RPF - III
(PERFORMA FOR SUBMISSION OF FINAL REPORT OF RESEARCH PROJECTS)

PART – I: General Information

600 Project Code : 60/2007

6001 Institute Project Code No. : 60

6002 ICAR Project Code No. :

601 Name of the Institute and Division:

6011 Name and Address of the Institute : National Academy of Agricultural Research Management, Rajendranagar, Hyderabad

6012 Name of the Division/Section : RSM Division

6013 Location of the Project : NAARM

602 Project Title: Assessment of new developments in nanotechnology for their potential applications in agriculture

603 Priority Area:

6031 Research Approach: Applied Res./Basic Res./Process or Tech./Transfer of

		Develop.	Technology
01	02	03	04

604 **Specific Area:** Technology Forecasting

6041 Previous Project/Projects in this specific area: Not applicable
(Year, type of funding, cost, etc.)

605 **Duration of the Project:** 4 years

6051 Date of Start of the Project: May 2008- March 2012- NAIP Funding
April 2012- March 2014 – NAARM funding

6052 Likely date of Completion of the Project: March 2014

606 Total Cost of the Project: Rs 18,10,700

6061 Expenditure to Date: **Rs. 4,11,795/-**

607 Summary of Achievements

The specially designed database model was used to organize information from R&D indicators in nanotechnology. Knowledge mapping concepts were applied and two case studies developed. Major outputs from work include development of assessment of nanotechnology for food processing sector and water applications in agriculture. All these are useful in preparation of road map for policy in use of NT in agriculture. Major

outcome has been recognition at several platforms for, both national and international levels during the project ; extending the knowledge domain to several institutions of NARS and outside NARS for initiating research studies in key areas. This has resulted in R&D projects being initiated by several institutes. It is also realized that studies on ethical, environmental and risk assessment of nanotechnology in agriculture are needed carried out before the technologies can be released/applied.

608 Key Words:
Nanotechnology, Nanoresearch areas, Agriculture R& D, Bibliometrics, Patent analysis, Technology forecasting, Roadmap, Knowledge mapping

Part-II : Investigator Profile
(Please identify clearly changes, if any, in Project Personnel)

610	**Principal Investigator**	**:**
6101	Name	: R.Kalpana Sastry
6102	Designation	: Head (RSM)
6103	Division/Section	:
6104	Location	: Hyderabad
6105	Institute Address	: NAARM, Rajendranagar, Hyderabad

611	**Co-Investigator**	**:**
6111	Name	:N.H.Rao
6112	Designation	: Principal Scientist
6113	Division/Section	:
6114	Location	: Hyderabad
6115	Institute Address	: NAARM, Rajendranagar, Hyderabad

Part – III: Technical Details

620 Introduction and Objectives

Nanotechnology (NT) is emerging as the new science and technology platform for the next wave of development and transformation of agri-food systems, as well as improve the conditions of the poor (UN Millennium Report, 2005). A UN Survey on potential applications of nanotechnology in developing countries identified agricultural productivity enhancement as the second most critical area of application for attaining the millennium development goals. Energy conversion and storage was ranked first and water treatment third. Both energy and water are also vital inputs to agriculture.

However, it is important that the new technologies, including nanotechnology, be extended across the entire agricultural value chain to increase agricultural productivities, product quality, consumer acceptance and resource use efficiencies. Consequently, this will reduce farm and consumer costs, raise the value of production and increase farm incomes. It will also lead to conserving and enhancing the quality of the natural resource base in agricultural production systems.

The need to maintain technological parity with global competitors is a critical strategic issue for the agricultural and rural sectors. Emerging technologies can create competitive advantage and commercial success for farmers and agricultural industries as well as benefit rural communities. However, this is possible only if a more coherent systems approach is adopted for planning technology development and implementation across the agricultural supply chains, to assess where innovation can contribute to competitive advantage. Equally important, commercial partners who can adopt and benefit from new technologies, and assist with their implementation, need to be identified early and actively pursued.

6201 Immediate Objectives:

(i) To develop a knowledge base of global scale research developments in agri-food nanotechnologies and assess their potential for application in agricultural production and processing systems in India.
(ii) To assess the social and environmental impacts of the new technologies
(iii) To develop a roadmap for agri-food nanotechnology research and development in India

6202 Long -term objectives:

The long-term objective of the project is to build the capacity of the National Agricultural Research System (NARS) in technology road mapping for agricultural research and development in India.

