will be valuable for making decisions. A database of answers to questions such as the following will be highly valuable. What is the soil/water availability? What is the disease history? What has been the production trend? Such a database will help in developing technological support system, input service support system, insurance policies, etc., and will serve as a continuous benchmark for the quality of the systems and policies. The database may be initiated by populating it with historical data.

(5) Automatic System for Livestock Management

Identifying and tracking individual animals over time are important capabilities. Imaging and RFIDs based tracking systems are examples of technologies that may be of use here. The capabilities can be used for:

Tracking nomadic animal herds: Even today, a large number of animals are reared by semi nomadic people. These animal herds are in constant move in search of better pastures. Very little has been done towards improving the health and productivity of these animals, mainly because of lack of means for their identification and tracking. These animals are potential carriers of diseases. Animal movements into the country from across the porous borders are a huge threat in causing epidemics. Tracking

nomadic herds will help in not only improving the health of these animals but also in mitigating the problems arising from them.

Developing performance records: Similar identification and tracking technologies, and image based control systems can also be put to use for related other problems, those of recording and following the health, productivity, estrus, artificial insemination, and pregnancy of individual animals owned by rural households; handling (e.g., sorting, vaccinating, deworming), feeding, identification and management of diseased animals; and general management of large animals like cattle, pigs and poultry in organized large farms.

(6) Benchmark Database of Terrain, Land Quality, and Physical and Chemical Properties of Soil

Benchmark sites need to be developed that would provide data on terrain, land quality, and physical and chemical properties of soil in different agro-ecosystems of the country. The data would be periodically updated by a tracking system that would be an integral part of the facility. Data from such sites will help develop management strategies that adapt to the status of soil resources which varies over time and with location, due to changing climate and land use patterns. This is a difficult and long term goal but essential for developing a practical and sustainable natural resource management system for agriculture and food. Work towards this objective has been pursued but substantial more remains to be done, including that on micro level land use planning and keeping track of quality dynamics over time. It will require collaboration among agricultural domain experts, IT experts, sensor/imaging experts, farmers and rural educated youth. The main researchable issues at the initial level will be to relate the benchmarking parameters with various sensor/imaging parameters and to develop hierarchical, GIS dependent micro to macro level databases**.**

3.2.2. Robotics, Sensors, Interpretation and Use of Sensor Data

Almost every branch, activity in agriculture and food needs the support of robotics, sensing and interpretation of sensor data. Much needs to be done. Indeed, the whole edifice of future sustainable agricultural and food technologies, capable of dealing with climate change and population growth, will require robotics and sensors, automated understanding of sensor outputs, and their seamless integration into decision making and action. The examples of projects given below are concerned with the following topics/areas/issues listed in Sec.: 3.1.1.(13); 3.1.1.(7); 3.1.1.(5); 3.1.2.(5); 3.1.2.(2); 3.1.2.(7); 3.1.1.(8); 3.1.4.(2); 3.1.5.(3); 3.1.1.(1); 3.1.1.(3).

(1) Robotics for *In Situ* Soil, Air and Water Quality Analysis

Technologies are needed for easily collecting data on soil, air and water quality at farmer's level. The results will help meet the data collection need of generating the hierarchical database mentioned in Sec. 3.2.1. While the need for regular soil and water testing for application and management of inputs for individual farms is well realized today, the methods used to meet the need are largely manual and therefore time consuming and expensive; these methods cannot be expected to cover every plot in a reasonable time frame. Consequently a typical farmer cannot perform the testing at the desired frequency. If a fast, automated solution is developed, it would allow at least community based testing every year.

(2) Sensor Networks for Monitoring Air and Water Quality at Different Geographic Scales

Sensor networks need to be developed to automatically collect data on various agriculture and food related parameters like crop cover, disease and pest conditions, and soil and moisture conditions, from farm to national levels. The data will be available for continuous analysis by background computational processes, and the results could be used to perform feedback actions as needed on continuous basis. This would avoid oversights, delays, and inaccuracies that would usually accompany manual reactions to field conditions. Availability of such networks would put to use, and thus complement, the capabilities to collect field data, discussed in Sec. 3.2.2.(1) above, and to access these data, discussed in Sec. 3.2.1.(1).

(3) Sensor Systems for Diagnosis of Diseases

Methods are needed to detect the presence and extent of diseases in livestock, fish, field and plantation crops, in a timely manner, at the farm as well as epidemiological levels. This capability can then be integrated into a system for disease management. Further, such sensors can, for example, be used by a breeder to identify plants without diseases in a large segregated population, to select disease resistant ones. Such applications require both precision and speed. Specific sensors, sensor networks and data understanding algorithms for diagnosis will be required. Such systems will form a part of the network discussed in Sec. 3.2.2.(3).

(4) Sensor Systems for Managing Food Quality

Methods are needed to easily, and in as much as possible, remotely and noninvasively estimate the quality of agricultural and food products. Quality refers to everything that impacts on the product's nutritional value, safety, taste, flavor, and visual appeal. It also includes any adulteration or contamination such as sometimes encountered in milk, sugar, and pulses, as well as any traces of fertlizers, pesticides and the like in vegetables, etc.

(5) Robotics and Sensors for Management of Protected Cultivation Environments and Phenomics

Protected cultivated systems are assuming increasing importance for niche markets and for growing under difficult conditions. These systems include ways of systematically controlling the growing conditions. The better the control, and the more precise and timely the applications of inputs, the higher are the output quality and productivity and lower is the cost. Precise controls and applications need automation. Since they are not for subsistence and are primarily for profit, they should draw investment.

The field of Phonemics is devoted to studying the behavior of plant/animal phenotypes by varying environmental parameters using advanced automation methods at a level, speed, scale, accuracy and precision that is manually difficult or impossible to achieve. Many branches of biological research including biotechnology need this capability. The systems available now are extremely expensive. Only a few organizations in India can afford to import them. It is important to start developing them.

Much work is needed in this area. First, estimating the plant/animal parameters poses technological challenges. Sensing and imaging systems need to be developed that are capable of measuring the desired parameters. Physical parameters, which would be at the heart of a potential sensor, must reflect the changes of interest in the above parameters. Therefore, development of sensors is itself a research issue. Second, in collecting the sensor data, as well as in maintaining the plants/animals, there is need for developing novel manipulation systems. Finally, machine learning and related IT technologies are needed to elicit quantitative relationships between the plant/animal parameters and sensor data.

(6) Automated Handling of Agriculture and Food Products

IT aided automation for inspection, sorting, processing, or handling of animal or plant products including horticultural crops can improve in-harvest and post-harvest processing, distribution of products and scalability of the production. It can enhance consistency, uniformity, sanitation, speed, packaging, market value and economy of the products. For example, automation can help improve the reliability of: harvesting of adequately ripe fruits and free from infection, grading of these fruits, and packaging of only quality fruits. Dependable sensing systems and making required inferences from the sensor data are central to the success of automation, e.g., for: (i) Estimating important characteristics of food items, e.g., any microbial contamination, size, color, visual appeal, etc., and (ii) automatically classifying the items to match the needs of different user segments, including farmers, fishers, primary market, food processors, retailers and end users. Multidisciplinary research effort is required for almost any aspect of automation; biological, electronic, mechanical and so on to suit a wide range of farm, animal and fishery products in specific parts of the country.

(7) Nondestructive in Situ Sensing and Chemical Analysis of Plants and Plant Products

Many of the economic traits of plants such as chemical, biochemical and physiological properties, flavor, moisture and micronutrient contents are difficult to measure in live individual plants in a fast and non-destructive manner. This difficulty in identifying variations among plants and plant products proves to be a great handicap for breeders to make selections, for surveying and preserving biodiversity in nature, and for quality control and management of plant products like fruits, seed and plant parts (e.g., for medicinal plants). A combination of efforts of biologists, chemists, electronic expert, imaging specialists, etc. will be required to develop sensing systems which can recognize the chemical properties of large numbers of plants in the field without destroying them.

