RPF – III

(PROFORMA FOR SUBMISSION OF ANNUAL PROGRESS REPORT OF RESEARCH PROPOSAL)

PART – I: General Information

600 Project Code : 57/2008

6001 Institute Project Code No. : 57 (3)

6002 ICAR Project Code No. :

601 Name of the Institute and Division :

6011 Name and Address of the Institute : National Academy of Agriculture, Rajendranagar, Hyderabad- 30.

6012 Name of the Division/Section : Agricultural Research Systems Management and Policies (ARSMP), NAARM, Hyderabad

6013 Location of the Project : NAARM, Hyderabad

602 Project Title:

Sub-Project under NAIP: Policy studies for promoting research and innovation in agricultural value chains
Research component-3: Intellectual Property Management in Public-Private Partnerships – Patents, PVP & Copyrights

603 Priority Area:

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

		Develop.	Technology
01	02	03	04

604 Specific Area:

Agricultural Research Management

605 Duration of the Project:

6051 Date of Start of the Project: 2008
6052 Likely date of Completion of the Project: 2014
6053 Period for which Report submitted: June 2013-March 2014

606 Total Cost of the Project: Rs 4 Crores (combined)

6061 Expenditure to Date: Rs 12 Lakhs approx.

607 Summary of Achievements

The work done in year under report resulted in developing ten case studies of technology development and innovations case studies in areas technology transfer.

608 Key Words:
Research and development; Grassroots rural innovation system; Grassroots rural innovations; Technology transfer

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

610 Principal Investigator :

6101	**Name**	**: Dr R. Kalpana Sastry**
6102	Designation	: Head
6103	Division/Section	: Research Systems Management (RSM)
6104	Location	: NAARM, Hyderabad
6105	Institute Address	: NAARM, Rajendranagar, Hyderabad-500030

611	**Co-Investigator-I**	**:**
6111	Name	: Dr S. K. Soam
6112	Designation	: Head
6113	Division/Section	: ICM Division
6114	Location	: NAARM, Hyderabad
6115	Institute Address	: NAARM, Rajendranagar, Hyderabad-500030

Part – III : Technical Details

820 Introduction and objectives

8201 Project Objectives :

Immediate Objectives:

To review current experiences in relation to developing patents, PVP and copyrights in Indian agriculture.
To analyze the effectives of current IP policy measures as related to patents, copyrights and PVP operating in public system
To develop suitable management options of IPs resulting from blend of resources of PP sectors

Long -term objectives:

To develop suitable management options of IPs resulting from blend of resources of PP sectors

8202 Background information and importance of the projects

821 Project Technical Profile

8211 Technical programme
(Indicate briefly plan of procedure, techniques, instruments and special materials, organisms, special environments etc.)

Information Collection:

- Review of relevant, legal and policy documents through secondary sources
- Interviews and discussions with IP practitioners, officials of the statutory bodies, academicians, seed producers, farmers/group of farmers to obtain their views on the PVP laws
- Training cum workshops of ICAR on IP /Technology commerlization
- Critical analysis and synthesis of the collected information. This synthesis was then discussed again with the concerned departments in the two institutes and a consolidated check list prepared.

8212 Total man months involvement of component project workers

PI- 6 m

Co-Investigator- 3m

822 Final Report on the Project
Detailed report containing all relevant data with a summary of results (not exceeding 2-5 pages)

8221 Achievements in terms of targets fixed for each activity

A brief summary of the results during the entire period of the project is given below:

i. Institutionalization of IP Policy in ICAR System

A review of the relevant legal and policy documents was done to understand the background of the obligations at national and at the international level. This was followed by a brief review of the role and functions played by some statutory agencies in India that are actively involved in IP facilitation. Later the National Agricultural Research System was studied with an intention to understand the complexities and magnitude *vis-a-vis* the IP policy. Then the provisions and governance model of the new IP policy of the ICAR was analyzed. Two constituent institutes namely Project Directorate of Poultry (PDP) and Directorate of Rice Research (DRR), animal-

based and crop-based institutes respectively, were studied in detail from the IP policy perspective. The study highlights on the implementation of guidelines, structural adjustments in decision making activities in IP management at institutes and at understanding the specific issues of IP management at these institutes.

