INSTITUTION OF AGRICULTURAL TECHNOLOGISTS,

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EVALUATION OF RKVY PROJECTS

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UNIVERSITY OF AGRICULTURAL SCIENCES,

RAICHUR

ESTABLISHMENT OF PESTICIDE RESIDUES ANALYSIS LABORATORY IN HYDERABAD KARNATAKA REGION

INSTITUTION OF AGRICULTURAL TECHNOLOGISTS,

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ESTABLISHMENT OF PESTICIDE RESIDUES ANALYSIS LABORATORY IN HYDERABAD KARNATAKA REGION

EXECUTIVE SUMMARY

Moving towards a sustainable global food system will become more difficult as global population increases. A common perception is that global food supply is currently sufficient to feed the world's population, with timely distribution required to avoid hunger (World Hunger Organisation, 2016), but that food production must increase dramatically in the next decades (Food and Agriculture Organisation of the United Nations, 2009) as global population increases to ≈9.7 billion in 2050 (United Nations Department of Economic and Social Affairs, 2015). However, the challenge of sustainably producing sufficient food for the growing global population will not necessarily be solved by increases in production.

Food and nutrition security are intimately interconnected, since only a food-based approach can help in overcoming malnutrition in an economically and socially sustainable manner. Food production provides the base for food security as it is a key determinant of food availability. The Indian food industry is poised for huge growth, increasing its contribution to world food trade every year. The country achieved a production level of 284 million tonnes. The food sector has emerged as a high-growth and high-profit sector due to its immense potential for value addition, particularly within the food processing industry.

Efforts at increasing the productivity in Indian farms has led to measures to reduce losses in production through insect pest and diseases and competition from weeds which share the nutrition meant for crop production. Use of pesticides and other chemicals has been the major means of reducing losses through attack by insect pests, diseases and weeds. Use of pesticides has been increasing in recent years as the pests have started developing resistance to the traditional chemicals.

Pesticides are mainly used in agriculture for the prevention, destruction or control of harmful organisms (pests) or diseases, or for the protection and preservation of plant products during production, storage and transport. Their application in agriculture has progressively increased after World War II and became a widespread practice that led to an increase in world food production. While use of pesticides has several advantages like cost effectiveness, timeliness and flexibility, quality, quantity and price of produce, prevention of various problems and protection of pets and humans, their use is also fraught with adverse effects like risk of residues in food, possible health effects at high residue levels, ground water and air contamination, effect of drift of sprays and vapour,

reduction of beneficial species, resistance development by pests and harm to farmer workers and environment. The extensive use of organic synthetic pesticides has resulted in the occurrence of residues of these chemicals and their metabolites in different environmental compartments such as water, soil and also in food commodities in quite small concentrations [Ahmed, 2001].

Global scientific concerns have been raised regarding the potential toxicity of pesticides that have promoted their strict regulation in order to protect consumers, environment and also the users of pesticides. The maximum allowable levels of these residues in foods are often stipulated by regulatory bodies in many countries. Regulations such as pre-harvest intervals also often prevent harvest of crop or livestock products if recently treated in order to allow residue concentrations to decrease over time to safe levels before harvest. Exposure of the general population to these residues most commonly occurs through consumption of treated food sources, or being in close contact to areas treated with pesticides such as farms or lawns (Walter Crinnion, 2009).

MRLs values defined as the highest levels of a pesticide residues that are legally tolerated in or on food or feed when pesticides are applied correctly (adoption of Good Agricultural Practices, GAPs) were established. Each country adopts their own agricultural policies and Maximum Residue Limits (MRL) and Acceptable Daily Intake (ADI).

The control of food safety and quality is an integral part of national programmes for development. National food control systems are designed to protect the health and welfare of the consumer, to promote the development of trade in food and food products and to protect the interests of the fair and honest food producer, processor or marketer against dishonest and unfair competition.

The Government of India regulates the pesticide residues detected in various food items through Prevention of Food Adulteration Act (now through Food Safety and Standards Act, 2005). Various organizations in India have been engaged in monitoring of pesticide residues in food commodities and environmental samples in their individual capacity primarily for academic purposes. Such studies were often overlapping and differed from one another in their results. Due to increasing public awareness and legalities involved in pesticide residues in food commodities, there was a need to harmonize the monitoring of pesticide residues in the country.

During 2009, Lok Adalat which was held in Kalburgi categorically recommended the establishment of pesticide residue analysis laboratory at Hyderabad-Karnataka region by looking into the indiscriminate usage of pesticides and its related hazards on the environment as well as on human beings in the area.

Keeping the above in view, the project, "**ESTABLISHMENT OF PESTICIDES RESIDUE ANALYSIS LABORATORY IN HYDERABAD KARNATAKA REGION"** was taken up by University of Agricultural Sciences, Raichur with Rashtriya Krishi Vikas Yojana funding. The project was implemented during 2015-16. The details of the project are as under:

1.	**Title of Project**	**:**	"**ESTABLISHMENT OF PESTICIDES RESIDUE ANALYSIS LABORATORY IN HYDERABAD KARNATAKA REGION"**
2.	**Nodal officer and Principal Investigator**	**:**	**Dr. M. Bheemanna,** Professor and Head, Department of Entomology, College of Agriculture, University of Agricultural Sciences, Raichur
3.	**Implementing Institution (S) and other collaborating Institution (s)**	**:**	Pesticides Residue and Food Quality Analysis Laboratory, College of Agriculture, Raichur
4.	**Date of commencement of Project**	**:**	2015-16
5.	**Approved date of completion**	**:**	2015-16
6.	**Actual date of completion**	**:**	2015-16
7.	**Project cost**	**:**	Rs. 35 lakhs

The objectives of the project are as follows:

1. Development and Standardization of the multi residue analytical method for major insecticides used in cereals and pulses insect pest management.
2. Monitoring of pesticides residues in samples collected from pigeonpea and paddy ecosystem.
3. Spatial sampling of fruits and vegetables from the market outlets and monitoring of pesticide residue in them.

The focus of Evaluation is:

i. To examine whether the pesticides residue analysis laboratory is strengthened in terms of infrastructural facilities and equipped with required state of art equipment to undertake pesticide residue analysis, heavy metal analysis and food proximate composition.

ii. To evaluate the impact of establishment of pesticide residue analytical laboratory at the centre.

iii. To evaluate the impact of pesticides residue analysis experiments in developing MRLs in different field crops.

iv. To evaluate the utility of pesticide residue analytical laboratory by the various stakeholders.

The process of establishment of the Pesticide Residues Analysis Laboratory was initiated during 2013 and the laboratory started working scientifically from 2016 onwards. Three national projects under Monitoring of Pesticide Residues at National Level sponsored under The Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Government of India, All India Network Project on Pesticide residues, Generation of baseline data for heavy metal in leafy vegetables sponsored by FSSAI, Government of India are being implemented by the Pesticide Residues Analysis Laboratory.

The laboratory has obtained accreditation status from National Accreditation Board for Testing and Calibration Laboratories (A constituent Board of Quality Council of India), Government of India for testing 74 pesticide residues in field crops, viz., rice, wheat, sorghum, red gram, black gram, green gram and bengal gram, 72 pesticide residues in fruit and vegetable crops, viz., pomegranate, grapes, banana, mango, sweet orange, guava, tomato, brinjal, okra, green and red chillies, cabbage, cauliflower and capsicum, 7 trace metal elements (lead, cadmium, arsenic, mercury, copper, zinc and tin) in cereals, pulses and its products, moisture, ash, crude protein, crude fat, crude fibre and carbohydrate in rice, rice flour, red gram, red gram dhal and bakery products, viz., biscuits. Range of testing/ Limits of Detection have been prescribed for all tests. The Accreditation Standard is ISO/ IEC 17025: 2005 and is valid for two years from 12/07/2018 to 11/07/2020. The laboratory has developed scopes under the sanctioned project for pesticide residue analysis, heavy metal analysis, food proximate composition, food adulterants and environmental gas estimation.

In United States of America, the pesticide residue monitoring program is a compliance program used by FDA to monitor the level of pesticide chemical residues in domestic and imported foods to ensure that they do not exceed the EPA limits or tolerances. FDA monitors a broad range of foods samples (over 7000 in fiscal year 2016), using a multi-residue method that analyzes approximately 700 different pesticide chemical residues in a single analysis and selective residue methods that detect pesticide chemical residues not covered by the multi-residue method.

Three national projects under Monitoring of Pesticide Residues at National Level sponsored under The Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Government of India are being implemented by the Pesticide Residues Analysis Laboratory. A developed, validated and uniform methodology is followed by all the participating laboratories for sampling, analysis of pesticide residues

and reporting of the results. The results are being confirmed with the help of gas chromatography-mass spectrometry (GC-MS) or liquid chromatography-mass spectrometry (LC-MS).

The projects involve collection samples of food commodities such as vegetables, fruits, cereals, pulses, spices, curry leaves, red chilli powder, milk, egg, fish/marine, meat, tea, etc. from various markets under the Agriculture Produce Marketing Committee (APMC), local markets, farm gate, organic outlets and Public Distribution Systems (PDS) and irrigated water from intensive agricultural fields from different parts of the country and analysis for the presence or absence of pesticide residues.

Totally 190 samples are generated by the laboratory and tested. It has been found that at All India level 2.1% samples were found above MRL as prescribed under Food Safety Standard Authority of India (FSSAI), Ministry of Health and Family welfare, Government of India.

The Pesticide Residues Analysis Laboratory in University of Agricultural Sciences, Raichur has developed and validated the multi residue analytical methods for 74 chemical pesticides used in cereals and pulses. The cereals, pulses, fruits and vegetable samples are being monitored for pesticide content.

For monitoring of pesticides residues in pigeonpea collected from Gulbarga region, about 120 grain samples were collected and analyzed. The pesticide residues were quantified. Similarly, paddy grains were collected from farmer's field during harvest and analyzed for pesticide residue using laboratory developed and validated method.