(8) Robotics Solutions Greenhouses and Nurseries

The products of greenhouses and nurseries serve niche markets. The facilities may belong to an individual small grower, to a large grower, or to a community of small growers. Activities in these facilities and those involving their products must be undertaken with due attention to timeliness, cost, specialization/suitability of manpower used, quality, and care in handling of plants and **products** during operations**.** Timeliness of the operations is of paramount importance for marketing. Complete or assistive automation of these operations is important for ensuring standards. Development of sensors and robotics is at the core of such automation. The sophistication, and therefore the technological details, of the automation required may be different for a large corporate growing system vs. for a system run by a group of small farmers.

3.2.3. Education, Extension and Information Delivery to Farmers

Taking technology to the farmer and empowering them with timely knowledge and information have been the weakest links in the efforts for accelerating the growth of Indian agriculture and food. Awareness of the fact that IT can immensely, effectively and reliably strengthen these links are not lacking among the technology providers, the governance system and policy makers. But success in the use of IT has remained confined to certain niches at best. Concerted efforts are required to generate demand and credibility among the farmers for IT and to provide need based IT. The examples of projects given below are concerned with the following topics/areas/issues listed in Sec.: 3.1.3.(3); 3.1.3.(7); 3.1.1.(10); 3.1.5.(2); 3.1.5.(8); 3.1.4.(7); 3.1.5.(4); 3.1.4.(1); 3.1.4.(6); 3.1.3.(1); 3.1.3.(8); 3.1.1.(1); 3.1.1.(3); 3.1.1.(2).

(1) Socio-Economic-Technological Analysis of an Agriculture and Food Practice

It is necessary to analyze the impact of various IT interventions in agriculture and food practices that have been made. It is desirable to have such studies done with scientific rigor. What is the best way of doing this impact analysis is in itself a research issue. This is in part because the nature of impact may be a complex interplay between socio-economic and IT effects, and their separation into tractably separate components for analysis is itself a challenge. The results of rigorous impact analyses will greatly help in designing effective policies, plans and execution strategies.

(2) Local Radio Broadcasting Systems

In a recent advice by the PM, an effective avenue to meet many common, region-specific needs for agriculture and food information may be through FM radio based broadcasting, used mainly in a dissemination (push) mode. Such a system would work well for providing local information regarding, e.g., price bulletins, weather information, handling of a particular pest approaching the region, vaccination drives, farmers' fairs, etc. The system could be developed and even run by a team based in a university, college or KVK, who will produce the broadcasts. This method may become one of the best sources of reliable local information.

(3) Socio-Technological Need and Service Model Analysis

Farmers' performance seriously depends on a range of available infrastructure, e.g., tools and services. Examples of tools include hardware, software, communication facilities such as broadband carriage way, and suitable power supply. Examples of services include governing structure, social facilitation (e.g., developing literacy), duly authenticated information needed by the farmers (and also the policy makers), along with mechanisms to access these services. The exact needs of a group of

farmers depend on a variety of factors: their region, specific challenges faced by them, presence of any enabling factors, and potential at different levels of stake holder, starting from the policy makers, to governance to the end users (farmers). What is needed is an analysis to determine exactly which combination of these factors and ways of addressing them will be most useful to a specific group of farmers in given agro-ecological and sociological situations. Availability of such analysis will greatly help in the formulation of policies and plans, from the highest, national level, down to the panchayat level, that would be most effective, e.g., in helping entrepreneurs develop a business model that meets the technology needs and is consistent with and augments the effectiveness of the policies.

(4) Effective Communication of IT Based Solutions to Farmers

Adoption of even potent IT solutions in agriculture and food cannot be assured if the farmers do not appreciate what is in it for them. Communication with farmers in general requires serious attention to factors that may be geographic, cultural, educational, linguistic, medium of communication (TV, etc.) related, etc. This need becomes particularly urgent when the communication is about a topic as esoteric as IT. What is needed is a guide for each region of interest that highlights the different locally relevant factors and time tested and accepted traditional communication methods, and how to take advantage of this knowledge to communicate effectively. Such a guide can then be used by various stake holders, such as IT content generators, service providers, technologists, government, opinion makers, policy makers, etc., to do their job better. To produce the guide would require collaboration with linguists, anthropologists, sociologists, etc.

(5) Social Media

A farmer-usable multimedia (e.g., text, sound, visual) system needs to be developed for information exchange among the rural level information providers, farmers and groups of farm-entrepreneurs. While the cost of this information system will be relatively small, the challenge will be capturing the content using text, sound, and visual information.

(6) Development of Alternative Power Solutions in Rural Settings for IT Devices and Access

Availability of electric power is a serious problem in rural areas. A farmer's life at home and the productivity of the agriculture and food sectors, both suffer as a result of unreliable power supply. Creative, practical solutions are needed to address this problem. Examples include power generation solutions based on solar energy, or even solutions that involve human labor, such as manually operated power generators, e.g., those requiring bicycle pedaling, walking, etc.

(7) Development of Devices and Software with Minimal Text Usage

Farmers may not find it easy to interact with an information system or a device using the usual keyboard and mouse, e.g., due to their level of literacy, or otherwise prefer the more natural means of communication, e.g., through speech, vision and touch. An interface that can seamlessly convert between text and speech is needed to make the power of computing and information-access easily available to farmers. In the long run, this may help develop a learning system in which minimal intervention of human intermediaries will be required. Initially, the capability of the system for automatic conversion between at least two languages will be required so that the farmer may converse in the local language while the system may use, e.g., English or Hindi. This type of effort would require a significant interdisciplinary collaboration among computer scientists, linguists, cognitive scientists, etc.

(8) A Multilingual Database of Indigenous Technological Knowledge

A wealth of indigenous knowledge exists about the best regional adaptations of agriculture and food materials and practices (e.g., seed types to suit local taste and climate), developed over centuries. Efforts have been made to develop systematic documentation and repositories of it. However, there are few actionable details to allow informed implementation and experimentation by farmers from other regions, speaking other languages. It would be useful to systematically collect such indigenous knowledge, and associate it with regions and other relevant agro ecological details so that farmers from similar agro ecological conditions can retrieve this knowledge and replicate/adapt it to their

environments. This would be particularly useful if a farmer can put the knowledge to use irrespective of the language s/he speaks.

(9) Cloud Computing Systems for Rural Use

The availability of computational resources on cloud has opened up an opportunity to raise the efficiency of rural agencies including farmers' groups and those engaged in grass root level information exchange on a day-to-day basis. The limited support such bodies have today involves acquiring and using computing and communication hardware and software which involves routine operational difficulties. A cloud computing source will obviate the local need for advanced hardware and software. In addition, it will help in centralizing a huge amount of information and knowledge base which will now be accessible to the entire clientele of farmers and other stakeholders. Low cost smart phones will vastly augment access and other processing based capabilities of farmers/farmer groups and institutions to avail of cloud information and services.

(10) Massive Open On-Line Courses (MOOCS) and Other Electronic Learning Systems

MOOCS have so far been confined mostly to the formal education sectors. It would be very useful to make available to farmers, farm entrepreneurs, para professionals and village level information and knowledge providers. The courses would need to be organized and classified by sub-areas, interlinked and layered according to a familiar knowledge taxonomy (with the layering providing, as an example, a coarse level overview in the highest layer and increasing amount of detail in the lower layers.) The courses can be revenue generating or free. The greatest advantage is that they will make the best education material available to the student at their convenience, at a very low cost or free, with reasonable interactions with the instructors and peers. Facilitation of peer interaction is one of the most significant advantages of such courses.

3.2.4. Agricultural Supply and Value Chain Management

Agriculture and Food supply and value chain, which starts with input suppliers and ends with the consumers' plates, is a complex but very ill defined system. The complexity starts with the fragmented distribution of the producers, plethora of commodities with a mind boggling range of characteristics. Any supply chain or value chain is completely dependent on information transmission across the chain. Understanding the existing systems and then developing business models for appropriate information transmission are essential for full commercialization. The examples of projects given below are concerned with the following topics/areas/issues listed in Sec.: 3.1.4.(6); 3.1.4.(1); 3.1.5.(2); 3.1.1.(9); 3.1.4.(3); 3.1.5.(6); 3.1.3.(2); 3.1.3.(6); 3.1.3.(7); 3.1.5.(8).