ii. Comparative Analysis of PVP Laws in six economies of Asia

The Asia-Pacific region comprising agrarian economies such as China, India, Indonesia, Philippines, Thailand and Vietnam forms a major zone of investment by the seed industry. This paper analyses and discusses various facets of the national laws on PVP in these countries of this region where PVP systems have been implemented. The study finds that these countries have adopted either UPOV or a country specific *sui generis* system. Results indicate that all countries have taken cues from existing model like UPOV and have attempted to suit to the local conditions and needs of their stakeholders. The Complexities and variations for PVP require a meticulous understanding of on-the-ground realities and the developmental goals of a country. The PVP laws in these countries need to be respected by investors and sustained to allow them to mature into strong protection regimes. This will provide the much-needed impetus to varietal innovation thereby promoting public and private seed sector investment in the region.

iii. Patent Analytics tools for R&D investments in NARS

Due to depleting reserves of fossil fuels, political uncertainties, increase in demand of energy needs and growing concerns of environmental effects, bioenergy as an alternative source of energy needs had taken centre stage globally. In this report, the progess made in lignocellulose, cellulose and fermentation based biofuels in addition to tree borne oil seeds was reviewed. Algae, as a source of feedstock for the biofuel was also studied. Recent developments in genome sequencing of biofuel crops, molecular breeding approaches have increased the understanding towards crop improvement of major feedstocks. This was further validated through an assessment of patent landscape analysis.. The results showed an increasing trend in published patents during the last decade which is maximum during 2011. A conceptual framework of “transgenesis in biofuels to industrial application” was further developed based on the patent analytics information viz., International Patent Classification (IPC) analysis and Theme Maps. A detailed claim analysis based on the conceptual framework revealed the current trends that have provided the

insights in current dimension of the technology. The study emphasizes the current thrust in bioenergy sector by various public and private institutions to expedite the process of biofuel production.

iv. Challenges in technology commercialization for GRI innovations

Innovations have been a constant feature, more particularly in rural landscape. The need for such interventions is driven primarily in solving problems at the local levels for immediate action and resulting with an informal approach. In the current market driven agriculture, such innovations may provide base for developing high order technologies which can cater to the market needs. The route of formalization of such innovations from the informal sector is often complex in the process of innovation. This process warrants a differential platform where all actors like NGOs, voluntary organizations, nonprofit organizations, public sector, private sector, academic and research institutions need to be in connectivity.

In this study an attempt was made to highlight some of the challenges faced by grassroots rural innovators. The study clearly evidences the hypothesis that most grassroots rural innovations (GRIs) are need based and often driven out as solutions to the local problems. Both case studies analyzed give an insight of the current grassroots ecosystem impacting agricultural production and consumption system in India. The major inferences drawn from the study include:

- Lack of formal connectivity with the R&D and the existing GRI system
- Inadequate up scaling and validation opportunities for GRIs
- Few financial opportunities for product development phase
- Grassroots rural innovations are sustainable in local ecosystem

It is important to recognize the role of science based standardized methods of widespread scouting, validation, up scaling for commercialization of grassroots rural innovations. This is will help to mainstream the innovations and provide authenticity to them. However, this can be accomplished only when strong networking of formal and informal sector with nongovernmental or voluntary organizations. As process of institutionalization sets in, concurrently the much needed necessary government and policy interventions need to be in place. Only then, the accommodation of grassroots rural innovations at par with the technologies from research and development will be achieved in contributing to the growth of the nation.

8222 Questions- Answered

Whether technology generated are IP-enabled?

If so, what are the mechanisms being adopted?

How does the institute institutionalize the IP policy in ICAR?

8223 Process/ Product/ Technology/ Developed

About 10 case studies for GRI sector, one case study in IP policy institutionalization, one analusis of PVP laws in six economies in Asaia, and research paper on Patent analytics as tools for R&D indicator in emerging sector like biofuel were outputs developed.

823 Publications and Material Development

(One copy each to be supplied with this proforma.)