6203 Specific Objectives for the year, as detailed in RPF-I:

Developing Bibliometric database, Patent search and analysis for Nanotechnology in Agriculture

621 **Project Technical Profile**

6211 Technical Programme:

(Indicate briefly plan of procedure, techniques, instruments and special materials, organisms, special environment, etc.)

Methodology for development of framework involved:

Part -III: Technical Details

822 Final Report on the Project

Detailed report containing all relevant data with a summary of results
(not exceeding 2-5 pages)

The implications of nanotechnology research for agriculture need to be assessed not only at the farm production system level, but also beyond the farm gate and encompassing all the links across the entire agricultural value chain: farm inputs; farm production systems, post harvest storage, transport and processing, and finally to the markets and consumers. To attain the targeted annual growth rate for the agricultural sector of four per cent on average by 2020 in a sustainable fashion, emerging technologies such as biotechnology and nanotechnology will have to complement the conventional green revolution technologies. The present report focuses on analyzing current trends in nanotechnology for assessing their implications for the agri-food sector in India.

Objectives:

The overriding objective of this study was to develop a sufficiently general systems and process based methodology for a systematic assessment of the potential for application of nanotechnology across the various links in the agricultural value chain, to develop a roadmap for nanotechnology applications in agricultural research in India. The specific objectives of the project included to: develop a general framework and process based methodology for nanotechnology assessment that facilitates integration of nanotechnology into the agricultural research domain; design and develop bibliographic and patents databases of nanotechnology research with potential for applications in agriculture, to map the nanoresearch areas to sectors across the agri-supply chain; engage, share, and facilitate the stakeholders in NARS in developing a new nanoscience and technology research agenda that enhances, complements and integrates with existing agricultural research; and assess implications for institutional policies, as well as for society and environment, to enable integration of emerging nanotechnologies into the agricultural value chain and facilitate technology transfer.

Outcome:

i. Development of knowledge database of agri-based nanotechnologies (literature and patents) for use in NARS and also by nanoresearchers in India
ii.Publication of research papers in peer reviewed national (2) and international (2) journals
iii. Invited talks at national (4) and international platforms (3)
iv. Part of panel discussions on potential of nanotechnology in agri food value chain across wide section of society
v.Recognition by institutes across NARS and also across other scientific institutions (national and international) and with strong indications of interest for further collaboration (s) with them
vi. Opportunity for interaction with Industry
vii. Reaching society through popular talks at school, college and also senior citizen, civil societies level
viii. Engaging young researchers (students and probationers of ICAR) towards projects on nanotechnology based issues
ix. Self learning for team on advances in analyzing tools for foresight and visioning studies
x.Team members invited as referees in high impact journals

Potential application:

- The database allows mapping research themes in nanotechnology to specific sectors in the agricultural value chain. This enables a rational assessment of the potential applications of nanotechnology in the Indian agri-food sector, identifying and prioritizing research needs across the agricultural value chain, and assessing the societal implications of this emerging technology. Such an assessment will lead to the development of a roadmap for agri-nanotechnology research in India.
- The specially designed database model was used to organize information from R&D indicators in nanotechnology.
- Knowledge mapping concepts were applied and six case studies were developed. These include development of assessment of nanotechnology for disease diagnostics, delivering, treatment, precision farming technologies, and rice cropping systems and for applications of agri-nanobiotechnology in agriculture. All these are useful in preparation of road map for policy in use of NT in agriculture.
- Extending the knowledge domain to several institutions of NARS and outside NARS for initiating research studies in key areas of nanotechnology in agri-food value chain. This has resulted in R&D projects being initiated by several institutes. It is also realized that studies on ethical, environmental and risk assessment of nanotechnology in agriculture are needed carried out before the technologies can be released/applied.

8221 Achievements in terms of targets fixed for each activity

All targets envisaged have been achieved.

Final Report submitted to NAIP. Assessment of development of Nanotechnology (NT) for agricultural research and development" -part of a major project on "Visioning Policy Analysis and Strategizing Gender (V-PAGE)". NHRao and R.Kalpana Sastry. 2012.

Copy enclosed.