(1) Cell Phone Based Farmer Identification and Service Delivery

There are various government and other schemes that the farmers must work with on a day to day basis, to carry out their job. Some examples are delivery of financial services such as LPG, fertilizer subsidies, and benefits such as food subsidies. The quality of execution of the schemes will greatly improve if the authenticity of a farmer's identity and claim to an allocation could be verified through a communication s/he has received on cell phone, instead of using the normal paper based protocols. By associating a farmer with the type of soil in his field or the specifics of the animals he owns, identified by their own identity tag, it would be possible to provide financial help on the basis of a well characterized individual need, rather than a blanket aid designed to cater to a statistical norm. The subsidy money may be sent directly to farmer's bank, along with an appropriate communication to the farmer. The farmer may then claim what s/he is owed from the bank on production of the cell phone communication as a proof. Making the process secure will be an important requirement on technology. The farmer should also be able to transfer the money to someone else. Appropriate government/policy regulations to allow such processing are expected soon; therefore, development of the necessary technology at this stage is timely. At the onset of the new regulations, the technology would then be ready for implementation, including for adoption by the service providers if they choose to do so.

(2) Input Chain Management

Input chain includes components such as labor, bio-fertilizers, medicines, vaccination, insemination, weather, finance and machinery. Its management requires developing quick responses to opportunities, but particularly to unexpected adverse conditions; activate advisories and other responses across the supply chain management. For example, if a drought occurs, the advisories ask farmers to switch to a crop having shorter term till harvest, and to change plans for the next rabi-summer season. However, this impacts the types of supplies required, starting with the seeds for the new short duration crops. As another example, many necessities (bio-fertilizers, bio-pesticides, etc.) need to be delivered to the farmer close to the time of need since the time windows for using these commodities are short and storing them for any significant length of time poses a serious challenge to the farmers, as they tend to have limited resources. Supplying commodities with short keeping times in a highly distributed system poses a major problem. Under uncertainties, finance planning also becomes difficult. Therefore, development of information network models to guide the supply system is a very important problem.

(3) An Agriculture and Food Commodity Status and Market Information System

A system like this is needed as it would allow a farmer to decide how long to hold a crop, where to get the best price and what is next year's price projection so that s/he can decide on next year's crop composition. With the system, a business retailer will decide about storage and price; the exporter will decide his contract plans; the food processors and organized retailers will decide their supply chains; industry and the governance organs will decide on support policies concerning infrastructure, seed supply, subsidy, etc.; the policy makers will decide what should be the long and short term agri-policies, and export import decisions and relations with foreign governments and markets. This requires long term planning involving, IT experts, economists, agriculturists, statisticians, and commodity experts and so on.

(4) Traceability Technologies for Agriculture and Food Produce and Processed Products

When production and processing are scaled up to large volumes, and the supply chains become distributed and complex, there is a need for tracing a product that has reached a client at any point in the chain. Traceability makes it possible to assess whether the product meets all of the, often cryptic, quality mandates such as contamination with chemicals, likelihood of diseases and inclusion of genetically modified parts. Traceability also helps in finding out the causes of defects and enforcing standards like HACCP. Traceability is particularly important for export oriented and processing based agriculture and food products, and is indeed being used as an important criterion for acceptability by agriculture and food products importers.

(5) A National Fodder and Feed Information System

A critical element of maintaining livestock is to handle disruptions in supplies of fodder and feed, for example, caused by disasters such as droughts and floods. These disruptions may temporarily sever normal supplier-consumer linkages, resulting in scarcities in some locations while other locations may be overflowing with supplies, even burning them. Very little has been done so far to develop a nationwide fodder and feed network. An information and supply chain management system to record and dynamically update the availability and demand status across the country, to help connect suppliers with consumers and to help manage their transactions would be very valuable. A real time or near real time capability would help it retain its utility in the most demanding situations, namely, under disaster conditions. Even under normal conditions, such a system would help enhance fairness and equity in transactions.

3.2.5. Decision Support Systems and Models

The crux of any effective and efficient automated system for agriculture and food is a decision support system which in turn will be based on decision models. The information systems detailed in A to D above will feed into the decision support systems, formal or informal. The more these decision systems are formalized, the more will be the efficiency of these systems. Modeling various information inputs to decision making will be the first step. The examples of projects given below are

concerned with the following topics/areas/issues listed in Sec.: 3.1.1.(3); 3.1.1.(5); 3.1.4.(5); 3.1.2.(3); 3.1.1.(11); 3.1.2.(4); 3.1.5.(5); 3.1.4.(8); 3.1.2.(1); 3.1.2.(2); 3.1.2.(5).

(1) DSS for Increasing Productivity and Profit

DSS are needed for increasing productivity and profit of the agriculture and food production chain, from farm to consumer, at macro as well as micro levels. At the farm level, decision support is required for, e.g., when to apply water to a crop, when to apply pesticides, etc. A farmer or a producer group may need help with identifying the best marketing solution. On a larger scale, at the level of governance for example, decisions have to be taken about how to deliver supplies while accounting for time, place, mode of delivery, available storage facilities, electric supply, etc., which vary with local conditions. At the policy level, decision support may be required to, for example, formulate the best crop insurance policy according to the farming situation.

(2) Minimizing Post-Harvest Losses

Solutions are needed for minimizing all forms of losses incurred after harvesting till the harvested commodity reaches a consumer or a processor. Each commodity has its own types of losses, with the farming location and conditions adding their own variations. Solutions may have to address a range of factors, from estimation of the losses caused by farming practices, marketing, existing policies, to development of appropriate technologies, to deployment of solutions, and verification of and learning from their field effectiveness.

3.2.6. Some Knowledge and Data Bases of Immediate National Need

The examples of projects given below are concerned with the following topics/areas/issues listed in Sec.: 3.1.4.(7); 3.1.1.(4); 3.1.5.(5).

(1) A Scientific and Technological Knowledge Resource Base

As noted in the advice given by the PM July 29, 2014, as well as highlighted in the SFM, there is a vast amount of scientific and technological knowledge related to agriculture and food that has been generated over the last fifty years in the Agriculture and Food Research System. The generation continues. The knowledge is scattered across, e.g., theses, papers, Annual Reports, technical bulletins in universities, ICAR labs, etc. Some of these are in digital form. There is not even definitive knowledge of what all is there, leave aside having it in an organized form. What is needed is a well taxonomized, data and knowledge base, searchable by educated farmers and scientists. Questions that need to be answered are the likes of: how to acquire/accumulate this data? How to structure the huge amount of data? How to use the machine learning technology so replies generated over time may be retrieved and supplied to the user directly when the sane queries are encountered again? It is also important to convincingly explain away any apparent contradictions farmers might see in the information packets they receive, which would otherwise lead to loss of trust. How to identify queries appropriate for other, interlinked databases, transmit them to those database, and forward replies received to the user? How to handle the IPR issues that will be sure to arise? How to take advantage of the available expertise of professionals such as librarians and other related professionals? How to use crowd sourcing, which is an obviously efficient way of collecting the highly dispersed, required information?

(2) A Database of Progressive and Entrepreneurial Farmers

As per Prime minister's advice, there is a need to have information on farmers who are typically literate and well informed about the latest developments in agriculture and food issues. They tend to more readily accept risks and try new technologies. They are the best opinion makers and information disseminators of new technologies. They are a good resource for extension agencies and researchers to serve as two way communicators between the agencies and the larger farmer community. A running database of such progressive farmers will help in forming and sustaining strong links among the farmer, extension agencies and researchers. KVK's, possibly along with Panchayats, are in a good position to help build the database.

(3) Animal Genetic Resources Management

***Pedigree database of artificially inseminated animals*:** Nation-wide efforts are required for improving indigenous breeds of livestock, especially cattle and buffaloes. For this purpose, keeping nationwide data on pedigree of progeny of selected males will be an important component. In addition, maintaining a record of animals with desirable traits will be required. This will be an effort dealing with the creation of a database of pedigree, productivity, health, nutrition, as well as images of individual animals from which experts can differentiate among different breeds, etc.