8231 Research papers

Research Papers:

i. Kalpana Sastry, R. 2008. Mechanisms of Protection of Agricultural Innovations in India, DESIDOC Bulletin of Information Technology, 27(6): 3-11.

ii. T. Sudhakar Johnson, Jyothi Badri, R. Kalpana Sastry, Anshul Srivastava P. B. Kavikishore and M. Sujatha. 2013.Genetic improvement of biofuel plants: Recent progress and patents. Recent Patents on DNA sequences and Genes. Vol. **7**: 2-12.

iii. Kalpana Sastry R and Tara OK . Grassroots rural innovations and perspectives of technology commercialization. Research Paper communicated- Editor-in-Chief, Technology in Society. Elsevier Publications.Date of submission: December 7, 2013. Paper currently under review Ms. Ref. No.: TIS-D-13-00077.

iv. –PC Golder,RKalpana Sastry and K.Srinivas. 2013 Research priorities in Bangladesh : Analysis of Crop Production Trends. SAARC Journal of Agriculture. Volume 11 (1) .Pages 53 -70

8232 Popular articles

Nil

8233 Books/Book Chapters/ Reports

a. Manpreet Hora, R.Kalpana Sastry and Vijay Paranjpae. 2009. PVP Laws in Major Jurisdictions of Asia-Pacific Region, *Working Paper - 7*, National Academy of Agricultural Research Management, Hyderabad, pp 26.

b. S.K.Soam, R.Kalpana Sastry and Mujrab Hussain. 2009. Intellectual Property Management in Public Private Partnerships.: Agro-biodiversity, geographical indication, and traditional knowledge. Research Report. 2008-09. Pages 40.

c. R.Kalpana Sastry.2009. Intellectual Property Regime in Indian National Agricultural Research System. In: CAS-IP NPI.2009. Institutionalization of Intellectual Property Management: Case Studies from Four Agricultural Research Institutions in Developing Countries. CAS-IP. Rome Italy. Available at: http://www.cas-

ip.org/public/uploads/2009/04/compilation_of_4_working_papers_npi_2008.pdf

d. NAARM-UoH. 2011. 6 resource books for PGD-TMA course .
e. Kalpana Sastry and Anshul Srivastava. 2013. Emerging Intellectual Property Regimes and Traditional Knowledge Systems in Indian Agriculture. In: Indigenous traditional knowledge for promotion of sustainable agriculture. Edited by V.Suresh Babu, KSuman Chandra and SMIlyas. Pages 145 to 160. NIRD. ISBN 978-81-85542-96-6. August 2013.

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

S.No	Author(s)	Year	Title	Conference	Pages
1.	R. Kalpana Sastry	2013	ITK and IPR	In: National workshop on "Indigenous Traditional Knowledge for Promotion of Sustainable Agriculture" during October 29 – 31, 2012. Organised by Centre for Agrarian Studies and Disaster Mitigation has planned to organize the" at National Institute of Rural Development, Hyderabad October 30 2012	Full Paper accepted. Conference proceedings in publication.
2.	R. Kalpana Sastry	2013	Genetically Modified Crops and Food Security	Invited Paper: International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI). Hyderabad	National Science Day Celebrations at ARCI.
3.	R. Kalpana Sastry	2008	Framework for Protecting Innovations of Grassroot Workers in Rural India	In: Agroecological Perspectives for Sustainable Development.CIIFAD Forum.March 5,2008.	http://ciifad.cornell.edu/seminars.cfm
4.	R. Kalpana Sastry	2013	Patents in biotechnology	Int Workshop on "Application of Genetic Engineering in Grain Legumes and its translation	November 18-27,2013 at ICRISAT

824 Infrastructural facilities developed

(Details of field, laboratory, note books and final material and their location)

Patent analytics databases and protocols, knowledge repository in IP laws , instruments for technology transfer analysis developed.

8224 Practical Utility

(not more than 150 words)

The utility of all these knowledge processes wil be useful in policy decisions and in prioritization of R&D investments.

8225 Constraints, if any

Nil

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)

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:

Co-Investigators 1.

Signature & Comments of the Head
Of the Division/ Section

Signature & Comments of the
Joint Director

Signature & Comments of the
Director

Annexure I

Research Paper communicated- Editor-in-Chief, Technology in Society. Elsevier Publications.
Date of submission: December 7, 2013.
Paper currently under review Ms. Ref. No.: TIS-D-13-00077.