Similarly, spatial sampling of fruits and vegetables from the market outlets were collected routinely every month and monitored the pesticide residues.

These studies will help in export of quality produce from the region.

The laboratory has prepared and adopted enforcement of quality system documents, viz., quality manual, management system procedures, standard operating procedures and forms and formats that would enable systematic assessment of pesticide residues in selected field crops, fruits and vegetables. Method development and validation for pesticide residues and heavy metal analysis in cereals and pulses, fruits and vegetables and food proximate analysis have been completed by the laboratory which will benefit in residue analysis and food proximate analysis. The laboratory has taken up maintenance and calibration (External and Internal calibration) of analytical equipment (critical and noncritical) for accurate analyses. Critical consumables such as certified reference materials, laboratory reagents and solvents to meet the different analytical requirements

have been procured. The laboratory has generated analytical data by conducting pesticide residues, heavy metals and food proximate analysis by collecting samples from the APMCs and fruit and vegetable markets in the region. From this quality assurance programme including retesting, replicate testing, spike and recovery and use of internal standards have been conducted. This goes a long way in ensuring quality of produce for export in the region.

REFLECTIONS AND CONCLUSIONS

1. All necessary steps to develop infrastructure and procure equipment required for the Pesticide Residues Analysis have been taken and a fully equipped laboratory has been established.
2. All necessary scientists involving various disciplines like Agricultural Entomology, Plant Pathology, Agricultural Microbiology, Processing and Food Engineering, Biochemistry and Biotechnology have been put in place to take up analytical studies.
3. The laboratory has obtained accreditation certificate from National Accreditation Board for Testing and Calibration Laboratories (A constituent Board of Quality Council of India), Government of India for testing 74 pesticide residues in field crops, viz., rice, wheat, sorghum, red gram, black gram, green gram and bengal gram, 72 pesticide residues in fruit and vegetable crops, viz., pomegranate, grapes, banana, mango, sweet orange, guava, tomato, brinjal, okra, green and red chillies, cabbage, cauliflower and capsicum, 7 trace metal elements (lead, cadmium, arsenic, mercury, copper, zinc and tin) in cereals, pulses and its products, moisture, ash, crude protein, crude fat, crude fibre and carbohydrate in rice, rice flour, red gram, red gram dhal and bakery products, viz., biscuits. Range of testing/ Limits of Detection have been prescribed for all tests. The Accreditation Standard is ISO/ IEC 17025: 2005 and is valid for two years from 12/07/2018 to 11/07/2020. The validity needs to be extended.
4. The Pesticide Residues Analysis Laboratory is involved in four National projects, viz., All India Network Project (AINP) on pesticide residues, heavy metal and antibiotic analysis in fruits and vegetables sponsored by Indian Council of Agricultural Research, New Delhi, Monitoring of Pesticide Residues at National Level (MPRNL) sponsored by The Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Government of India, Study to generate Baseline Data on occurrence of heavy metal contaminants in vegetables sponsored by Food Safety Standard Authority of India (FSSAI), Ministry of Health and Family welfare, Government of India and creating a protease knockout in E. coli by crelox mechanism to solubilize recombinant proteins sponsored by Department of Biotechnology, Ministry of Science and Technology, Government of India. These have given the laboratory a National Status.

5. The Pesticide Residues Analysis Laboratory in University of Agricultural Sciences, Raichur has developed and validated the multi residue analytical methods for 74 chemical pesticides used in cereals and pulses. Similarly, spatial sampling of fruits and vegetables from the market outlets were collected routinely every month and monitored the pesticide residues. This goes a long way in ensuring quality of produce for export in the region.
6. The laboratory has prepared and adopted enforcement of quality system documents, viz., quality manual, management system procedures, standard operating procedures and forms and formats that would enable systematic assessment of pesticide residues in selected field crops, fruits and vegetables. Method development and validation for pesticide residues and heavy metal analysis in cereals and pulses, fruits and vegetables and food proximate analysis have been completed by the laboratory which will benefit in residue analysis and food proximate analysis.
7. The laboratory has generated analytical data by conducting pesticide residues, heavy metals and food proximate analysis by collecting samples from the APMCs and fruit and vegetable markets in the region. From this quality assurance programme including retesting, replicate testing, spike and recovery and use of internal standards have been conducted. This goes a long way in ensuring quality of produce for export in the region.

ACTION POINTS

1. The objectives of the project have been well implemented and the laboratory is the absolute need of the region since 75 to 80% food grains produced in the region are exported and needs estimation of pesticide residues in order to export. Indeed, this laboratory needs to be upgraded and strengthened by the University for the benefit of farming community in the region.
2. The project should be on PPP mode and generating income on its own for maintenance on long run so that the manpower shortage can be met from generated income.
3. The project should aim at training human resources on use of equipment of sophisticated nature.
4. There is need for convergence of user departments in developing quality standards for the natural resources.
5. The laboratory should display Dos and Donts in the laboratory and all the laboratory equipment and infrastructure developed under RKVY funds should be labelled.
6. All the equipment are well maintained and used. However, there is need to maintain separate deadstock and consumables registers.
7. There is need for training scientists on use of equipment in the advanced areas.

8. Biopesticide residual laboratory may be established.
9. The laboratory can also associate and may be streamlined for food analysis in the region.

RESEARCHABLE ISSUES

1. To work out the cost efficiency and profitability of the technology and its spread.
2. Establishment of centralized laboratory to avoid duplicity of purchasing equipment and chemicals and production of quantitative data besides in convergence through PPP mode of operation.
3. Develop protocols of standards of heavy metals and their safe limits in food grains, vegetables and fruits.

ESTABLISHMENT OF PESTICIDE RESIDUES ANALYSIS LABORATORY IN HYDERABAD KARNATAKA REGION

INTRODUCTION

Moving towards a sustainable global food system will become more difficult as global population increases. A common perception is that global food supply is currently sufficient to feed the world's population, with timely distribution required to avoid hunger (World Hunger Organisation, 2016), but that food production must increase dramatically in the next decades (Food and Agriculture Organisation of the United Nations, 2009) as global population increases to ≈9.7 billion in 2050 (United Nations Department of Economic and Social Affairs, 2015). However, the challenge of sustainably producing sufficient food for the growing global population will not necessarily be solved by increases in production because there is a limit to the potential for efficiency gains, and many of these come with greater environmental costs, while increasing agricultural area by land use change almost invariably leads to losses of biodiversity.

Over 60 per cent of the Indian population continue to depend on agriculture and allied activities for their livelihood. Hence, growth of this sector is an essential perquisite for overall economic growth. Globally, India is the third largest producer of cereals, with only China and the USA ahead of it. India is 2nd in rice, wheat and production of other cereals. It is the largest exporter of cereal products and offers huge opportunity for milling technology, up-gradation, automation, integration, fortification etc. India is 2nd largest global producer of fruits and vegetables with 254 MT production. Adoption of innovative technologies like protected cultivation, hydroponics and aeroponics have contributed to improvement in quality of horticultural produce.

Food and nutrition security are intimately interconnected, since only a food-based approach can help in overcoming malnutrition in an economically and socially sustainable manner. Food production provides the base for food security as it is a key determinant of food availability. The Indian food industry is poised for huge growth, increasing its contribution to world food trade every year. The country achieved a production level of 284 million tonnes. The food sector has emerged as a high-growth and high-profit sector due to its immense potential for value addition, particularly within the food processing industry. It is an undisputed fact that the area of the agriculture land on the planet will decrease and the demand for food and fibre for the ever-increasing population will keep on increasing.

Against the back drop of Government's intention of doubling farm income by 2022, the emphasis has been directed towards reducing the cost of inputs, ensuring

remunerative prices, reducing wastage at the farm level and creating alternative sources of income.

Efforts at increasing the productivity in Indian farms has led to measures to reduce losses in production through insect pest and diseases and competition from weeds which share the nutrition meant for crop production. Use of pesticides and other chemicals has been the major means of reducing losses through attack by insect pests, diseases and weeds. Use of pesticides has been increasing in recent years as the pests have started developing resistance to the traditional chemicals. Worldwide, about 10,000 species of insects are important as pest, out of 750,000 identified species. Over 50,000 species of fungi are responsible for some 1,500 plant diseases. Over 1,800 species of weeds out of the known 30,000 cause serious economic loss. About 15,000 species of nematodes produce more than 1,500 serious deleterious effects on plants. Over 30 household pests are worthy of attention, like files, fleas, bedbugs, lice, cockroaches, mites, termites and moths. Every year pests destroy food which could be food for 135 million people. Loss of food grains from the different types of pests may be as high as 23% from insetcs, 25% from diseases, 28% from weeds, 10% from storage pests and 8% from rats.

The term ‘pesticide’ is used for all toxic chemicals used as pest control agents. They have become very popular with progressive farmers interested in obtaining high yields of crop. Large number of pesticides has been developed in recent years for the chemical control of diseases and pests which destroy crops and stored grain food grains worth millions of rupees every year. These substances may be sprayed as dust, granules or may be applied in the form of emulsions and suspensions. Pesticides are applied as insecticides, fungicides, rodenticides, acaricides, herbicides or fumigants. Annually around USD 40,000 million worth of pesticides are used globally.

Pesticides are mainly used in agriculture for the prevention, destruction or control of harmful organisms (pests) or diseases, or for the protection and preservation of plant products during production, storage and transport. Their application in agriculture has progressively increased after World War II and became a widespread practice that led to an increase in world food production. While use of pesticides has several advantages like cost effectiveness, timeliness and flexibility, quality, quantity and price of produce, prevention of various problems and protection of pets and humans, their use is also fraught with adverse effects like risk of residues in food, possible health effects at high residue levels, ground water and air contamination, effect of drift of sprays and vapour, reduction of beneficial species, resistance development by pests and harm to farmer workers and environment. The extensive use of organic synthetic pesticides has resulted in the occurrence of residues of these chemicals and their metabolites in different environmental compartments such as water, soil and also in food commodities in quite small concentrations [Ahmed, 2001].