***Databases and tracking systems for animal/fish breeds/species*:** It is a national concern that animal and fish breeds are getting eroded for various reasons including invasion of alien species (especially fish), deteriorating feed, food bases and commercialization. It is imperative that a dynamically updatable database be developed and made available to provide current status of these breeds and species. For any plan of productivity improvement, such a system will be of immense value. In addition it will help in bio diversity conservation.

4. Team Proposals

To address the above challenges, ITRA seeks high quality proposals by teams of researchers from the disciplines of at least Ag&Food and IT, for addressing problems in the Ag&Food areas listed in Sec. 2. ITRA invites proposals on novel, potentially transformative research to address multiplicity of interrelated technical challenges associated with the chosen problems. Collaboration is a major goal of this RFP, therefore the proposed problems and approaches should be team-oriented by nature. The teams may, for example, include an appropriate mix of intra- and inter-disciplinary activities; in one or multiple institutions; and involve outreach programs in, e.g., research, content development, technology transfer, education, extension, and entrepreneurship. Through mutual interactions, each II in a team may expect to benefit from the complementary strengths of team members, and thus to broaden and grow its expertise in different ways and to different degrees. This should enhance the team's collective productivity, core competence, and impact, and therefore lead to growth in its value, sustainability, preparedness and funding beyond the life of the project at hand. ITRA highly encourages the team to aim at becoming the team of choice for expertise in the chosen area. It is envisaged that Ag&Food related challenges will spur novel developments in IT and/or agriculture. These developments along with existing technologies will play a central role in supporting advances in sustainable Ag&Food solutions.

It is also understood that in any large team effort, interesting and challenging problems may often emerge that have narrower scope, and require effort by, e.g., only individual researchers. Work on such problems as a part of the team effort is welcome. The intent of the interdisciplinary nature of this RFP is only that a central and overarching objective of the proposals be collaborative work on solving a major relevant problem; attendant work on any narrower problems by the team members is a welcome side product.

A team may consist of researchers from academic and research institutions, including agriculture universities, ICAR research institutes, IT research institutes, or any institution connected with IT and/or agriculture, and with any other disciplines as/if needed; and field-level experts from extension agencies such as Krishi Vigyan Kendras, extension wings of agriculture universities, NGOs, trusts, state agriculture departments, and industries connected with IT and agriculture. It would also be useful to be aware of the type of activities already taking place under ITRA-Water and ITRA-Mobile since some of the ongoing projects therein might provide useful linkages for sharing experts or translators and increasing potential for sustained mutual learning, etc.

The details of the required team structure, eligibility criteria for applying, and roles and responsibilities of IIs are given in Annexure 4.

5. Possible Organizational Support from ITRA

ITRA will be available to work closely with the institutions as they explore the match of their strengths with this RFP, conceptualize and plan work, and later implement and evaluate their plans. Following are examples of stages where ITRA will be able to contribute to:

1. Formation of teams of IIs and collaborating other organizations. Identification of end user problems which when solved would lead to publications, and students working on those would earn higher degrees.
2. Identifying and connecting teams with mentors in relevant areas.
3. Attracting and hiring of faculty such as through organizing large scale faculty recruitment efforts, ITRA professorships, hiring into ITRA teams, and research initiation grants, arrangements for visits by and to mentors.
4. Identifying/connecting with eminent experts to join and mentor the teams, e.g., co-advise students, co-author papers, co-teach courses, etc.
5. Providing critiques of the work done by the teams for use as constructive feedback.
6. Recognizing performance through awards.
7. Providing support for entrepreneurial activities.
8. Establishing curricula, laboratories and other facilities in specific areas.
9. Identifying experts as Adjunct faculty, and help in organizing their long and short term visits, e.g., to offer short courses or regular courses, Co-advise students, etc.
10. Identifying and implementing ways of attracting students, particularly for advanced degrees, such as through ITRA fellowships, arrangements for students to visit eminent experts and be co-advised by them, travel support such as to conferences, support for entrepreneurial activities, and awards/fellowships recognizing their contributions.
11. Disseminating achievements of teams.
12. Transferring any technologies developed by the teams to end users through collaborating agencies.
13. Strengthening interactions among the team institutions, such as through regular intra-team meetings, common facilities or other resources, etc.
14. Devising general mechanisms for inter-institutional collaborations for advancement of curricula and research methodology, e.g., new or joint graduate degree programs.

Any reasonable requests for ITRA help, financial/organizational/other, **explicitly listed in this RFP or not**, which are well thought out and well integrated to form a convincing overall plan for enhancing II quality, will be welcome and enthusiastically evaluated by ITRA as a part of the proposal or otherwise.

6. Performance Evaluation and Recognition

ITRA and all Ag&Food teams will engage in the following periodic exercises to ensure healthy progress.

6.1 Quarterly Team Meet for Inter Team Interactions

PIs and Co-PIs of each team will meet every three months, to take stock of the progress and discuss the work that is to follow. After each of these meets, they will prepare a quarterly report, to be submitted by the PI to ITRA. The contents of the reports will be specified in a report template to be provided to the teams by ITRA.

6.2 Semi-Annual Focus Area Meet for ITRA Feedback

Along with the usual 2nd quarterly meet of the PIs and Co-PIs, there will also be a focus area meet aimed at providing feedback to the team. Each team, including PI, Co-PIs, PhD students and other researchers, will participate. A subset of the mentors along with other experts will provide their comments on the progress made and any suggestions to help enhance the quality of the planned subsequent work.

6.3 Annual ITRA Meet for Performance Evaluation, Recognition and Planning

This meet, coinciding with 4th quarter inter-team meets, will again be attended by the entire teams, including PI, Co-PIs, PhD students and other researchers, from all focus areas. The objective will be to evaluate each team's performance over the preceding year. Based on performance, a panel of mentors and experts will make decisions about whether in the following year a team, an II or an activity should be continued or modified, and accordingly, if any changes, e.g., updates in the budgets, proposed work, etc., are needed. The panel would also recognize students, subsets of IIs, entire teams, etc. for noteworthy performance with respect to the ITRA quality metrics and towards meeting various other ITRA objectives, by presenting various ITRA awards. Details are given in Annexure 3.

7. Proposal Development

To maximize the likelihood of a match of the proposal with ITRA expectations, a two-stage process will be used for teams to develop their proposals. In the first stage, a brief *Expression of Interest* (EOI) statement will be submitted by that lead PI of a team who is designated as the point of contact. This will help ITRA arrive at a preliminary assessment of the proposed effort, and select certain EOIs for further consideration. ITRA may provide feedback to these selected teams, to help improve the chances of their eventual acceptability of any full proposal they may develop. In addition to any comments regarding the content, the feedback may include suggestions about potentially useful groupings among teams, other changes in team structures, etc. The selected teams will be invited to submit a full proposal. If necessary, a meeting of some of the invited teams may be held to resolve any questions about the feedback and the desired changes. The second stage will be submission of a *full proposal*. The information required in the EOI (Section A) will be a small part of the full proposal (Section B).

Foresight Award: In providing the information required in all parts of the proposal (Sections A and B below), please be specific and, whenever possible, quantitative. Significant interaction among the team members during the development of EOI and full proposals by teams is normally needed to achieve the proposal quality that would be considered worthy of support. Teams are encouraged to work together to develop innovative approaches and present them well. Those proposals that are reviewed as having well presented, out-of-the-box, creative ideas will be given a top-up grant, beyond the grant amount they otherwise propose, as **Foresight Award (see Annexure 3 for details.)**

A. Expression of Interest

The EOI contains a compressed form of a part of the information required in the full proposal. EOI template is available for online completion and submission at the ITRA website. Relevant details can be found in Annexure 5. The EOI calls for the following information:

1. **Cover Page:** Information of Researchers and Institutions involved in the project
2. **Technical Description:** 3 page description of the proposed work.
3. **R&D Objectives:** 4-8 major R&D objectives of the proposed work
4. **Plans to Pursue Each R&D Objective:** Information about the pursuit of each R&D objective
5. **Impact of R&D on curriculum:** Information about how the R&D activity may benefit related curriculum
6. **Outreach:** Activities that may be planned to transfer the R&D results outside the research team, such as to industry, Government organizations and NGOs
7. **Mentors:** Information about renowned researchers, etc., proposed as Expert Advisers
8. **Budget and Budget Explanation:** Estimated expenses of the project, one budget per group/institution, along with a brief explanation of each line item
9. **References:** A list of bibliographic items cited in the proposal
10. **Any other information:** 1 Page
11. **CVs:** 2 pages per Lead PI/PI/Co-PI

B. Full Proposal

The full proposal should consist of the components listed below, in the format indicated. The entire proposal should be written using a font size of at least 11 points. At least 1 inch margin must be kept on all sides of each page. Further details of the submission procedure will be made available on the ITRA homepage.