Grassroots rural innovations and perspectives of technology commercialization

Kalpana Sastry R [a]*, Tara OK [a]

1. Introduction

Innovation activities occurring at the rural grassroots-level are basically ingenious solutions developed locally to address the system challenges in the long run for improving rural livelihoods and promote sustainability. In this process such novel bottom–up solutions which respond to the local situations and suit to the interests and values of the communities involved are termed as “grassroots rural innovations”(GRI). In contrast to mainstream research and development (R&D), grassroots initiatives operate in civil society arenas and involve committed activists helping local people with social innovations often being green use technologies [1]. These are usually catalyzed through large networks of activists and local organizations [2]. Innovations of this nature tend to take the shape of simple but rustic technologies which provide solutions to drudgery and solve the immediate problems faced by the user. A typical characteristic of these innovations is that these are pervasive. They need scouting, identification and often a push to move forward to develop as technologies and later as business solutions.

The primary objective of this study is to analyze the current process of innovation at the grassroots rural level and the current transfer mechanisms for their commercialization in India. The study also seeks to compare the grassroots model of innovation impacting Indian agricultural production and consumption system, the technology building and its transfer with similar attempts in R&D sector of formal system. Finally, it suggests steps to catalyze the technology up scaling and product development activities for GRI.

2. Grassroots innovations-An insight

The term grassroots innovators’ refers to "individual innovators”, who often undertake innovative efforts to solve localized problems and generally work outside the realm of formal organizations like business firms [3]. They are the key players in grassroots innovation system that often arises in reactive mode to perceived social injustices and environmental problems observed in conventional industrialization models [4]. The GRIs

are also some of the solutions developed as value additions to the existing technologies or new innovations. In case of agriculture, these are strongly linked to traditional knowledge (TK) and indigenous traditional knowledge (ITK) systems. The green revolution [5] that started in 1960s in Indian agriculture has led to development of technology driven solutions from formal sector. With opening of markets in 1990s, these technologies are getting into product development cycle and enterprise developing systems. The GRI system is still exploring the opportunities existing in this newly emerged system, which hold promise to an enhancement of rural livelihoods and gaining recognition at that informal level.

2.1. Global grassroots activity

Emergence of stronger economies in developing countries like Brazil and India during the last decade is the major impetus for new innovation ecosystem where grassroots activities are participating. But, the persistence of structural inequality calls for understanding the patterns of innovation, appropriation and development [6,7, 8]. The appropriate technology movement in the 1970s, the People's Science Movement in India in the 1980s, today the Honey Bee Network in India and the technologies for social inclusion movement in Latin America are initiatives labeled under 'grassroots innovation movements' [4]. There have been good number of community initiatives and government supported functionaries like Australian Agency for International Development (AusAID) [9], United States Agency for International Development (USAID) [10], National innovation foundation (NIF) [11] working for the grassroots rural innovations in different countries. The institutional forms for grassroots innovative niches are also complex, but working in different modes. There are diverse organizational forms: cooperatives, voluntary associations, mutuals, informal community groups, social enterprises. Their resource base is similarly pluralistic, including grant funding, limited commercial activity, voluntary input and mutual exchanges [2]. Even though grassroots rural innovations present varied complexities in different countries, they have the elements of sustainability, traditional knowledge and nativity embedded in them. Indeed, institutionalization of the grassroots movements has been a beneficial phenomenon in India and has spread to more than 14 countries in world till now.

2.2. Grassroots ecosystem in India

India is now recognized as one of the major seat for grassroots innovations at global level primarily due to efforts of Honey Bee network [8]. The Honey Bee [12] is a social network guided with the spirit of scouting rural innovations that could bring in natural and environment friendly technologies. The National Innovation Foundation (NIF) [11] is an initiative from Department of science and technology (Dept of S&T), Government of India (GoI) that also works in collaboration with Honey Bee Network. Till now, there have been about 1,81,000 ideas, innovations and traditional knowledge practices that have been pooled from all parts of the country to validate, scale up, collaborate and create IP value for the innovators. Creation of linkages and dissemination of grassroots traditional knowledge horizontally and vertically across the country has been initiated since the year 2000.

A tabulation of some of the organizations working for enhancing rural innovations at grassroots level is given below in table 1.