The pesticide present on leaves, skin or any other surface right after application is called deposits. Sometimes deposits can be easily seen, as is with many dusts or wettable powder formulations. If pesticide deposits remain on the surface one day after application, it is called as residue. Food and Agriculture Organization (FAO) has defined pesticide residues as any specified substance in food, agriculture commodities, animal feed, soil or water, resulting from use of pesticides. The term includes any derivatives of pesticide such as conversion products, metabolites, reaction products and impurities that are of toxicological significance. The term pesticide residue thus includes residues from unknown and unavoidable source (e.g. environmental) as well as from known uses of pesticides.

Pesticide residue refers to the pesticides that may remain on or in food after they are applied to food crops (IUPAC, 1997). Some pesticides leave little or no residues, and others leave residues for weeks, months or even years. Depending upon on manner and place pesticides are used, each pesticide will vary in duration it remains on the crop or on the surface. It is important to establish what residues, if any, remain on the crop after a given period of time. A long lasting residue may be desirable because pesticides are effective for a longer period of time and they need not be applied very often. However, long lasting residues on food sources pose health risk to consumers. The amounts of residues remaining on crop after harvest depends on how long before harvest pesticides were applied.

Global scientific concerns have been raised regarding the potential toxicity of pesticides that have promoted their strict regulation in order to protect consumers, environment and also the users of pesticides. The maximum allowable levels of these residues in foods are often stipulated by regulatory bodies in many countries. Regulations such as pre-harvest intervals also often prevent harvest of crop or livestock products if recently treated in order to allow residue concentrations to decrease over time to safe levels before harvest. Exposure of the general population to these residues most commonly occurs through consumption of treated food sources, or being in close contact to areas treated with pesticides such as farms or lawns (Walter Crinnion, 2009).

MRLs values defined as the highest levels of a pesticide residues that are legally tolerated in or on food or feed when pesticides are applied correctly (adoption of Good Agricultural Practices, GAPs) were established. Each country adopts their own agricultural policies and Maximum Residue Limits (MRL) and Acceptable Daily Intake (ADI). The level of food additive usage varies by country because forms of agriculture are different in regions according to their geographical or climatical factors. Some countries use the International Maximum Residue Limits -Codex Alimentarius to define the residue limits; this was established by Food and Agriculture Organization of the United Nations (FAO) and World Health Organization (WHO) in 1963 to develop international food standards,

guidelines codes of practices, and recommendation for food safety. Currently the CODEX has 185 Member Countries and 1 member organization (EU) (CODEX International Food Standards).

Legislations were enacted in the USA, the European Commission (EC) and other countries to regulate pesticides in food products. More specific in EC, the European Food Safety Authority (EFSA) in order to assess the safety for consumers based on the toxicity of the pesticide, the maximum levels expected on food and the different diets of Europeans established EC legislation on MRLs that harmonizes and simplifies pesticide MRLs, and sets a common EC assessment scheme for all agricultural products for food or animal feed. Regulation EC 396/2005 and amendments cover pesticides currently or formerly used in agriculture in or outside the EC (around 1100 compounds) [European Commission, 2017]. Therefore, the development of reliable, accurate and sensitive analytical methods is essential so as to protect human health and to support the compliance and enforcement of laws and regulations pertaining to food safety. As a consequence, several techniques have been developed and optimized for the qualitative and quantitative determination of pesticides residues in complex matrices, such as food. Taking into account the multiplicity of food along with the fact that measurement of trace levels for target organic contaminants must be achieved numerous multi-residue methods (MRMs) capable of simultaneously determining more than one residue in a simple analysis have been proposed and applied [Lacorte et al., 2006, Ridgway et al., 2007, Beyer et al., 2008]. Due to the fact that several compounds of different physicochemical properties such as polarity, solubility, volatility and pKa value have to be simultaneously extracted and analyzed makes the development of MRMs a difficult task [Biziuk and Stocka, 2015].

Fruits and vegetables are capable of retaining large quantities of pesticides. Moreover, several pesticides have the ability to accumulate in fruit skins. It has been reported that the crops most exposed to the presence of pesticides are grapes, citrus fruits and potatoes [Biziuk and Stocka, 2015].

Many of the chemical residues, especially derivatives of chlorinated pesticides, exhibit bioaccumulation which could build up to harmful levels in the body as well as in the environment (Walter Crinnion, 2009). Persistent chemicals can be magnified through the food chain and have been detected in products ranging from meat, poultry, and fish, to vegetable oils, nuts, and various fruits and vegetables (Stephen Chung and Benedict Chen, 2011).

Regulations

The control of food safety and quality is an integral part of national programmes for development. National food control systems are designed to protect the health and welfare of the consumer, to promote the development of trade in food and food products

and to protect the interests of the fair and honest food producer, processor or marketer against dishonest and unfair competition.

Emphasis is placed on the prevention of chemical and biological hazards which result from contamination, adulteration or simple mishandling of foods. An important part of a national food control system is the capability for the analytical laboratory service to detect and quantify food contaminants such as residues of pesticide chemicals.

In India, the food safety is based on the guiding principle of risk analysis of the Codex Alimentarius Commission (CAC). In order to exploit full potential of pesticides in agriculture and public health programmes without adversely affecting the environment, it is essential to study the facts about pesticide behavior and their persistence / dissipation under tropical Indian conditions. There is also a need to know the status of pesticide residues to ensure the safety to the consumer and to overcome the trade barriers at international level.

The Government of India regulates the pesticide residues detected in various food items through Prevention of Food Adulteration Act (now through Food Safety and Standards Act, 2005). Various organizations in India such as institutions under the Indian Council of Agricultural Research (ICAR); State Agricultural Universities; Central Insecticides Laboratory (CIL); Indian Institute of Grain Storage; institutions under Indian Council of Medical Research (ICMR); Council of Scientific and Industrial Research (CSIR) and Bhabha Atomic Research Centre (BARC), and other research groups have been engaged in monitoring of pesticide residues in food commodities and environmental samples in their individual capacity primarily for academic purposes. Such studies were often overlapping and differed from one another in their results. Due to increasing public awareness and legalities involved in pesticide residues in food commodities, there was a need to harmonize the monitoring of pesticide residues in the country.

The Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare had started a central sector scheme, “Monitoring of Pesticide Residues at National Level” (MPRNL) in food commodities and environmental samples during 2005-06 with the participation of various laboratories representing Ministry of Agriculture, Indian Council of Agriculture Research, Ministry of Health and Family Welfare, Ministry of Environment and Forest, Council of Scientific and Industrial Research, Ministry of Chemical and Fertilizer, Ministry of Commerce and State Agricultural Universities across the country.

Objectives:

1. To identify crops and regions having preponderance of pesticide residues in order to focus extension efforts for Integrated Pest Management (IPM) and Good Agriculture Practices (GAP).
2. To strengthen infrastructure at Quarantine stations to prevent entry of food and food commodities which have pesticide residues above maximum residue limit (MRL).
3. Testing / Certification of pesticide residue in export / import consignments.
4. To test pesticide residues and other contaminants in food commodities and environmental samples like soil and water.

The Project Coordinating Cell, AINP on Pesticide Residues, IARI, New Delhi of ICAR is the nodal Centre. These participating centres have been accredited by National Accreditation Board for Testing and Calibration of Laboratories (NABL) in the field of chemical testing as per ISO/IEC 17025:2005 to ensure the generation of authentic data. Totally 31 laboratories have been accredited by NABL so far. There are also 40 APEDA recognized analytical laboratories in the country which are equipped to test the pesticide residues.

The analytical methods are those for determination and confirmation of residues in foods. They are offered in an array which allows the determination of groups of like residues in broad multiresidue detection. Individual residue methods are suggested for singular residue needs.

Today, Gas Chromatography (GC), High Performance Liquid Chromatography (HPLC) and ELISA are the most widely used classical methods of pesticide residue analysis in food commodities throughout the world.

Some of the new trends in pesticide residue analysis are –

Gas Liquid Chromatography-Mass Spectrometry (GLC-MS), High Performance Liquid Chromatography-Gas Chromatography (HPLC-GC), Liquid Chromatography- Mass Spectrometry (LC_MS), Tandem Mass Spectrometry (MS-MS) and Supercritical Fluid Chromatography (SFC) combined with GC, HPLC or MS.

However, the use of these techniques and instruments is largely depending upon the availability of the equipment in the particular laboratory. The laboratory described above, we can use any of these techniques/ equipment and also more than one technique/equipment and run the laboratory successfully.

During 2009, Lok Adalat which was held in Kalburgi categorically recommended the establishment of pesticide residue analysis laboratory at Hyderabad-Karnataka region by

looking into the indiscriminate usage of pesticides and its related hazards on the environment as well as on human beings in the area.

Keeping the above in view, the project, "**ESTABLISHMENT OF PESTICIDES RESIDUE ANALYSIS LABORATORY IN HYDERABAD KARNATAKA REGION"** was taken up by University of Agricultural Sciences, Raichur with Rashtriya Krishi Vikas Yojana funding. The project was implemented during 2015-16. The details of the project are as under:

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3. Spatial sampling of fruits and vegetables from the market outlets and monitoring of pesticide residue in them.

HYPOTHESIS

The context of the evaluation arises from the following facts:

1. The Government of India regulates the pesticide residues detected in various food items through Prevention of Food Adulteration Act (now through Food Safety and Standards Act, 2005). Various organizations in India such as institutions under the Indian Council of Agricultural Research (ICAR); State Agricultural Universities;

Central Insecticides Laboratory (CIL); Indian Institute of Grain Storage; institutions under Indian Council of Medical Research (ICMR); Council of Scientific and Industrial Research (CSIR) and Bhabha Atomic Research Centre (BARC), and other research groups have been engaged in monitoring of pesticide residues in food commodities and environmental samples in their individual capacity primarily for academic purposes.