1. Cover Page
2. Proposal Summary
3. Technical Description
4. Plan to Impact Related Curriculum
5. Outreach Plan
6. Statement of Tasks
7. Deliverables and Metrics
8. Intra-Team Collaboration and Management Plan
9. Organizational Assistance Sought from ITRA: References
10. Curriculum Vitae
11. Budget
12. Supplementary Material

8. Examples of Budget Categories

ITRA encourages teams to think of creative ways of pursuing the technical problems in the technical focus area of this RFP and other ITRA objectives. Indeed, ITRA will present the foresight award mentioned earlier to the teams submitting proposals that are judged by the reviewers to contain out-of-the-box approaches that promise a major impact. The proposed budget can include all related expenses even if such expenses are not explicitly mentioned in the RFP. All proposed budget items must be clearly, completely and succinctly justified.

Following is an illustrative list of budget line items for which support will be provided by ITRA:

1. Manpower Expenses: Salaries of project staff, Fellowships to PhD students, Internships to UG/PG students, and Honorariums for Mentors and Domain Experts.
2. Project Specific Specialized Labs/Facilities and Capital Equipment.
3. Activities concerning development and dissemination of R&D Motivated Curricula,
4. Outreach Activities,
5. Joint Activities of a LIN with PINs.
6. Special Programs to Attract Undergraduate and MS students to PhD.
7. National and International Travel.
8. Miscellaneous and Contingencies, and
9. Overheads

Note: For the *ITRA-Mobile* and *ITRA-Water* focus areas that are already operational, ITRA made a distinction between private and other institutions. ITRA did not provide any support for the Miscellaneous and Contingencies, and Overhead line items to private institutions. Changes in this policy of distinction are being discussed, and if approved, will be communicated before the full proposals are due.

9. Proposal Review Process

Submitted proposals will be reviewed by a diverse panel of eminent experts (with no conflicts) from academia, industry, research laboratories, Government and other organizations as needed. The evaluation criteria for selecting the winning teams will be based on the quality and quantity of:

1. Team and degree of teamwork
2. Proposed R&D
3. Impact of the R&D activity on curriculum and instruction
4. Outreach activities
5. Relevance and importance of the topic/application area
6. Plans for human resource development (PhD/MS/Postdocs)
7. Expected other societal impact

ITRA may make suggestions about some desired revisions to the proposal.

10. Timeline and Submission

Following are the dates for the various stages of this RFP:

RFP posted	*Nov 12, 2014*
Expression of Interest (EOI) deadline for **online submission**	*Jan 16, 2015*
Feedback on EOI to teams	*Feb 20, 2015*
Full Proposal (FP) deadline for **online submission**	*Apr 8, 2015*
Team presentations to Review Panel	*May 14-16, 2015*
Announcement of awards	*May 30, 2015*
Approximate projects start date	*June 15, 2015*

11. Further Information and Questions

Email your queries to itra.agfood@gmail.com

Annexure - 1

ITRA MODEL

IT Research Academy (ITRA) is a National Programme aimed at building a national resource for advancing the quality and quantity of R&D in Information and Communications Technologies and Electronics (IT) and its applications at a steadily growing number of academic and research institutions, while strengthening academic culture of IT based problem solving and societal development. While the research component of this RFP is targeted primarily at the institutions that grant PhD degrees, or are soon to start doing that, other institutions may also have roles to play. The core areas of IT lie in the various engineering disciplines that involve handling of information, notably computer science and engineering, and electrical engineering, although applications may come from almost any discipline in, and importantly, beyond engineering.

Quality is measured in terms of the following four parts: the R&D work itself, aimed at developing skills of problem formulation and solving, as reflected in commonly used metrics (publications, etc.); impact of the R&D on enhancing curriculum and instruction; programs for developing sensitivity to society, so the researchers tend towards routinely spotting societal problems and developing an urge for solving them as targets of their R&D work; and making an impact on society at large through entrepreneurial activity or other ways of transferring technologies and knowledge developed in the R&D work.

ITRA plans to enhance the quality of the ITRA institutions (to be referred to as IIs in the sequel) through R&D, by closely interacting teams of researchers and institutions that have expertise in specific IT research areas, or in the use of IT in other engineering and non-engineering domains. To realize effective interaction among increasing number of institutions, ITRA plans to network these existing institutions as a pyramid. All IIs will be academic institutions or Government Supported Research Laboratories. They will form the nodes of a pyramid. These IIs will closely collaborate with non-academic institutions, such as research labs, industry, Government organizations and NGOs, the latter typically adding or extending the capabilities of the IIs in translating their R&D into societal impact, e.g., through technology transfer to industry, startups, etc. As is well recognized, such translation of technical innovation into societal impact requires much more than the innovation itself. Thus, the participation of non-academic institutions is central to achieving the objectives of the Request For Proposal (RFP). However, this role will be played by them through collaboration with the IIs in the pyramid as the primary target of ITRA is enhancement of the quality of academic/research institutions. A critical other component of the ITRA teams will be the presence of world class scientists, technologists, industrialists, etc., as central players and an integral part of the team, who will mentor the rest of the team from the proposal stage through the actual activities, including planning, publications, these supervision, and general professional guidance.

Each problem P in the focus area identified as important (Sec. 3) will be addressed by a set of pyramids. The problems will be divided into sub problems, and work on each sub problem S will be undertaken by N (N being one or more) interacting pyramids IP(s). The value of N will depend on the size/requirements of S. A more ambitious S may call for a larger number of IPs. Each IP will begin with an initial set of research groups, led by a Lead Institution (LIN) at the root level, with the next level formed by Partner Institutions (PINs), forming a two-level pyramid, called a pyralet. A LIN will distribute and carry out the project work jointly with its PINs, in the process bringing up the quality of the PINs. At the end of a cycle of 1.5-2 years after becoming an II, each PIN will be required to add a layer of 2-3 new PINs of its own for whom it will act as LIN.

The pyramid will thus grow in chunks, each chunk being the new layer of PINs added at the bottom, thus expanding the pyramid. The expansion will be done as soon as a PIN is ready, typically every 1.5-2 year cycle. An II may appear in multiple pyramids, associated with different focus areas, represented by II's different research groups. Those IIs with a broader research program will indeed tend to appear in the ITRA pyramids more frequently.

An II will typically improve its quality in a focus area with help from its LIN, its parent node in the pyramid, while helping raise the quality of its own PINs, its children nodes in the layer below. It is therefore envisioned that the entire pyramid will rise in quality with time, while layers of new PINs are added at the bottom. The rate at which the PINs are added to the pyramid will itself grow directly with the number of institutions in the pyramid, i.e., the pyramid size will grow exponentially.

The focus areas will either be disciplines within IT itself, or aimed at applying IT to an important problem domain X, referred to as IT-in-X. ITRA will help initiate IPs for each S, by selecting a set of seed pyralets for each S, based on a single proposal jointly submitted by the team. The primary responsibility, accountability and rewards for the improvement in the quality of PINs in a pyralet will primarily flow through the PIN itself, its LIN and the mentors. However, collaboration within a team is preferred to be broader, to take advantage of the complementarities in the strengths of all IIs in the team. The teams will be established through initial grants. Future layers will be added during the same grant, through renewals of these grants or new grants.

ITRA will proactively and continuously work with the IIs to identify the needs and opportunities for achieving greater efficiency. ITRA will arrange for the necessary resources and mechanisms and pyramid-wide access to them.

Achievements by teams will be recognized through a variety of awards: starting from the quality of their proposals; to quality work done at the level of individuals, institutions and teams; at different stages during the work; with respect to all four ITRA quality metrics mentioned earlier. Details can be seen at Annexure 3 Note that one of the award is about the quality of the proposed work plan itself – a proposal selected for support may, in addition, be selected for Foresight award if it presents promising, relevant, out-of-the-box ideas.