Most of these organizations function with a base idea of scouting and validation of innovations in rural areas. They create awareness at local levels on the existing GRI system and significance of traditional knowledge. Often, they work for the dissemination of knowledge and innovation flow across the country that nurture the need based technologies in grassroots rural ecosystem. Acting as platforms for voicing the problems of innovators in their journey of innovation, most of these organizations work as conduits for technology building and enhancing the scale up opportunities for the grassroots innovations. In this process they are facilitating as linkages with formal system.

3. Methodology

A case study approach was adopted to understand grassroots rural innovations and their impact on Indian agricultural production and consumption system. A detailed analysis of two case studies was based primarily on technologies generated for solving local problems in Andhra Pradesh state(A.P) [13].

3.1. Preliminary approach for identification of case studies

Andhra Pradesh is one of the biggest states in southern part of India endowed with agricultural, fishery and other traditional base owing to the availability of resources, soil diversity and good irrigation facilities. Agriculture is the chief source of income to the state's economy with majority of the contribution from rural pockets of the state with

respect to agriculture development. Palle Srujana [14] a voluntary organization in this state has been closely working with rural communities scouting various rural innovations or technologies and according recognition to innovators for the past few decades.

3.2 The primary source of data -Interviews

The preliminary information was gathered from field visits and personal interviews [Appendix A] with innovators from grassroots rural level in Andhra Pradesh. Some of the rural technologies were selected based on the criteria of usefulness, adaptability, sustainability, sufficiency of rural needs and the ease of acceptance by the rural communities. The baseline for selection of the cases was the agricultural connectivity and those which have better scope of technology transfer. Among these, two case studies were identified for more detailed analysis. The selected cases were those which were in prototype stage and ready for up scaling.

3.3 Secondary data

Secondary data was gathered from the literature survey and identification of innovations from available databases of Palle Srujana [15], Honeybee network [12], NIF [11] and the associated organizations. Literature about grassroots rural innovations was also taken from CERA, various journals, books, press reports, articles, magazines and other e-resources.

4. A comparative study of formal sector technologies and grassroots technologies

Based on the data from primary and secondary resources a comparative analysis of technology commercialization pathways of formal system with R&D in place and GRI systems from informal sector is presented in table 2.Seventeen criteria were taken up based on the data collected and analyzed.

The data clearly indicates the type of support to innovations in R&D sector as compared to GRIs. This support is extended right from early stage of research to technology up scaling and incubation facilities. The market intelligence studies done in the formal sector enhance the visibility of the encapsulated know-how driven by a strategic procedure with a complete supporting ecosystem. The state-of-art infrastructure, manpower, pool of capacities, funds, ease of technology transfer makes the R&D technologies available for commercialization. Yet, in the formal sector, more particularly public sector also has

constraints in form of bureaucratic delays but support from policy makers and government helps to overcome these constraints. In contrast, the grassroots innovations face challenges at each stage right from fund mobilization to capacity building of innovators themselves. Poor literacy and lack of institutional support further hinder the advancement. Often, most innovators are not aware of any mechanism and strategy for transfer of technologies. The case studies present the existing scenario for grassroots innovations.

5. Case studies

5.1. The case of an agricultural input (1)

Zero tillage is a practice with advantages of reduced land degradation, higher levels of organic matter and biological activity, more manageable soils and improved soil structure. Maize was sown in coastal regions of Andhra Pradesh (A.P) on zero tillage [16] for the past decade. In Guntur district [17] of A.P, maize was cultivated for harnessing the water residues in the paddy fallows. But the period of paddy harvesting is crucial and labor intensive that creates deficit of labor for sowing maize with no tillage. In addition to this, the state organized work schemes of National Rural Employment Guarantee Act's (NREGA) and Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) for poverty alleviation with a guarantee of 100 days of paid work for one person per household led to diversion of labor from agricultural activities [18]. All these led to acute labor challenge in the rural areas.