2. According to relevant literature fruit and vegetables are capable of retaining large quantities of pesticides. Moreover, several pesticides have the ability to accumulate in fruit skins. It has been reported that the crops most exposed to the presence of pesticides are grapes, citrus fruits and potatoes [Biziuk and Stocka, 2015]. Many of the chemical residues, especially derivatives of chlorinated pesticides, exhibit bioaccumulation which could build up to harmful levels in the body as well as in the environment (Walter Crinnion, 2009). Persistent chemicals can be magnified through the food chain and have been detected in products ranging from meat, poultry, and fish, to vegetable oils, nuts, and various fruits and vegetables (Stephen Chung and Benedict Chen, 2011).
3. Pesticides residue analysis studies were often overlapping and differed from one another in their results. Due to increasing public awareness and legalities involved in pesticide residues in food commodities, there was a need to harmonize the monitoring of pesticide residues in the country.
4. The Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare had started a central sector scheme, “Monitoring of Pesticide Residues at National Level” (MPRNL) in food commodities and environmental samples during 2005-06 with the participation of various laboratories representing Ministry of Agriculture, Indian Council of Agriculture Research, Ministry of Health and Family Welfare, Ministry of Environment and Forest, Council of Scientific and Industrial Research, Ministry of Chemical and Fertilizer, Ministry of Commerce and State Agricultural Universities across the country with the objectives of identifying crops and regions having preponderance of pesticide residues in order to focus extension efforts for Integrated Pest Management (IPM) and Good Agriculture Practices (GAP), strengthening infrastructure at Quarantine stations to prevent entry of food and food commodities which have pesticide residues above maximum residue limit (MRL), testing / certification of pesticide residue in export / import consignments and testing pesticide residues and other contaminants in food commodities and environmental samples like soil and water.
5. These participating centres have been accredited by National Accreditation Board for Testing and Calibration of Laboratories (NABL) in the field of chemical testing as per ISO/IEC 17025:2005 to ensure the generation of authentic data. Totally 31 laboratories have been accredited by NABL so far.

OBJECTIVES AND ISSUES FOR EVALUATION

The scope of evaluation is to study the impact of scheme, "**ESTABLISHMENT OF PESTICIDES RESIDUE ANALYSIS LABORATORY IN HYDERABAD KARNATAKA REGION"** implemented by University of Agricultural Sciences, Raichur during 2015-16.

1. Stake Holders

a) University of Agricultural Sciences, Raichur – Sponsorer
b) Rashtriya Krishi Vikas Yojane – as Monitoring Authority
c) Institution of Agriculture Technologists – as Consultant
d) Farmers / beneficiaries as target group of evaluation

2. Purpose of Evaluation

Evaluation Framework

The focus of Evaluation is:

i. To examine whether the pesticides residue analysis laboratory is strengthened in terms of infrastructural facilities and equipped with required state of art research facility to undertake pesticide residue analysis, heavy metal analysis and food proximate composition.
ii. To evaluate the impact of establishment of pesticide residue analytical laboratory at the centre.
iii. To evaluate the impact of pesticides residue analysis experiments in developing MRLs in different field crops.
iv. To evaluate the utility of pesticide residue analytical laboratory by the various stakeholders.

LOG FRAME/THEORY OF CHANGE/PROGRAM THEORY

The intention of the project is to establish fully equipped pesticide residue analysis laboratory equipped with high-end equipments which are required for the analysis of pesticide residues, elemental analysis, proximate analysis and various parameters related to food quality in various commodities/ substrates and develop good infrastructure catering to the needs of various stake holders viz., farmers, researchers, students, scientists, food & processing industries, food grain packers and exporters.

EVALUATION DESIGN

Evaluation design has a rationale of requirement of field level data (primary) that is required to study evaluation objective with respect to beneficiary farmers on one part and the projects taken up for study per se on the other part. The evaluation requires analysis of administration obligations under the two heads and hence a secondary data analysis becomes important and accordingly formats were designed to procure secondary data. The

third obligation under evaluation is opinion of stake holders with respect to improvement of the schemes, which require group discussions and exchange of views both in the form of a format, as well as group discussions with the stake holders. The entire evaluation process required a central administration of all activities.

A core team of experts at the Institution level considered three methods to bring a meaningful evaluation of the subject, keeping in mind the scope, evaluation questions and sub-questions duly keeping its focus on the purpose of evaluation. The three methods are:

a. Accessing and analysis of secondary data from the implementing department.
b. Interaction with Principal Investigator and his team.
c. Actual visit to the project site to study and obtain necessary information to elicit answers to the evaluation questions.

DATA COLLECTION AND ANALYSIS

Establishment and strengthening of Pesticide Residues Analysis Laboratory

The process of establishment of the Pesticide Residues Analysis Laboratory was initiated during 2013 and the laboratory started working from 2016 onwards. The following hitech and state of art equipment have been purchased and installed in the laboratory:

List of Major Equipments purchased:

S.No.	Description	Purchase Order No. and date	Date of Receipt	Total Cost	Purpose of purchase
1.	NH2 Analytical HPLC Column	--	29.12.2015	36,693/-	Pesticide Residue Analysis
2.	High Volume Homogenizer	SPO/UASR/422/2015-16 & 11-03-16	31.03.16	6,00,000/-	
3.	All In One Desktop	--	27.07.16	1,24,954/-	
4.	Electronic Balance Sartorius	SPO/UASR/473	20.09.16	99,698/-	
5.	E2 Class Weight Box	09.08.2016		98,413/-	
6.	Microwave Oven	--	--	16,259/-	
7.	pH meter	09.08.2016	--	25,924/-	
8.	Electronic Balance Sartorius	SPO/UASR/473	14.10.16	99,698/-	
9.	UV-Vis Spectrophotometer	SPO/UASR/228/2016-17 & 10.07.2016	05-12-17	8,14,436/-	
10.	Kyocera Taskalfa Ecosys	--	22.07.16	99,170/-	
11.	Bio Safety Cabinet	SPO/UASR/323/2016-17 &11-01-2017	06.04.17	3,93,543/-	
12.	Low Volume Homogenizer	SPO/UASR/491/2016-17 & 22-03-2017	30.03.17	1,70,037/-	

The main equipment involved in pesticide residues analysis is the GC-MSMS and LC-MSMS Ultraviolet Spectrophotometer using which more than 200 samples have been analysed for pesticide residues. The operation of the spectrophotometer is done exclusively by a trained and well qualified person. The laboratory is being maintained by 7 well qualified research scientists from various disciplines including Agricultural Entomology, Plant Pathology, Agricultural Microbiology, Processing and Food Engineering, Biochemistry and Biotechnology. There are also 12 research fellows and analysts who are assisting the scientists in managing the laboratory (Annexure 1). The laboratory has obtained accreditation certificate from National Accreditation Board for Testing and Calibration Laboratories (A constituent Board of Quality Council of India), Government of India for testing 74 pesticide residues in field crops, viz., rice, wheat, sorghum, red gram, black gram, green gram and bengal gram, 72 pesticide residues in fruit and vegetable crops, viz., pomegranate, grapes, banana, mango, sweet orange, guava, tomato, brinjal, okra, green and red chillies, cabbage, cauliflower and capsicum, 7 trace metal elements (lead, cadmium, arsenic, mercury, copper, zinc and tin) in cereals, pulses and its products, moisture, ash, crude protein, crude fat, crude fibre and carbohydrate in rice, rice flour, red gram, red gram dhal and bakery products, viz., biscuits. Range of testing/ Limits of Detection have been prescribed for all tests. The Accreditation Standard is ISO/ IEC 17025: 2005 and is valid for two years from 12/07/2018 to 11/07/2020. The laboratory has

developed scopes under the sanctioned project for pesticide residue analysis, heavy metal analysis, food proximate composition, food adulterants and environmental gas estimation.

The laboratory has been equipped with high-end equipments which are required for the analysis of pesticide residues, elemental analysis, proximate analysis and various parameters related to food quality in various commodities/ substrates. Good infrastructure has been developed and catering to the needs of various stake holders viz., farmers, researchers, students, scientists, food & processing industries, food grain packers and exporters.

Three national projects under Monitoring of Pesticide Residues at National Level sponsored under The Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Government of India are being implemented by the Pesticide Residues Analysis Laboratory. The Project Coordinating Cell, AINP on Pesticide Residues, IARI, New Delhi of ICAR is the nodal Centre. The participating centres have been accredited by National Accreditation Board for Testing and Calibration of Laboratories (NABL) in the field of chemical testing as per ISO/IEC 17025:2005 to ensure the generation of authentic data.

The 31 participating laboratories (including Pesticide Residues Analysis Laboratory in University of Agricultural Sciences, Raichur) collect food commodities such as vegetables, fruits, cereals, pulses, spices, curry leaves, red chilli powder, milk, egg, fish/marine, meat, tea, etc. from various markets under the Agriculture Produce Marketing Committee (APMC), local markets, farm gate, organic outlets and Public Distribution Systems (PDS) and irrigated water from intensive agricultural fields from different parts of the country and analyze for the presence or absence of pesticide residues.

A developed, validated and uniform methodology is followed by all the participating laboratories for sampling, analysis of pesticide residues and reporting of the results. The results are being confirmed with the help of gas chromatography-mass spectrometry (GC-MS) or liquid chromatography-mass spectrometry (LC-MS).

Totally 190 samples are generated by the laboratory and tested. It has been found that at All India level 2.1% samples were found above MRL as prescribed under Food Safety Standard Authority of India (FSSAI), Ministry of Health and Family welfare, Government of India.

Impact of establishment of pesticide residue analytical laboratory at the centre and impact of pesticides residue analysis experiments in developing MRLs in different field crops.

The Pesticide Residues Analysis Laboratory in University of Agricultural Sciences, Raichur has developed and validated the multi residue analytical methods for 74 chemical pesticides used in cereals and pulses. The cereals, pulses, fruits and vegetable samples are being monitored for pesticide content.