The central roles of mentors may be complemented by involving other accomplished researchers and pertinent others as Adjunct Faculty as and when needs or opportunities arise. Details will be made available in due course on our website itra.medialabasia.in.

ITRA will itself act as a central repository of the major advances (results, solutions, technologies, etc.) made by ITRA teams over time. As ITRA covers more and more focus areas, it should be in a position to serve as a knowledge source and a think tank for IT, and IT-enabled problem solving in an increasing number of domains.

Annexure – 2

MECHANISMS TO SELECT AND INITIATE PROJECT ACTIVITIES IN A FOCUS AREA

Focus Areas with societal relevance are chosen for nurturing research with advice from Advisory Committee (AC) of ITRA. To begin the pursuit of a selected focus area, a Strategy Formulation Meeting (SFM) is held to identify and discuss different aspects of the area. Well known researchers and applications experts in the focus area, from India and abroad, are invited to the meeting. They are selected from the relevant government and nongovernment organizations, industry, etc., so as to represent the viewpoints of all stakeholder communities, including researchers, mentors, sponsors, developers, outreach groups, users, domain knowledge providers, etc. The SFM participants help formulate a comprehensive national research initiative in the area.

The SFM outcomes are used to prepare a Request for Proposals (RFP) to form ITRA teams working on the identified short-term, medium-term and long-term objectives. The RFP embodies ITRA's emphasis on team based work. All proposals are required to be submitted by teams. The team consists of academic institutions or government research labs (together referred to as ITRA institutions, or IIs) and other, collaborating organizations. Each team consists of:

(a) One or more pyralets (defined as: one lead II and, typically, two partner IIs), and
(b) Other collaborating organizations, if any, including research labs, industry, government organizations, NGOs, international organizations, etc., to complement the expertise of the IIs to form a well-rounded team that can help improve as many parts of the ITRA quality measure and to as large an extent as possible. These organizations act as translators of the pyralets.

To maximize the likelihood of a match with ITRA expectations, a two-stage process is used for teams to efficiently develop proposals. In the first stage, a brief Expression of Interest (EOI) statement is submitted by the lead institution of a team. This helps ITRA to arrive at a preliminary assessment of the proposed effort and provide any feedback that may help improve the chances of eventual acceptability of any full proposal that follows. Those teams with acceptable EOIs are invited to submit a full proposal. ITRA may provide inputs about potentially useful groupings among the selected teams. The second stage is submission of a full proposal. Submitted full proposals are reviewed and shortlisted by a diverse panel of eminent experts from academia, industry, research laboratories, Government and other organizations as needed. Subsequently, the shortlisted collaborative projects are taken up in the selected focus areas.

Annexure - 3

ITRA AWARDS

ITRA projects are fundamentally team oriented. Teamwork needs particularly strong attention in Indian academia and research institutions. The awards below are linked to the performance of the ITRA teams (including student researchers) with respect to the fundamental objectives of ITRA.

General Guidelines

1. All awards are planned to be given at the end of a year, based on the performance during the year, applicable to only the following, one year.
2. The awards will be given to either individual Students or to entire Teams of ITRA Institutions.
3. The awards are based on self-competition, i.e., making noteworthy leaps in capabilities, and not based on performing better than others. Whether an award is even given in a specific year would depend on whether anyone has made award worthy progress with respect to the award criteria.

The extent of progress is judged from quantitative measurements of performance with respect to the four ITRA metrics.

(1). STUDENT AWARDS

(i) PhD Research Awards
(ii) PhD Dissertation Awards

(i) PhD Research Awards

To help continuously enhance the quality of PhD research, ITRA will recognize good work done by PhD students annually.

The research performance of each student will be evaluated and assigned a performance grade at the end of each year, by a panel comprising mainly of technical experts.

Award worthy work will be assigned one of two levels – Exemplary and Outstanding. Awards will be given annually.

The award will consist of:
For Exemplary Performance: 2 L
For Outstanding Level: 1 L

(ii) PhD Dissertation Award

To recognize high quality of PhD thesis of students in ITRA teams, in which the individual contributions made in different parts have high coherence and integrative value.

PhD theses will be evaluated for quality and impact and those theses meeting a quality threshold will be given the award. This award will be given annually.

The award will consist of a citation and a gold plated medal.

(2). TEAM AWARDS GRANTS

Faculty leadership is central to the success of the ITRA projects. Team award grants are aimed at recognizing the leadership PIs, Co-PIs and other senior personnel and collaborative achievements made by entire teams.
There are four types of team awards:

(i) Foresight Award Grant
(ii) Team Achievement Award Grant
(iii) Partnership Award Grant
(iv) Interdisciplinary Collaboration Award Grant

Each award will be in the form of a grant to the team. The recipient team will submit a brief statement of work along with a budget for the award amount. The budget will be flexible in that it could be used for any category of expense, e.g., to attend a different type of conference, invite experts, hire extra students for possible new work, etc., as needed. Any use of the award grant money on large equipment or international travel by the researchers will be acceptable, but it will be subject to the pertinent ITRA policies (discussed below), and therefore, will require prior ITRA approval.

(i) Foresight Award Grant
To encourage potential ITRA teams to be ambitious and come up with bold new ideas as a part of planning for ITRA project activities, particularly for addressing India specific problems. Accordingly, ITRA project proposals will be recognized for innovative, out-of-the-box content.

The award will consist of a grant in the amount of Rs. 10 L

(ii) Team Achievement Award Grant
To recognize performance of an ITRA team with respect to each of the four ITRA quality metrics (Research, Impact on Curriculum, Societal Sensitivity Development and Outreach).

The award will be in three categories, each for award worthy performance with respect to the following groupings of ITRA performance metrics: (i) Research, (ii) Curricular Impact and (iii) Societal Sensitivity Development and Outreach (combined).

Award worthy work will be assigned one of two levels – Exemplary and Outstanding.

The award will consist of a grant, in the amount of:
For Exemplary Level: 20 L
For Outstanding Level: 10 L

(iii) Partnership Award Grant
To recognize a particularly important aspect of ITRA architecture – Partnering Institutions (PINs) in a pyralet advancing their quality with the help of their Lead Institution (LIN). It highlights the high level of importance ITRA associates with inter-institutional collaboration.

Award worthy work will be assigned one of two levels – Exemplary and Outstanding.

The award will consist of a grant, in the amount of:
For Exemplary level: 6 L (i.e., 3 L/institution)
For Outstanding level: 3L (i.e., 1.5 L/institution)

(iv) Interdisciplinary Collaboration Award Grant
To recognize cross-fertilization achievements between IT institutions and X (domain specific) institutions in a team, leading to major interdisciplinary advances in IT-in-X research projects.

The award will have 2 levels – Exemplary and Outstanding.

The award will consist of a grant, in the amount of:
For Exemplary level: 6 L (i.e., 3 L/institution)
For Outstanding level: 3L (i.e., 1.5 L/institution)

The information on this page may be updated from time to time. The latest version will be made available at http://itra.medialabasia.in/?p=2196

Annexure - 4

TEAM STRUCTURE

A valid team consists of interacting researchers from the disciplines of IT, and Agriculture and Food. The team must be structured in specific ways to facilitate the interdisciplinary and inter-institutional activities this focus area requires, as well as to make progress with respect to the different progress metrics. To form a valid team would normally require the following structures and participants.