The innovation came into light owing to the mix of challenges faced by the rural farmers due to labor intensive manual agricultural practices as follows:

- Dearth for labor during harvest period
- Lack of uniformity in seed distribution
- Improper placement of seeds
- Uneven growth due to old practices
- Problem of administration of weedicides
- Difficulty in effective exploitation of moisture and fertility of the soil

5.1.1 Innovator's journey to innovation

Recognizing the issue and to overcome the local as well as labor problems, a farmer and grassroots rural innovator, Mr.Guravaiah sought to conceptualize a multifunctional

contraption. His advocacy of minimal tillage practice with maize on paddy fallows has driven to a unique concept of machine. The biggest challenge to the innovator is his lack in technical expertise and strategizing on the concepts. He approached Bapatla Engineering College [19], and sought to experiment the existing machinery. His idea of using old seed dispenser and modifying it, established his concept with two rows of furrows for seeding. Lack of monetary sources from the institution, discontinued his experimentation further. Some of these challenges in augmenting for financial support were inadvertently voiced at the platform of Palle Srujana. This incident helped in connecting to the grassroots innovator to the voluntary organization which catalyzed networking with the rural technical helpers in executing his ideas into machinery design. The connectivity also gave linkage to funding sources as National Bank for Agriculture and Rural Development (NABARD) [20] for working on the design. The iterative process of displaying the machine, acquiring suggestions and modifications was done through crowd sourcing. Finally, the machine emerged as an attachment to a tractor which performs multiple tasks simultaneously as follows:

1. Making furrows for seeding at defined depth
2. Measured dispersion of seeds in the furrows
3. Designated quantity of fertilizer dispersion
4. Closure of furrows
5. Herbicide spraying between the rows.

The improved machine was tested and tried in the fields of Guntur and Krishna districts. It was validated by the agricultural department of Andhra Pradesh. The award from Samsung Innovation Quotient 2 (SIQ-2) as first runner up [21] through the intervention of Palle Srujana gave due recognition to Mr.Guravaiah. This signals positive trends of awareness or acceptance of rural innovation system by formal system.

5.1.2. Inferences from the case

Data in table 3 clearly elucidates that, this technology in comparison with the present techniques has high opportunity costs, as the operations by the machine are functional under zero tillage. This mitigates the problem of labor, as the innovation caters to large acreage in short span of time. Thus, the farmers using Guravaiah's seed drill cum herbi sprayer stand to gain advantage in terms of reduced labor costs. This is in tune with the

primary objective of Mr.Guravaiah to design improvement on existing machine and make it cost-effective for end users which is crucial for sustaining the present agricultural practices in Andhra Pradesh.

5.1.3. Other advantages

Additionally, it was found that this grassroots rural technology simultaneously saves on other input costs (seeds, weedicides, and fertilizers), reduction in irrigation leading to minimal power and water consumption. Targeted seed placement and application of herbicide ensured better crop population and higher yields. In an agrarian economy like India, such initiatives with multiple applications impacting economy and ecology positively have been often voiced by the farmers at various interactive platforms with scientists and other technology developers. Mr.Guravaiah's attempt was a step towards achieving this impact.

5.2. A case of agricultural sustained ecosystem (2)

In most water bodies, water hyacinth *(Eichhornia crassipes*) provides a congenial atmosphere for spawning of fish. However, rapid proliferation of these plants has led to emergence of a major weed problem impacting production of fish. Often, the over growth of these plants creates serious ecological problems [22]. Hindrance of water transport, clogging at intakes for irrigation, effecting hydropower and water supply systems, blocking of canals and rivers causing flooding has been reported. In small water bodies, the micro-habitat conversely becomes stimulatory for a variety of disease vectors. Several studies have been conducted in the R&D sector for elimination of this weed by biological, chemical and physical control mechanisms. While, there is no single solution for the problem, the affordability and lack of technical profess often curtail the solutions at local level. The case of solution provided by a GRI is presented below.

5.2.1. The case of fishermen in Muktapur, Andhra Pradesh

Muktapur is a small hamlet of 10 villages in Nalgonda district of Andhra Pradesh (A.P), India where fishing is predominant. Majority of the villagers eke their livelihood through fishing in the lakes and other water bodies in and around the village. The supply chain for marketing their catch is through a contractor. From early 1990s, the emergence of water hyacinth in their fishing water bodies became a major problem. The floating weeds marooned the boats which proved a setback for fishing. Re-emergence of the plant had a

disastrous effect on food supplies, reducing the fish population. Thus, the presence of water hyacinth in local ponds challenged their livelihood itself leading to poverty and debt traps.