For monitoring of pesticides residues in pigeonpea collected from Gulbarga region, about 120 grain samples were collected and analyzed. The pesticide residues were quantified. Similarly, paddy grains were collected from farmer's field during harvest and analyzed for pesticide residue using laboratory developed and validated method.

Similarly, spatial sampling of fruits and vegetables from the market outlets were collected routinely every month and monitored the pesticide residues.

Evaluation of the utility of pesticide residue analytical laboratory by the various stakeholders.

The laboratory has prepared and adopted enforcement of quality system documents, viz., quality manual, management system procedures, standard operating procedures and forms and formats that would enable systematic assessment of pesticide residues in selected field crops, fruits and vegetables. Method development and validation for pesticide residues and heavy metal analysis in cereals and pulses, fruits and vegetables and food proximate analysis have been completed by the laboratory which will benefit in residue analysis and food proximate analysis. The laboratory has taken up maintenance and calibration (External and Internal calibration) of analytical equipment (critical and noncritical) for accurate analyses. Critical consumables such as certified reference materials, laboratory reagents and solvents to meet the different analytical requirements have been procured. The laboratory has generated analytical data by conducting pesticide residues, heavy metals and food proximate analysis by collecting samples from the APMCs and fruit and vegetable markets in the region. From this quality assurance programme including retesting, replicate testing, spike and recovery and use of internal standards have been conducted. This goes a long way in ensuring quality of produce for export in the region.

FINDINGS AND DISCUSSION

The process of establishment of the Pesticide Residues Analysis Laboratory was initiated during 2013 and the laboratory started working from 2016 onwards. Three national projects under Monitoring of Pesticide Residues at National Level sponsored under The Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Government of India are being implemented by the Pesticide Residues Analysis Laboratory.

The laboratory has obtained accreditation status from National Accreditation Board for Testing and Calibration Laboratories (A constituent Board of Quality Council of India), Government of India for testing 74 pesticide residues in field crops, viz., rice, wheat, sorghum, red gram, black gram, green gram and bengal gram, 72 pesticide residues in fruit and vegetable crops, viz., pomegranate, grapes, banana, mango, sweet orange, guava, tomato, brinjal, okra, green and red chillies, cabbage, cauliflower and capsicum, 7 trace metal elements (lead, cadmium, arsenic, mercury, copper, zinc and tin) in cereals, pulses and its products, moisture, ash, crude protein, crude fat, crude fibre and carbohydrate in rice, rice flour, red gram, red gram dhal and bakery products, viz., biscuits. Range of testing/ Limits of Detection have been prescribed for all tests. The Accreditation Standard is ISO/ IEC 17025: 2005 and is valid for two years from 12/07/2018 to 11/07/2020. The laboratory has developed scopes under the sanctioned project for pesticide residue analysis, heavy metal analysis, food proximate composition, food adulterants and environmental gas estimation.

In United States of America, the pesticide residue monitoring program is a compliance program used by FDA to monitor the level of pesticide chemical residues in domestic and imported foods to ensure that they do not exceed the EPA limits or tolerances. FDA monitors a broad range of foods samples (over 7000 in fiscal year 2016), using a multi-residue method that analyzes approximately 700 different pesticide chemical residues in a single analysis and selective residue methods that detect pesticide chemical residues not covered by the multi-residue method.

Three national projects under Monitoring of Pesticide Residues at National Level sponsored under The Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Government of India are being implemented by the Pesticide Residues Analysis Laboratory. A developed, validated and uniform methodology is followed by all the participating laboratories for sampling, analysis of pesticide residues and reporting of the results. The results are being confirmed with the help of gas chromatography-mass spectrometry (GC-MS) or liquid chromatography-mass spectrometry (LC-MS).

The projects involve collection samples of food commodities such as vegetables, fruits, cereals, pulses, spices, curry leaves, red chilli powder, milk, egg, fish/marine, meat, tea, etc. from various markets under the Agriculture Produce Marketing Committee (APMC), local markets, farm gate, organic outlets and Public Distribution Systems (PDS) and irrigated water from intensive agricultural fields from different parts of the country and analysis for the presence or absence of pesticide residues.

Totally 190 samples are generated by the laboratory and tested. It has been found that at All India level 2.1% samples were found above MRL as prescribed under Food Safety Standard Authority of India (FSSAI), Ministry of Health and Family welfare, Government of India.

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For monitoring of pesticides residues in pigeonpea collected from Gulbarga region, about 120 grain samples were collected and analyzed. The pesticide residues were quantified. Similarly, paddy grains were collected from farmer's field during harvest and analyzed for pesticide residue using laboratory developed and validated method.

Similarly, spatial sampling of fruits and vegetables from the market outlets were collected routinely every month and monitored the pesticide residues.

These studies will help in export of quality produce from the region.

The laboratory has prepared and adopted enforcement of quality system documents, viz., quality manual, management system procedures, standard operating procedures and forms and formats that would enable systematic assessment of pesticide residues in selected field crops, fruits and vegetables. Method development and validation for pesticide residues and heavy metal analysis in cereals and pulses, fruits and vegetables and food proximate analysis have been completed by the laboratory which will benefit in residue analysis and food proximate analysis. The laboratory has taken up maintenance and calibration (External and Internal calibration) of analytical equipment (critical and noncritical) for accurate analyses. Critical consumables such as certified reference materials, laboratory reagents and solvents to meet the different analytical requirements have been procured. The laboratory has generated analytical data by conducting pesticide residues, heavy metals and food proximate analysis by collecting samples from the APMCs and fruit and vegetable markets in the region. From this quality assurance programme including retesting, replicate testing, spike and recovery and use of internal standards have

been conducted. This goes a long way in ensuring quality of produce for export in the region.

REFLECTIONS AND CONCLUSIONS

1. All necessary steps to develop infrastructure and procure equipment required for the Pesticide Residues Analysis have been taken and a fully equipped laboratory has been established.
2. All necessary scientists involving various disciplines like Agricultural Entomology, Plant Pathology, Agricultural Microbiology, Processing and Food Engineering, Biochemistry and Biotechnology have been put in place to take up analytical studies.
3. The laboratory has obtained accreditation certificate from National Accreditation Board for Testing and Calibration Laboratories (A constituent Board of Quality Council of India), Government of India for testing 74 pesticide residues in field crops, viz., rice, wheat, sorghum, red gram, black gram, green gram and bengal gram, 72 pesticide residues in fruit and vegetable crops, viz., pomegranate, grapes, banana, mango, sweet orange, guava, tomato, brinjal, okra, green and red chillies, cabbage, cauliflower and capsicum, 7 trace metal elements (lead, cadmium, arsenic, mercury, copper, zinc and tin) in cereals, pulses and its products, moisture, ash, crude protein, crude fat, crude fibre and carbohydrate in rice, rice flour, red gram, red gram dhal and bakery products, viz., biscuits. Range of testing/ Limits of Detection have been prescribed for all tests. The Accreditation Standard is ISO/ IEC 17025: 2005 and is valid for two years from 12/07/2018 to 11/07/2020. The validity needs to be extended.
4. The Pesticide Residues Analysis Laboratory is involved in four National projects, viz., All India Network Project (AINP) on pesticide residues, heavy metal and antibiotic analysis in fruits and vegetables sponsored by Indian Council of Agricultural Research, New Delhi, Monitoring of Pesticide Residues at National Level (MPRNL) sponsored by The Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Government of India, Study to generate Baseline Data on occurrence of heavy metal contaminants in vegetables sponsored by Food Safety Standard Authority of India (FSSAI), Ministry of Health and Family welfare, Government of India and creating a protease knockout in E. coli by crelox mechanism to solubilize recombinant proteins sponsored by Department of Biotechnology, Ministry of Science and Technology, Government of India. These have given the laboratory a National Status.
5. The Pesticide Residues Analysis Laboratory in University of Agricultural Sciences, Raichur has developed and validated the multi residue analytical methods for 74 chemical pesticides used in cereals and pulses. Similarly, spatial sampling of fruits and vegetables from the market outlets were collected routinely every month and monitored the pesticide residues. This goes a long way in ensuring quality of produce for export in the region.

6. The laboratory has prepared and adopted enforcement of quality system documents, viz., quality manual, management system procedures, standard operating procedures and forms and formats that would enable systematic assessment of pesticide residues in selected field crops, fruits and vegetables. Method development and validation for pesticide residues and heavy metal analysis in cereals and pulses, fruits and vegetables and food proximate analysis have been completed by the laboratory which will benefit in residue analysis and food proximate analysis.
7. The laboratory has generated analytical data by conducting pesticide residues, heavy metals and food proximate analysis by collecting samples from the APMCs and fruit and vegetable markets in the region. From this quality assurance programme including retesting, replicate testing, spike and recovery and use of internal standards have been conducted. This goes a long way in ensuring quality of produce for export in the region.

ACTION POINTS

1. The objectives of the project have been well implemented and the laboratory is the absolute need of the region since 75 to 80% food grains produced in the region are exported and needs estimation of pesticide residues in order to export. Indeed, this laboratory needs to be upgraded and strengthened by the University for the benefit of farming community in the region.
2. The project should be on PPP mode and generating income on its own for maintenance on long run so that the manpower shortage can be met from generated income.
3. The project should aim at training human resources on use of equipment of sophisticated nature.
4. There is need for convergence of user departments in developing quality standards for the natural resources.
5. The laboratory should display Dos and Donts in the laboratory and all the laboratory equipment and infrastructure developed under RKVY funds should be labelled.
6. All the equipment are well maintained and used. However, there is need to maintain separate deadstock and consumables registers.
7. There is need for training scientists on use of equipment in the advanced areas.
8. Biopesticide residual laboratory may be established.
9. The laboratory can also associate and may be streamlined for food analysis in the region.
10. A diploma programme may be started with a capacity of 2-3 students/ year on use of equipment and standards.