8222 Questions- Answered

Yes

8223 Process/ Product/ Technology/ Developed

Against a premise that the technology road mapping process takes into account both the nature of the emerging technologies as well as the scenario for technology generation, dissemination and transfer, an attempt to develop a systematized protocol for developing a framework was made. Keeping in view the emerging transformation of the agricultural research system in India to an innovation system (NARS to NAIS, being piloted by the NAIP), the framework was thus developed to map nanoresearch areas to the research themes along the agricultural supply chain, or the entire production-consumption system. This generalized and process based framework enables identification and characterization of the outputs (publications, patents, etc.), and maps them to the different agricultural research theme areas through the filter of links in the agri-value chain. The framework also helps in assessing the implications for technology transfer, and impacts on society and

environment. Therefore the framework comprises: identification of relevant nanoresearch and agri-food research thematic areas and mapping the outputs of nanoresearch areas (publications and patents) to the agri-food research areas using the different links in the agricultural value chain as guides using database technologies.

1. Identification of nanoresearch and agri-food research thematic areas through
    1. A preliminary survey and assessment of literature,
    2. Interviews with leading experts in Cornell University, USDA, National Nanotechnology Initiative (NNI), and other centers in the U.S (Kalpana Sastry et al, 2007), and
    3. Data collected from researchers in National Agricultural Research System (NARS) in India.

2. Framework for integrating nanotechnology into agri-food value chain

Research and Development (R&D) outputs of nanotechnology is assessed and quantified by publications (for scientific performance), patents (for technological performance), and products in the market (for commercial presence). A generalized and process based framework to enable identification and characterization of the outputs (publications, patents, etc.), and map them to the different agricultural research theme areas through the filter of links in the agri-value chain is proposed. The framework also permits assessing the implications for technology transfer, and impacts on society and environment.

3. Designing the database structure for bibliometric and patents data storage and analysis

Literature/patents accessed on the basis of carefully chosen search strings was scanned carefully to assess and entered in the database: agricultural nanotechnology area, supply chain sector, agricultural research area, possible health and environmental risks, social implications risks, areas and regions of technology concentration, and for addressing various issues relating to technology assessment.

8224 Practical Utility
(not more than 150 words)

i. A database of nano research work related to agri-food systems with a mode of query, search and digitalized version of the output indicator developed.

ii. Biosynthesis of nanoparticles protocols worked out.

iii. Guidance to six students of BTech course, The ICFAI Institute of Science and Technology on assessment of nanobiotechnology in agriculture.

iv. Collaboration on basic work in nanosynthesis with DRR,DOR, agro-biotech foundation,ARCI

v. IP landscaping of nanobiotechnology related patents in agriculture

8225 Constraints, if any

NIL

823 Publications and Material Development
(One copy each to be supplied with this proforma.)

8231 Research papers

Enclosed

8232 Popular articles

Enclosed

8233 Reports

Enclosed

8234 Seminars, conferences and workshops (relevant to the project) in which the scientists have participated. (List abstracts forwarded)

Enclosed

824 Infrastructural facilities developed
(Details of field, laboratory, note books and final material and their location)

825 Comments / Suggestions of Project Leader regarding possible future line of work that may be taken up arising out of this Project.

The results can be integrated into ICAR Platform on Agrinanotechnology. The results from this project from NAARM were used for project proposals in this Platform by several scientists in ICAR system. The team in the said project is also part of proposal under Theme V of prposed Platform Project on agrinanotechnology.

Part-IV : Project Expenditure
(Summary)
Year----------

830 Total Recurring Expenditure

8301 Salaries: (Designation with pay scale)

	Estimated	Actual
i) Scientific		
ii) Technical		
iii) Supporting		
iv) Wages		
Sub-Total		

8302 Consumables

i) Chemicals		
ii) Glasswares		
iii) Others		
Sub-Total		

8303 Travel

8304 Miscellaneous (other costs)

8305 Sub-Total (Recurring)

831 Total Non – Recurring Expenditure (Equipments and works)

i)		
ii)		
iii)		

823 Total (830 and 831)

Details under the heads mentioned above placed in report enclosed herewith.

Part-V : Declaration

This is to certify that the final report of the Project has been submitted in full consultation with the Project workers as per the approved objectives and technical programme and the relevant records, note-books, materials are available for the same.

Signature of the Project Investigator: R. Kalpana Sastry

Co-Investigators 1. Rao

Signature & Comments of the Head
Of the Division/ Section

Signature & Comments of the
Joint Director

Project Targets completed

R. Kalpana Sastry

डॉ.आर. कल्पना शास्त्री
Dr. R. Kalpana Sastry
संयुक्त निदेशक/Joint Director
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National Academy of Agricultural Research Management
राजेन्द्रनगर/Rajendranagar, हैदराबाद/Hyderabad-500 030.

Signature & Comments of the
Director

Report submitted fully.

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डॉ. एस.एल. गोस्वामी
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