Mr.Narasimha a local from this village whose family profession is fishing, sought to work for a solution for this hyacinth problem. Even though, he was trained apprentice in local technical school, he continued his family profession of fishing. However, in order to supplement his income, he also taught in the local school. The village had a protocol of hyacinth weed cleaning in local water bodies in rotation wherein about 50-60 members of the community needed to work for 90-100 days. Since all members of the community had to manually clean the hyacinth from the lake, Mr.Narasimha found it difficult to cope up with this job at school when his turn came for cleaning. Added to this, he was concerned with the repeated skin infections and snake bites which were proving a serious health hazard to community. His interest in mechanical machines triggered the idea of making a hyacinth cleaning machine which could be operational in the water bodies in his village.

Mr.Narasimha started to design a hyacinth cleaning machine by raising loan from his village and neighboring villages. Initially, a prototype was made. It was observed that, the cleaning manually done by 60 members in a time span of 3 months was completed in 10 days by the use of this machine. The publicity of this event in local newspapers helped him to gain the connectivity with Palle Srujana, that incubated the case for further improvement. This platform through Palle Srujana gave an opportunity for Mr.Narasimha for bettering his prototype with a financial grant from NABARD and market support from Creative Minds [23]. As on date, six customized machines including an amphibian model have been made which clear hyacinth in large water bodies according to the location, type of weed and position of the weed. The major steps for working of the machine are:

1. Floating Hyacinth is pulled towards the machine
2. The hyacinth is lifted mechanically on a conveyor to drop on a cutting machine
3. The finely chopped pieces are then easily disposed by mini trucks in open places

This innovation of Mr.Narasimha is sustainable and enhances the extension feasibility to any water spreads.

5.2.2. Benefits from the hyacinth cutting machine

Mr.Narasimha's "hyacinth cutting machine" is a device that is unique in its function and has enormous economic and social benefits. Table 4 presents the comparative advantage of hyacinth removal by the designed machine and savings for the fishermen community. The machine reduced the pain of lifting and removing the heavy hyacinth plants from murky water bodies. It made the disposal easier due to reduction in weight of the plants by cutting them into pieces. The economic advantage for the community was 2,13,500 INR which, in fact relieved the burden of debt traps. The challenges of health hazards, including mosquito breeding were reduced to large extent. The community gained extra earnings. The debris has been found to have large market potential for animal feed, paper, textile and other industries [24]. Narasimha's efforts gave scope for spin offs and thus, impacting the agricultural production and consumption system.

6. Discussions

6.1 Innovations with rural impact-supporting ecosystem

The two cases analyzed, clearly indicate that grassroots rural innovators conceptualized their ideas and designed into desired innovative models that met their needs. Since, these innovations emanate from the natural environment based on drudgery evasion mechanisms where the need is felt, these are user friendly and cost effective. The two cases are indicative innovations that are emerging or form ethical capital which is sustainable in agricultural system. A number of factors were pivotal in achieving these tasks. Personal inspiration was the major initiation factor to serve fellow community members. The contemplation to achieve a need-based technology, led to the designing of models. The support of voluntary organizations, nonprofit organizations, nongovernmental organizations (NGOs) and government initiatives like NIF-India proved a major catalyst in the process. The study indicated that these technologies were based on felt needs of the society and were driven out from the imperative to meet the rural demands at the ground level. In both the cases, the technologies were more environmentally sustainable. Affordability as criterion is also one of the important parameter considered important during innovation process. It is clear that such changes in the strategy with bottom up makeover [8]with good supporting linkages like Palle Srujana can enhance the process of taking forward of rural technologies.

6.2. The scope for technology transfer

The initiative from a knowledge base of individuals shapes up to a technology in a systematic process with industrial applicability from R&D sector. Transfer of such technologies for commercialization in a top to bottom scenario is strategically built. But, GRIs differ in conceptualization into a purposeful innovation which is often not in a systematic manner. This necessitates a bottom up change for the technologies to be commercialized. A look at the scope of such technologies from the above case studies clearly indicates more prospects than CLTs with proper persuasion. As observed, in case study (1) the technology developed is a user friendly input for rural farmers facing severe dearth of agricultural labor. Since, this machine is an attachment for tractor, it gives the advantage for the farmers owning such machines. The machine covers large acreage creating an opportunity to share the machine by the small and medium range farmers. Maximum utility can be obtained with minimal number of machines in a rural pocket. This innovation can also be used as service providing machine for short periods with reduction in investment. Thus, viable business models can be developed with investment by few providers and serve the needs of the farmers ina zone. In case study (2) the technology is unique by itself. Unlike movers, cutters, diggers and such other mechanical devices, this hyacinth cutting machine performs the task on a customized system according to the location of water bodies. This gives the advantage of working on any weeds with much ease on large water spreads. At this stage it can be automated but, the innovator Mr.Narasimha chose to keep the present model as it creates employability. This perhaps is the social impact of the innovation. The worth of this technology was immediately realized and taken by Greater Hyderabad Municipal Corporation (GHMC) [25].