RESEARCHABLE ISSUES

1. To work out the cost efficiency and profitability of the technology and its spread.
2. Establishment of centralized laboratory to avoid duplicity of purchasing equipment and chemicals and production of quantitative data besides in convergence through PPP mode of operation.
3. Develop protocols of standards of heavy metals and their safe limits in food grains, vegetables and fruits.

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Sl. No.	Name	Designation	Academic / Educational Qualification	Experience	Training
1	Dr. M. Bheemanna	Professor & Head-PRFQAL	M. Sc. (Agri. Entomology) Ph. D.	33 years (6 years on Pesticide Residue Analysis)	1. NABL documentation, 2. 21 Days Training (Entomology), 3. IPM Training, 4. Laboratory Quality System Management as per ISO/IEC 17025:2005
2	Dr. Udaykumar Nidoni	Professor & Head-PFE	M. Tech, Ph.D (Processing & Food Engineering)	26 years (15 years on Food analysis)	1. NABL Documentation 2. Laboratory Quality System Management as per ISO/IEC 17025:2005
3	Dr. Nagaraj M Naik	Assistant Professor of Agri. Microbiology,	M. Sc (Agri. Microbiology), Ph. D.	11 years (8 years on Food Analysis)	Instrumentation training on: ICPMS, GC-MS/MS, LC-MS/MS, UHPLC and FT-IR Laboratory Quality System Management & Internal Audit as per ISO/IEC 17025:2005 & 17025:2017 Training on Microbial analysis in food and water by CFTRI Training on multielemental analysis in fruits and vegetables using ICPMS conducted by FSSAI
4,	Dr. Saroja Narsing Rao	Assistant Professor of Biochemistry	M. Sc. (Biochemistry), Ph. D. Post Doc (France, Australia and USA)	10.2 years (Enzymes, Kinetics, Protein purification and Genetic Engg) 2.5 years on Food Analysis)	Instrumentation training on: FPLC, PCR, Electroporator , IEC, GPC,western blotting, Protein and DNA Electrophoresis, HPLC, DNA sequencing, Calorimeter, NMR, EPR and Microbiology techniques Pesticide Residue Analysis Laboratory Quality System Laboratory Quality System Management & Internal Audit as per ISO/IEC 17025:2005 & 17025:2017
5	Dr. Harischandra Naik, R	Assistant Professor of Entomology	M. Sc. (Agri. Entomology), Ph. D. PGDIPR, PGDAEM, PGDPP.	9 years (8 years on Pesticide Residue Analysis)	1. Pesticide Residue Analysis 2. Laboratory Quality System Management as per ISO/IEC 17025:2005 & 17025:2017 3. Instrumentation training GC-MS/MS, LC-MS/MS, ICP-MS, HPLC and GC-ECD 4. Refresher Training Programme on Pesticide Residue

					Analysis 5. Impact of Pesticides and Insect Resistance to Chemical Pesticides. 6. Method Validation & calculation of Measurement of Uncertainty in PRA
6	Mrs. Anita P	Lab Assistant	B. Sc. (Agri.) Accounts Higher, Accounts over, General Law Part I and Part II	9 years	1. Laboratory Quality System Management as per ISO/IEC 17025:2005
7	Dr. Pallavi M. S	Research associate	M. Sc. (Agri), Ph.D (Plant Pathology) PGD (IPR) PGD (RD) PGD (AEM)	5.5 years (3.5 years on Pesticide residue analysis)	Refresher Training Programme on Pesticide Residue Analysis Instrumentation training on: GC-MS/MS, LC-MS/MS, ICP-MS, HPLC and GC-ECD Laboratory Quality System management and Internal Audit as per ISO/IEC-17025:2005
8	Dr. Nandini	SRF/ Analyst	M.Sc (Agricultural Entomology) Ph.D PGDIPR, PGD on NANOBIOTECHNOLOGY	5 years 8 months (1 year on Pesticide Residue Analysis)	Training on Estimation of Pesticide Residues in Food Commodities Instrumentation training on : LC-MS/MS, GC-MS/MS
9	Mr. V Chandra Sekhara Reddy	SRF/ Analyst	M. Sc (Bio-technology)	5 years 2 months (3 years 4 months on Pesticide Residue Analysis & Food Quality Analysis)	Instrumentation training on : UHPLC, LC-MS/MS, GC-MS/MS, FT-IR, UV-VIS Photo chemical derivatizer (PhCR) Solid phase Extraction Unit (SPE) Laboratory Quality System management and Internal Audit as per ISO/IEC-17025:2005
10	Mr. Pavan Kumar	SRF/ Analyst	M. Pharmacy	6 years	Instrumentation training on : HPLC, GC-FID,ECD,TCD, HSGC, PSD, FT-IR, UV-VIS, Automatic Potentiometric Titrator, KF Titrator, LC-MS/MS, GC-MS/MS

					Laboratory Quality System management and Internal Audit as per ISO/IEC-17025:2005 Refresher Training Programme on Pesticide Residue Analysis Training on Water Quality Analysis as per IS 10500:2012
11	Mr. Vasant Kumar	SRF/Analyst	M.Sc. (Chemistry)	4 years 2 months	Instrumentation training on: ICP-MS, LC-MS/MS, GC-MS/MS, FT-IR, UHPLC, UV-VIS, SOCSPLUS, FIBRAPLUS, KJELDHAL UNIT Laboratory Quality System Management & Internal Audit as per ISO/IEC 17025:2005
12	Mrs. Tejashri. K	SRF/Analyst	M.Sc. (Chemistry)	4 years 2 months	Instrumentation training on: ICP-MS, GC-MS/MS, LC-MS/MS, HPLC, FT-IR, SOCSPLUS, FIBRAPLUS, KJELDHALUNIT, UV-VIS Training on multielemental analysis in fruits and vegetables using ICPMS conducted by FSSAI Laboratory Quality System management and Internal Audit as per ISO/IEC-17025:2005
13	Mrs. Shruti Patil	SRF/Analyst	M.Sc. (Botany)	5 years 1 months	Instrumentation training on: UHPLC, FT-IR, UV-VIS spectrophotometer, Automatic Kjeldhal Analyzer, SOXTHERM, SOCS PLUS, FIBRETHERM with Fibre Bag-Technology, FIBRA PLUS, Turbidity bench top Meter, Anion portable meter, TDS/EC/Salinity bench top meter, Flash evaporator Laboratory Quality System Management as per ISO/IEC 17025:2005 Training on Water Quality Analysis as per IS 10500:2012
14	Mr. Naveen Kumar P	SRF/ Analyst	M.Sc. (Bio-chemistry) Post Graduate Diploma in Plant Health Management with	1 year 2 months	Laboratory Quality System Management as per ISO/IEC 17025:2005 Training on Agricultural Extension Management Training on Estimation of Pesticide Residues in Food Commodities. Instrumentation Training on: HPLC, GC-FID, TCD, GC-

			Specialization in Pesticide Management		MS/MS
15	Mrs.Vimala	SRF	M.Sc (Biotechnology) Ph.D Thesis Submitted	5 years 2 months (Mass Multiplication of Bioagents, Insecticide resistance Monitoring studies at Molecular and Biochemical levels)	Molecular and Advanced Training on Immunotechniques. Training on IPR. Nanoscience and Technology 6 months Project work/ training at Plant Tissue Culture Laboratory, UAS, Dharwad.
16	Dr. Jamuna	SRF/Analyst	M. Sc. (Agri Entomology) Ph. D, PGDIPR, PGDHR	1 year	Training on advances in seed production, processing and quality assurance
17	Mrs. Shwetha A	JRF	B' Pharmacy M.Sc. (Chemistry) Diploma in Pharmacy	5.5 years (Quality assurance, NABL Documentation & Pesticide residue analysis)	Laboratory Quality System Management as per ISO/IEC 17025:2005 Instrumentation Training on: LC-MS/MS, HPLC Training on Estimation of Pesticide Residues in Food Commodities.
18	Ms. Ratnamma	JRF	M. Sc (Agri. Entomology),	4 months	--
19	Mr. Deevaraja	JRF	M. Sc (Agri. Entomology),	4 months	--

TERMS OF REFERENCE

FOR THE EVALUATION OF THE PROJECT ENTITLED "ESTABLISHMENT OF PESTICIDE RESIDUES ANALYSIS LABORATORY IN HYDERABAD KARNATAKA REGION" IMPLEMENTED DURING 2015-16 BY UNIVERSITY OF AGRICULTURAL SCIENCES, RAICHUR

1. Title of the Study: Establishment of Pesticide Residues Analysis Laboratory in Hyderabad Karnataka region"
2. Department/ Agency implementing the Scheme : University of Agricultural Sciences, Raichur

3. Project Approval No (Sector) : KA/RKVY-AGRE/2017/841

4. Year of start : 2013-14
   Year of conclusion : Continued project

5. Total budget of the project : 0.35 crores.

6. Background and the context

In India, insect pest infestation contributes lot for the crop losses both at field and in storages. However, the judicious use of pesticides in containing the wide spectrum of pest's species in agriculture played a crucial role towards enhancement of the agricultural production and contributed lot to the nation's food security. Whereas in recent years, non judicious use, misuse and abuse of pesticide were reported and has been categorized as one among the major reason for several pest outbreak in different agro-ecosystem besides leaving their significant level of residues. One of the most important concerns in this area is that the monitoring of pesticide residues in different agro-ecosystem to know the status of used pesticides and their interaction with different strata of ecosystem, to acquaint with their safe limits and restrict those pesticides recorded beyond their permissible limit. Pesticide residues in agricultural commodities in excess of the MRLs fixed by the PFA and Codex will also adversely affect the exports of agricultural products at international trade.