1. Pyralet

A pyralet is an indivisible constituent unit of a team. A team must be assembled from one or more pyralets. The number of pyralets needed in a team will depend on the size and difficulty of the problem chosen. The structure of a pyralet is motivated by ITRA's central goal of expanding research activity into an increasing number of institutions. Accordingly, a pyralet must include a well-established research group as the LIN, and the 2-3 PINs in the next layer should be institutions that are "slightly behind" the LIN. PINs should have an ambition to grow a strong research and related programs. The gap between the accomplishments of the LIN and PINs must be just right: small enough for the PINs to feel that they can keep up and grow well working with the LIN, but not too large for this to be a difficult task. The LIN and the PINs should be enthusiastic about working as partners, and the larger is their mutual need for the interaction, the better. For example, an NIT group may, as a rule of thumb (but not necessarily) be a better match as a PIN group for a strong LIN group from an IIT, than another IIT group (even if the IIT is just beginning, as an IIT typically has more resources, motivation and other opportunities for getting established by itself). This pyralet structure may also provide other opportunities. For example, while growing their own research programs, the PINs may be simultaneously making more than their share of contributions to "non-research" aspects of the teamwork (technology transfer, entrepreneurship, field evaluation, etc.), thus complementing and benefitting the LIN and creating a win-win situation. How well do a team's pyralets meet the aforementioned characteristics in the above sense will be a weighty criterion during proposal evaluation.

Currently, the agriculture-focused institutions tend to have limited space allocated for serious IT in their academic/research programs, and the use of Ag&Food as an application domain by IT researchers is limited. Therefore, the number of researchers working at the intersection of IT and Ag&Food tends to be small. This situation leads to a need for another relationship that needs to be built into the team structure, namely, the IT and Ag&Food researchers need to form partnerships. This allows one of the partners to complement their own disciplinary knowledge with that of the other, extending the scope and reach of their individual activities, to find effective interdisciplinary solutions to real Ag&Food problems. This partnership parallels and coexists with the LIN-PINs partnerships. In either case, the PINs grow working with their LIN.

A structure for ITRA-Ag&Food project teams to realize the aforementioned two-way partnerships is depicted in Figure 1. This structure is required to be followed by all teams submitting proposals. According to this structure, a pair of IT institution and A&F institution should come together as lead institutes, forming a Lead Pair (LINP), resulting in two Lead PIs for the project (one each from the lead institutions in IT and A&F). The lead PI from the IT LIN is designated as the Coordinating Lead PI (CLPI). Each LINP institution has its own pyralet, one formed purely of IT institutions, and one purely of A&F institutions. Co-existent with this LIN-PIN structure are the IT-Ag&Food partnerships, pairing a LIN (PIN) in the IT pyralet with a correspondingly placed LIN (PIN) the Ag&Food pyralet. This gives rise to a Dual Pyralet (DP) – a bi-disciplinary analog of the simple pyralet. In addition, given the critical role to be played by the domain knowledge and the field relevance and transferability of the results, the team must have two additional parts. To provide the domain knowledge, each team must include a mentor institution having expertise specific to the project, e.g., an ICAR institute dedicated to the chosen domain. For help with field relevance, testing, and feasibility of the results, the team must include a source of such expertise, e.g., an extension institute. Thus, the types of organizations involved in the teams may include, but are not

limited to, academic institutions, research and development laboratories, industry, government laboratories, extension institutes, and non-governmental organizations (NGOs).

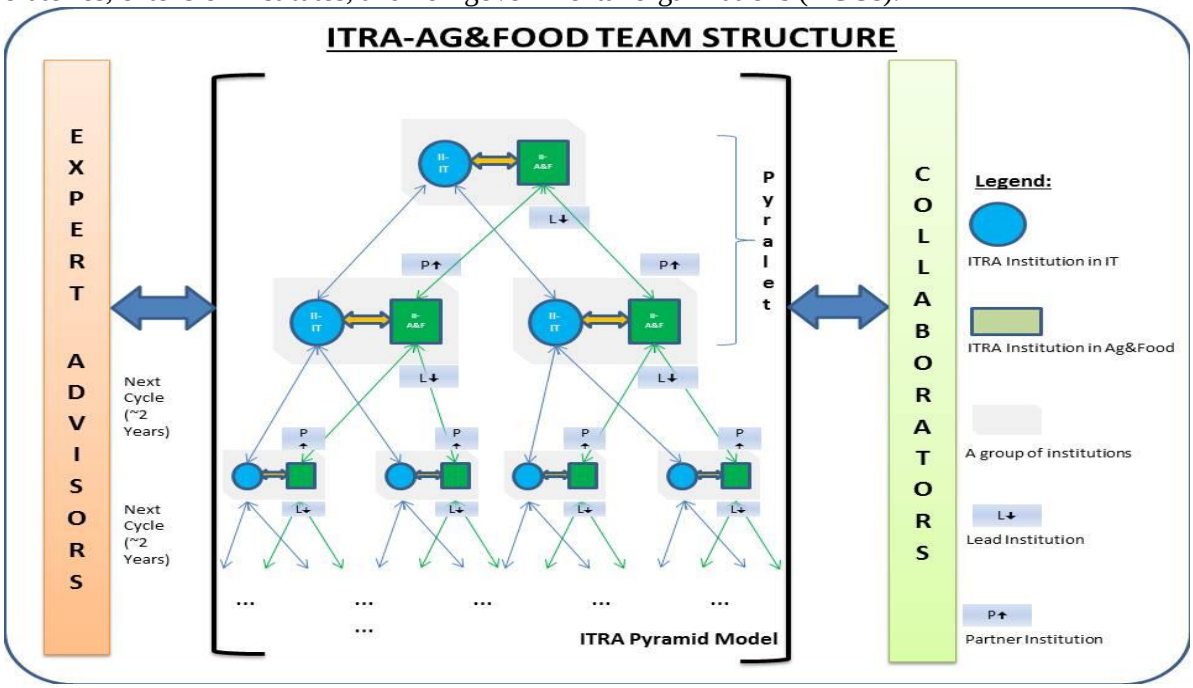

Figure 1. The Dual-Pyralet structure to facilitate the LIN-PIN and interdisciplinary R&D interactions among the multiple institutions forming an ITRA-Ag&Food team. There are two co-existing pyralets, one formed by IT institutions and the other by Ag&Food institutions. The vertical links among the pyralet institutions denote the LIN-PIN interactions in the usual mono-pyralet structure of ITRA. The horizontal links emphasize the interdisciplinary interactions that exist between the two, relatively different types of R&D institutional cultures. The role of ICPR institutes engaged in R&D activities in the areas relevant to a team's proposal is critical in appropriately steering the work of the team to domain and applicability relevance. The Krishi Vigyan Kendras (KVKs) fulfil their normal role of translating the R&D advances being made by the pyralets and the mentors working together into actual impact on the field and farmers. The successive growth cycles are as is usual in ITRA pyramids, expanding both coexisting pyralets exponentially every growth cycle of approximately 2 years. The proposed ecosystem brings together multiple types of institutions to collaborate. With time, there is growth in the interdisciplinary, IT and Ag&Food, activity of the institutions; the numbers of institutions with such activity; the extent to which they work with and benefit from the already existing ICAR institutes; and the impact they make in the field while working with the already existing KVKs.

2. Mentors

Each team must include mentor who have agreed to be involved in the project. A mentor is a renowned expert from an academic institution, ICAR institution, R&D lab, industry, government, NGO, within or outside India, who may help with: developing a good research culture by participating in R&D activities, being a co-PI, co-advising students, co-authoring papers, mentoring young faculty, attracting new faculty, co-teaching, identifying important technological developments at the II, entrepreneurial activities, assessment of societal potential of the work done, and refining and transferring a technology to realize its societal impact. The number of mentors should be chosen so that they possess expertise to cover the breadth of the team's proposed work and would thus vary with project. As a rough estimate, this number could be 1 or 2 members per pyralet in the team.The choice of mentors, their roles, and mechanisms for participation should be explained in the supplementary material section, which should also include letters of agreement from them. Since this RFP is designed to support only Indian institutions, any Co-PI level involvement (i.e., beyond other mentor activities) by foreign researchers may be indicated by listing them as Co-PIs, and reflecting the costs of their activities (travel, local expenses, honoraria, etc.) in the budget.

3. Translators

A major role for individual translators as well as translating organizations in the team is outreach programs. Individuals/groups within translating organizations, and the types and methods of the proposed outreach activities with them should be explained in the Supplementary Materials section which should also include letters of agreement from the organizations.

4. Team Size

While no specific minimum or maximum size constraints are imposed on the number of investigators or institutions involved, it is anticipated that a team will typically consist of 1-2 DPs (1-2 interacting pairs of traditional pyralets), i.e., 1-2 LINPs and 2-4 PINPs, thus consisting of a total of 3 to 6 II pairs, with the number of investigators in any specific II determined by the team to suit the work plan. The total number of selected teams will depend upon the number of acceptable proposals on the problem/area/topic themes identified in the SFM report, or otherwise.