The Hyderabad-Karnataka is a socioeconomically challenged region (6 districts, *viz.,* Bidar, Gulbarga, Yadgir Raichur, Bellary, Koppal) having large mass of agrarian population with an irrigation potentiality of 12 lakh hectares through two major irrigation projects *viz.,* Tungabhadra project (TBP) and Upper Krishna Project spanning a total geographical area of 44.96 lakh hectares accounting 33.60 per cent of the geographical area of the state, of which nearly 68 per cent is

under cultivation. The diversity of crops grown in this region includes cotton, rice, sugarcane, pigeon pea, chickpea, soy bean, sorghum, many vegetables and fruit crops. The crop protection cannot be imagined without inclusion of insecticides in the schedules of Integrated Pest Management programme for different crops. Further, the crops like rice and pigeonpea protection are largely depends upon the use of pesticides to protect the expected yield as because of these crops are grown in commercial mode even though they belong to food crop category. In recent days, even we had Bt technology in cotton production but the farmers have to rely on use of insecticide to manage the sucking pest complex. However, chickpea, sugarcane and soybean production is also need to have use of pesticide to protect their yield. In overall scenario, HK region after the implementation of two major irrigation projects, commercial mode of crop cultivation has began and use of pesticide has increased tremendously over the years with consumption of 50 percent pesticides in the state's share and this region has adjudged as one of the high pesticide pressure area.

Raichur is privileged of being an oldest establishment of Agricultural Research Station in 1932 with a mandate to carry out research on dry land farming. However, the full fledged University has established during 2009 with an objective to conduct the location specific research in this area as because of diverse cropping pattern, concern towards issues related to the agrarian sector and sustainable development of the farming community. So for the University has developed various research establishments, particularly in the field of Plant breeding, seed production and supply of quality seed, crop protection and crop production to overcome the various hurdles in modern agricultural productions. Keeping in view the growing concern over the pesticide residues in various agro-commodities, recently with the financial aid from RKVY and MOFPI, Government of India, the University of Agricultural Sciences, Raichur has established a well equipped Pesticide Residue and Food Quality Analysis Laboratory by hosting all necessary equipments which are currently being used in other research and quality control laboratory of the nation. In respect of pesticide residues in foods, the Pesticide Residue and Food Quality Analysis Laboratory, University of Agricultural Sciences, Raichur will be promoting the research activities on pesticide residues in agricultural produce, dissipation of pesticides in crops from supervised trials to work out the safe limits between pesticide application and harvest of the produce, devise simple, sensitive and cost effective analytical methodology for quantification of pesticide residues and their degradation products, the effect of processing of food commodities for the decontamination of pesticide residues.

7. The objectives

1. Development and Standardization of the multi residue analytical method for major insecticides used in cereals and pulses insect pest management
2. Monitoring of pesticides residues in samples collected from pigeonpea and paddy ecosystem

3. Spatial sampling of fruits and vegetables from the market outlets and monitoring of pesticide residue in them,

8. Present status of the project

The above project was implemented during 2015-16 at University of Agricultural Sciences, Raichur and continued since then. It is being operating since implementation for the objective mentioned. The research works conducted in the project are follows,

1. Developed and validated the multi residue analytical method for 74 chemical pesticides used in cereals and pulses. The cereals, pulses, fruits and vegetable samples are being monitored for pesticide content.

2. Monitoring of pesticides residues in pigeonpea collected from Gulbarga region. About 120 grain samples were collected and analyzed. The pesticide residues were quantified. Similarly, paddy grains were collected from farmer's field during harvest and analyzed for pesticide residue using laboratory developed and validated method.

3. Spatial sampling of fruits and vegetables from the market outlets were collected routinely on every month and monitored the pesticide.

Apart from the above technical work, following documentation work has been attended as part of the accreditation of the laboratory as per the ISO/IEC 17025:2005 under National Board for testing and calibration laboratory, Government of India.

1. Technical requirement for pesticide residue and Heavy metals analysis in fruits, vegetables, cereals and pulses as per international standard of ISO/IEC17025:2005 at PRFQAL, UAS Raichur were attended.
2. Prepared, adopted and enforcement of quality system documents; Quality Manual, Management system Procedures, Standard Operating Procedures, Forms and Formats.
3. Method development and validation for pesticide residue and heavy metal in cereals and pulses, fruits, vegetables and food proximate analysis.
4. Maintenance and calibration (External and Internal Calibration) of Analytical equipments (critical and non critical analytical equipment) at PRFQAL.
5. Procurement of critical consumable such as certified reference materials, laboratory reagent and solvents to meet out the different analytical requirements.
6. Generated of analytical data in samples collected from different sources for pesticide residue and heavy metal, and food proximate analysis and conducted of Quality Assurance Programme *viz.,* replicate testing, re-testing, spike and recovery, use of internal standards.

7. Conducted /participated of Inter Laboratory Comparison test.
8. Participated in Proficiency Testing by external PT provider; NIPHM, and Hyderabad.
9. Conducted the Internal Audit and attended the corrective actions.
10. Arranged and organized the Management Review Meeting and attended corrective actions.
11. Attended and complained to the Pre-Assessment conducted by Lead Assessor (Officials) from NABL, Dept. of Science and Technology, Govt of India. Attended the Corrective action for Non compliance raised during the Pre-assessment.
12. Attended and complained to NABL Final Assessment conducted by Lead Assessor and Technical Assessor (Officials) from NABL, Dept. of Science and Technology, Govt of India. Attended the Corrective action for Non compliance raised in the Final Assessment.
13. Submitted the Corrective Action to the NABL for granting of Accreditation as per the International Standard ISO/IEC 17025:2005 in the field of Testing for Chemical Analysis (Scope).
14. Generation of Revolving fund through analysis of customer sample for pesticide residues and environmental gas monitoring.
15. Delivered the lecture on Pesticide Residue and Heavy metal analysis and its importance in various food articles to the Farmers, Extension Workers, Scientist and other stake holders from various training programme conducted at UAS, Raichur upon their visit to the PRFQAL.

Projects being undertaken at PRFQAL

1. All India Net Work Project (AINP) on pesticide residues, heavy metal and antibiotic analysis sponsored by ICAR, New Delhi.
2. Monitoring of Pesticide Residues at National Level (MPRNL) sponsored by Ministry of Agriculture and Farmers Welfare, Government of India.
3. Study to generate baseline data on occurrence of metal contaminants in vegetables sponsored by FSSAI, Government of India.
4. Creating a protease knockout in *E.coli* by Crelox mechanism to solubalize recombinant proteins, funded by Dept. of Biotechnology, Ministry of Science and Technology, Government of India.

9. Outcome of the project:

1. Construction of the separate and independent laboratory building was completed and the required analytical equipments were being installed, operated and maintained.

2. Appointment of the Scientist for the post of Assistant Professor of Entomology, Assistant Professor of Microbiology and Assistant professor of Biochemistry were made.

3. Method development and validation was completed.

4. The NABL accreditation for the laboratory as per the international standard ISO/IEC 17025: 2005 was obtained in the field of **Testing** for **Chemical Analysis** for pesticide residue analysis in fruits, vegetables, cereals and pulses.

5. Laboratory is catering the need of various stakeholders such as farmers, students, research scholars, and food processing industries, food packers, scientific and academic institutions and organic growers, export agencies and others.

6. Laboratory developed scopes under the sanctioned project

    A. Pesticide Residue Analysis
    B. Heavy Metal Analysis
    C. Food Proximate Composition
    D. Food Adulterants
    E. Environmental Gas Estimation

9. Assets: Including building, equipments – all the assets purchased under the project

Sl. No.	Description	Manufacturer/ Supplier	Brief Specifications	Purchase Order No. and date	Date of Receipt	Total Cost **(Rs. In Lakhs)**	Purpose of purchase
01	NH2 Analytical HPLC Column				29.12.15	36,693/-	Pesticide Residue Analysis
02	HP Laptop	Hewlett-Packard India Sale Pvt Ltd. 24, Salarpuria Arena Hosur Main Road, Adugodi Bangalore – 560030	**Performance:** Core i3 3rd Gen 2.4 Ghz 4 GB DDR3 RAM 2Graphics **Design:** 15.6 inches (39.62 cm) 1366 x 768 pixels 2.47 Kg, 36.3 mm thick **Storage:** 500 GB HDD SATA 5400 RPM		13.02.16	55,387/-	PRFQAL
03	Bio-metrics	ESSL Security #24, 23rd Main Rd, Marenahalli, 2nd Phase, J. P. Nagar, Bengaluru, 560078	Biometric System Segment: Office Transactions: 80000 Display Size: 2.8 inch Identification speed: 1 second Colour: Black Display: LED		20.03.16	21,045/-	PRFQAL
04	Air Cooler	Symphony House FP-15 TP-50 Bodakdev Off SG Highway Ahmedabad, Gujurat 380054			16.03.16	47,740/-	PRFQAL
05	Mixer Grinder	TTK Prestige Limited 38, Sipcot Industrial Complex, Hosur-635126 Tamil Nadu			30.03.16	4,275/-	PRFQAL
06	High Volume Homogenizer		Homogenizer (High Volume)	SPO/UASR/422/2015-16 11-03-16	31.03.16	6,00,000/-	Pesticide Residue Analysis

07	Magnetic Locks				14.07.16	22,133/-	
08	All In One Desktop	Hewlett-Packard India Sale Pvt Ltd. 24, Salarpuria Arena Hosur Main Road, Adugodi Bangalore – 560030	Hewlett-Packard All in one Desktop computer **Processor**: Intel Core I5 4th Generation **RAM**: 4 GB, **Hard Disk**: 500GB DVD writer, Keyboard, Mouse, Wireless LAN, Web Camera, 19.5" Screen and DOS		27.07.16	1,24,954/-	PRFQAL
09	AC	Blue Star Limited CBO ACRSD 2nd Pokhran Road Majiwada Thane – 400601	Samsung 2.0 TON capacity Split A C 3-Star Rating (2015) Digital temperature display, Allergen Filter, Multi Jet Technology, Tropicalized compressor, Anti bacterial Filter, Auto clean, Good Sleep, Optimal Singlre blade for better air flow, smart saver, turbo mode, Dehumidification, Auto mode, Digital temp display, 24-Hour On Off timer. **Indoor gross weight**: 14.4 Kg **Outdoor unit gross weight**: 55.8 Kg **Air circulation**: 16 meter cube per min	UAS/2014-15/IND650	27.07.16	53,759/-	PRFQAL
10	Digital Sense Pre-Calibrated Thermo hygrometer				01.09.16	19,923/-	PRFQAL
11	Electronic Balance Sartorius	Sartorius India Pvt Ltd No. 69/2 & 69/3, Kunigal Road, Jakkasandra, Nelamangala Taluk Bengaluru - 562123	**Model**: BSA 224S-CW **Brand Name** : Sartorius **Size** : Pan: 90 mm **Repeatability** : <+0.1 mg **Readability** : 0.0001 G-0.1 Mg **Application Text**: Weighing In Percentage.	SPO/UASR/473	20.09.16	99,698/-	Pesticide Residue Analysis

			Dynamic Weighing/Animal Weighing Cunting Net Total **Linearity** : <+0.2 mg **Response Time**: 1 second				
12	Laboratory E2 Class Weight Box	Weigh India Plot no 137, Functional Industrial Estate, Patparganj New Delhi - 110092	Model: AX 206 Serial No: 1129330752 Max Capacity: 210 g Readability: 0.001 mg Repeatability: 0.004 mg Linearity: 0.008 mg Temperature: (22.0±2.0)˚C	09.08.2016		98,413/-	Pesticide Residue Analysis
13	pH Meter	Systronics Technologies B/116-129, 1st Floor , Supath-II Complex. Nr. Juna Wadaj Bus Terminus, Asharam Road, Ahmedabad – 380013 Gujurat (India)	pH: 0 to 14.00 pH Resolution: 0.01 pH Repeatability: ± 0.01 pH ± 1 digit Temperature: 0 to 99 ˚C Resolution: 0.1˚C pH Calibration: 2 & 3 point calibration with standard pH buffers. Display: 7 digits, 7 segment LEDs with auto polarity and decimal point	09.08.16		25,924/-	PRFQAL
14	Microwave Oven	-	-	-		16,259/-	
15	Filing Cabinet	-	-	-	09.08.16	21,000/-	PRFQAL

11. Where the project is under taken: The project was undertaken at University of Agriculture Sciences, Raichur head quarters.

12. Evaluation questions and minimum expectations:

1. Whether the PRFQAL centre is strengthened in terms of infrastructure facilities?	Yes
2. Whether this quality control laboratory is fully equipped at the centre?	Yes
3. Whether the required equipments are procured for this lab?	Yes
4. Have the quality control laboratory started analyzing the samples on large scale?	Yes
5. Which are the analysis are currently being undertaken at the centre and the available for service to the customer	Pesticide Residue analysis Heavy metal analysis Food proximate composition
6. Whether the analytical referral laboratory at the centre is fully equipped?	Yes
7. Have basic equipments for the analytical laboratory is procured?	Yes
8. Whether the glassware's and chemicals for both the laboratories is made available to the farmers?	Yes
9. Whether the services of the laboratory are made available to the farmers?	Yes
10. Whether in the analytical referral laboratory farmer's soil samples are analyzed?	Yes
11. Have the centre has undertaken scientific validation of ZBNF?	No
12. Whether the centre is having separate field unit for conducting research and demonstration pesticide residue analysis	Yes
13. Whether any organic experiments (multi location trials) & demonstrations carried out at these stations?	Yes
14. Whether extension work is carried out by the centre out by the centre in transmission of quality control service to farming community	Yes
15. Whether the centre is having any training facilities for farmers, line department officials and students?	Yes

13. Evaluation of Laboratory Performance
    1. By conducting assuring the quality of test results
    2. By participation of Inter-laboratory comparison
    3. Participation in Proficiency testing
    4. Internal Audits
    5. Management review Meetings
    6. Evaluation by NABL officials on laboratory performance.
    7. The training facilities available at the centre have to be inspected and evaluated for their utility?

14. Deliverables:
    A detailed report of the impact of the project on quality control in pesticide residue research needs to be submitted.

15. Duration and time schedule for the study
    The task should be completed in three months time.
    - Visit of respective centre and inspection of laboratories, training, facilities, field unit, nutrient production units and demonstration unit.
    - Discussion with Principal Investigator/ Co-ordinator
    - Visit to ARS/ ZARS centre (Chintamani & Nagenahally) and discussion with SFS.
    - Preparation of draft report.
    - Presentation of draft report.
    - Final report to be submitted before the end of three months.

16. Quality Expected from the Evaluation report:
    The report should highlight the following
    1. The importance of strengthening of PRFQAL under the research aspect in residue analysis
    2. The impact of pesticide residue analytical lab established at the centre.
    3. The utility of the PRFQAL by the various stakeholders.
    4. The impact of the service to the customer of the laboratory
    5. The impact of pesticide residue analysis experiments in developing the MRLs in different field crops.

17. Recommendations:
    Specific recommendations leading to policy change in providing more financial grants in strengthening the PRFQAL under the UAS, Raichur.

18. Cost and schedule budgets:

The budget would be released as follows:

1. The first installment of consultation fee of 30% of the total fee shall be paid as advanced to the consultant after the approval of the inception report, but only on execution of a bank guarantee of a schedule nationalized bank valid for a period of at least one month from date of receipt of advance.
2. Second installment of consultation fee of 50% of the total fee shall be payable to consultant after the approval of the draft report.
3. Third and final installment of consultation fee amounting to 20% of the total fee shall be payable to the consultant after the receipt of hard and soft copies of the final report in the format and the number as prescribed in the agreement along with all original documents.
4. Tax will be deducted from each payment as per the rates in force; in addition the evaluator is expected to pay statutory taxes at their end.

19. Minimum qualification of the consultant:

20. Providing Oversight

21. Contact Persons: Officer In-charge of the Project, mailing address, Contact Phone No.

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Principle Investigator
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EVALUATION TEAM MEMBERS

Sl. No.	Name	Designation
1	Dr. M. A. Shankar	Principal Investigator
2	Dr. B. C. Suryanarayana	Associate Investigator
3	Sri. Siddaraju	Associate Investigator
4	Dr. A. R. V. Kumar	Subject Matter Specialist

Dr. M. A. Shankar is a doctorate in Agriculture with specialization in Agronomy. He is former Director of Research, University of Agricultural Sciences, Bengaluru and presently the Executive Member of Institution of Agricultural Technologists, Bengaluru and Co-Chairman of Agribusiness Consultancy Subcommittee. He has implemented 51 research projects for the University funded by International organizations, Central and State governments, Private firms. He has guided 6 Ph. D. students and 15 M. Sc., (Agri) students. As Dean of College of Agriculture, Hassan, he has, with his administrative skills, streamlined accounting, financial, academic and administrative issues. He has been involved in review and evaluation of Technical Reports of 32 All India Co-ordinated Research Projects (AICRP) spread all over India. He has also evaluated 11 operational research projects for the technical feasibility and implementation. He has published 173 peer reviewed research papers. He has also penned 54 booklets and books for the University. He has vast experience in evaluation studies of projects.

Dr.Suryanarayana, B.C. is a doctorate in Agriculture with specialization in Agronomy and is a Certified Associate of Indian Institute of Banking (CAIIB), Fellow of Indian Institute of Valuers. He worked in State Bank of India from the year 1981 to 2014 as a Technical Officer and retired as Asst. General Manager (Rural Development). He is a practicing consultant in the field of Agriculture, Horticulture, poultry, dairy, fisheries and plant tissue culture and covered cultivation. He has about 35 years of experience in the field and has prepared several project reports for financial institution, written books in vanilla cultivation, anthurium, medicinal and aromatic crops, minor irrigation, poultry and dairy farming. He has appraised more than 6,000 proposals in agriculture and related fields for funding by the Bank and has also been involved in many studies relating to development of Agriculture and allied activities. He has served as a General Manager in a bio-fertilizer, bio-pesticides and organic manures manufacturing company and is also a Technical Director in a company involved in manufacture of agricultural implements and equipment.

Sri. Siddaraju is a Graduate in Agriculture with more than 35 experience in the field of Agriculture. He has served in the Karnataka State Department of Agriculture (KSDA) as Asst. Agricultural Officer in Farmers' Training and Education Centre, Soil Testing laboratory and as Subject Matter Specialist. He was Deputy Director of Agriculture (Commercial Crops) for 6 years, District Watershed Development Officer for 2 years. He has also been Joint Director of Agriculture (Inputs) for 5 years. He was involved in preparation of Annual Programme Planning booklets pertaining to Agricultural Inputs in Department of Agriculture. After retirement, he is serving as Chairman, Agriculture Consultancy Subcommittee, Institution of Agricultural Technologists, Bengaluru and has been actively involved in evaluation studies of projects.

Dr. A.R.V. Kumar, is a doctorate in Agriculture with specialization in Agricultural Entomolgy from University of Agricultural Sciences, Bangalore. He served in the University in various capacities and retired as University Head of Entomology Department, Professor of Entomology. He has worked on aspects of Pest management in different cropping systems and for an extended period on the management of White grubs in different cropping systems. He has built up a collection of over 50,000 white grub specimens of India at the department. He has also worked on the use of neem in pest management and Insect Tolerant Transgenic Crops. He has guided both masters and Ph.D. students on various aspects of Pest Management and Insect Taxonomy. He has taught Insect Morphology, Principles of IPM, Insect Ecology and Insect Taxonomy at the University. He took special interest in the development of infrastructure at the Department of Entomology, set up a molecular biology lab and to set up the First Butterfly Park at the Banneraghatta National Park, Bengaluru. He has 95 research articles and Two edited books to his credit. Two of his publications are being extensively used in teaching Community Ecology. Currently he is working on the development of mass multiplication techniques for several insects as sources of animal protein.