The financial support from ITRA available to different IIs in a team towards the expenses of collaborating non-academic organizations, domain experts, etc., may vary. However, all joint work will be eligible for and expected to lead to joint authorship of publications and other scholarly results, and joint credit for pertinent other achievements.

5. Eligibility Criteria for Pyralet Institutions

1. Indian Academic Institutions, meeting the qualifications listed in the note "Institutional Qualifications" below, and not-for-profit government research institutions are eligible if they have PhD programs.
2. The institution may be a university with departments, or a college, or a teaching and research institutes, or a deemed university, etc.
3. A research institution that does not have teaching programs and PhD students may pair up with an academic institution, and the pair may act as a "single institution" for the purposes of responding to this RFP. They can choose a PI, Co-PIs and other researchers seamlessly from both institutions.
4. For example: All ICAR Institutes are eligible. Those institutes that do not enroll PhD students of their own may work with an Agriculture/Food institution with a PhD program, and together they may act as a single institution for the purpose of responding to this RFP. In this case, an ICAR institute scientist can even play the role of the PI from the "single institution."
5. The institutions should be interested in developing/strengthening their research capabilities in the area of IT in Agriculture and Food.
6. Premier institutions with proven research record in any Engineering/Technology streams, including IITs and IISc Bangalore, do not qualify as PINs.
7. Institutions applying as PINs should have a critical mass for conducting research in the proposed area.

Also See Sec. 10 Limitations on the Roles an Institution can Play in a Proposed Team

Note on Institutional Qualifications:

1. The minimum requirements for the institutions to be eligible is compliance with the "UGC's minimum standards and procedures for award of M.Phil/PhD Degree, Regulation, 2009 (ref. The Gazette of India July11, 2009, Part III, Ssec (4)) as amended from time to time." Accordingly, eligible institutions include:

1.1 All Central Universities, Institutions and Colleges, and Institutions of National importance are eligible

1.2 Institutions recognized by Academic Committee constituted for Visvesvaraya PhD Scheme by DeitY. State Universities, Deemed Universities and Institutions are also eligible subject to the following criteria:

1.2.1 "The Institute should have existing post graduate streams in areas relevant to IT in Agriculture and Food and should have enrolled PhDs in these areas during the last 3 years. The PhD student(s) should be admitted as per UGC admission norms.
1.2.2 The Institute should be recognized by AICTE and NBA (National Board of Accreditation) for its programmes relevant to IT in Agriculture and Food.

Or

The Institute should be accredited by NAAC (National Assessment and Accreditation Council of UGC)".

2. The rules under Item 1 above are under discussion and are likely to be approved in the near future; once approved, they will be communicated.

6. Project Duration and Financial Outlay

ITRA plans to select about 5-10 multi-institution teams, at an average funding of about Rs. 1 Cr per institution for 3 years.

7. Roles and Responsibilities of LIN in ITRA projects

The LIN(s) and PINs in a team will work together, each contributing to the proposed work in ways planned. Recall that in addition to enhancing its own quality, a LIN is expected to help PINS in activities that would improve the PIN quality too. The LIN may help formulate such activities, provide follow up advice, participate as much as needed, etc. Following are some illustrative examples of the responsibilities of the LINs, for various quality metrics:

1. R&D: LIN researchers advice appropriate PIN researchers as the latter execute their tasks PIN researchers co-publish with them and hold joint research meetings. LIN faculty advises students from PINs on their theses or other projects.
2. Curricular Impact: LIN faculty and students help design courses /transfer/adapt improve
3. Outreach: LIN researchers give seminars at PINs
4. Societal Sensitivity Development:

It is expected that both LIN(s) and PINs will benefit from this interaction in different ways. There are certain specific awards targeted at quality interactions among LINs and PINs.

8. Roles and Responsibilities of PIN in ITRA projects

1. The PIN researchers would be working closely with their LIN researchers to develop and strengthen their research capabilities in the areas of *ITRA-Ag&Food*. These linkages are represented by the vertical links in Fig. 1.
2. There will be additional links of close interaction, between IT and Ag&Food institutions. These will mark interdisciplinary interactions between two different types of R&D activities as well as institutional cultures. The two lead IIs in IT and Ag&Food will interact closely. Similarly, the proposal will specify for each PIN in the IT pyralet another PIN in the Ag&Food pyralet with which it would interact closely. The interdisciplinary understanding and problem solving represented by these horizontal links are central to the success of the initiative.
3. In the middle of Year 2 of the 3-year grant, the PINs at the bottom of the seed pyramid (pyralets) are expected to propose a suitable new layer of PINs. The proposal will also include new activities through which the added PINs will participate to the project during Year 3, and how these activities will enrich the work by the rest of the team. These proposals will be considered by ITRA along with any other candidate institutions that may have shown interest in performing similar activities. These activities of these PINS will be limited as they will provide them time to orient themselves to the project. In addition to the existing team, ITRA will also support the selected additional layer of PINs, for their Year 3 activities.

4. It is anticipated that there will be opportunities for the team to continue to work beyond Year 3, through additional ITRA grants and collaborations. During Year 3, all institutions in the extended pyramid may submit proposals, on expansions, extensions and additions to the work they have been doing, or propose related new projects.

9. Criteria for a II researchers to qualify as PIs and CoPIs

Each senior member of the team must commit at least 15% of their time to the project.

10. Limitations on the Roles an Institution can Play in a Proposed Team

The IT and Ag&Food "institutions" referred to in this RFP mean distinct Teaching and Research Units (TRUs) to which the proposing team members belong. (As stated earlier in Sec. 5.2, a research institution that does not have teaching programs and PhD students may pair up with an academic institution, and the pair may act as a "single institution" for the purposes of responding to this RFP. They can choose a PI, Co-PIs and other researchers seamlessly from both institutions.) To be acceptable, the each TRU must have its own independent teaching/research mandate, with its own administration and agenda to pursue the mandate. Examples of acceptable different "institutions" or TRUs for this RFP include: different universities/deemed universities/institutes/major research laboratories, different colleges within a university/deemed university, and different departments within a university/deemed university/college. Different mandates for this RFP include IT, Agriculture and Food, different established sub-disciplines of these major disciplines, Economics, Sociology, etc. These are only examples of TRUs and mandates; any cases missed here may be considered provided the main criterion - the aforementioned independence – exists and is clearly brought out in the proposal.

A TRU may be a part of more than one team responding to this RFP. The constraints on such multiple participation are given below:

1. A TRU can participate as a LIN (IT) in at most one team
2. A TRU can participate as a LIN (Ag&Food) in at most one team.
3. A TRU can be a LIN in one discipline in one proposal, and also a PIN in the other discipline in a second proposal; i.e., (i) a LIN in IT in one proposal and a PIN in Ag&Food in a second proposal, or (ii) a LIN in Ag&Food in one proposal and a PIN in IT in a second proposal.
4. A TRU canNOT participate as a LIN in one proposal and also as a PIN in a second proposal if both are in the same discipline (IT or Ag&Food).
5. A TRU can participate as a PIN in one proposal and also as a PIN in a second proposal if these are in different disciplines.
6. A TRI can participate as a PIN (IT) in at most two teams.
7. A TRI can participate as a PIN (Ag&Food) in at most two teams.

Note for all IIs: The projects are awarded to institutions, so it is expected from the PIs and Co-PIs that they will not be changing their institutions during the course of the project, and the management of the institution will try to ensure this. In case of extenuating circumstances, ITRA should be informed at the earliest. Further, the team PI should work with the management of the institution being affected by the change to arrange for an appropriate replacement at the earliest possible opportunity before the move takes place.

Annexure - 5

Guidelines for Submitting Expression of Interest (EOI)

(1). Download the EOI form from ITRA website http://itra.medialabasia.in/?p=2189

(2). Fill in the desired information

(3). Create a PDF of your EOI by clicking on the Finish Button in the EOI form

(4). Upload the pdf file on website. (the link would be updated on website soon)