It is evident that many people from informal sector have the worth and talent in them but fall back due to lack of connectivity and encouragement. The analysis of cases indicated that a supportive hand from voluntary organization proved to be of much value to society in bringing out such innovations and their creators to focus. In fact, the effort of voluntary organizations paved way for technology dissemination through all channels. Linking innovations, creating funds and commercialization of such rural technologies with due credit of innovation has been initiated by GIAN [8], a collaboration of Honey Bee network and Government of Gujarat in 1997. Such initiatives seem imperative and

are needed in all parts of the country to address the issues of technology building and rural technology transfers. A major bottle neck [8]for transfer of such innovations is the lack of connectivity among rural areas and weak institutional linkages. This has impacted the current rural technology transfer mechanism and processes for GRIs. In spite of the moral support with mentoring given by voluntary organizations like Palle Srujana and others [table1] as well as financial support from NABARD and other institutions, a need for technology push arises due to lack of awareness about such existing useful technologies. The up scaling and production of such rural technologies can make up to the practical solutions for tenacious problems in agricultural production and its allied sectors. There is the issue of top-down technology transfer from R&D Institutes to rural areas which is a concern for uptake and dissemination of rural technologies. Rural innovations came as native solutions from the agricultural rural system, with better prospects over the available technologies from upper end. The grassroots rural technologies are spin-offs from the rural problems with need based mechanisms and have fair opportunity for adoption with ease for dissemination. The scope for commercialization of such innovations enhances when the issues of economic viability, technical expertise, connectivity, enterprising, and marketability are addressed.

7. Conclusions

Innovations have been a constant feature, more particularly in rural landscape. The need for such interventions is driven primarily in solving problems at the local levels for immediate action and resulting with an informal approach. In the current market driven agriculture, such innovations may provide base for developing high order technologies which can cater to the market needs. The route of formalization of such innovations from the informal sector is often complex in the process of innovation. This process warrants a differential platform where all actors like NGOs, voluntary organizations, nonprofit organizations, public sector, private sector, academic and research institutions need to be in connectivity.

In this study an attempt was made to highlight some of the challenges faced by grassroots rural innovators. The study clearly evidences the hypothesis that most grassroots rural innovations (GRIs) are need based and often driven out as solutions to the local problems. Both case studies analyzed give an insight of the current grassroots ecosystem impacting agricultural production and consumption system in India. The major inferences drawn from the study include:

- Lack of formal connectivity with the R&D and the existing GRI system

- Inadequate up scaling and validation opportunities for GRIs
- Few financial opportunities for product development phase
- Grassroots rural innovations are sustainable in local ecosystem

It is important to recognize the role of science based standardized methods of widespread scouting, validation, up scaling for commercialization of grassroots rural innovations. This is will help to mainstream the innovations and provide authenticity to them. However, this can be accomplished only when strong networking of formal and informal sector with nongovernmental or voluntary organizations. As process of institutionalization sets in, concurrently the much needed necessary government and policy interventions need to be in place. Only then, the accommodation of grassroots rural innovations at par with the technologies from research and development will be achieved in contributing to the growth of the nation.

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[10] United States Agency for International Development (USAID) established in 1961 for purpose of furthering America's interests while improving lives in the developing world. Accessed on September26th 2013 Available at: http://www.usaid.gov/

[11] National Innovation Foundation (NIF) is built upon the Honey Bee network philosophy. This was set up by the Department of science and technology in February 2000 at Ahmedabad to achieve its goals essentially through a non-government spirit. This is India's national initiative to strengthen the grassroots technological innovations and outstanding traditional knowledge. Accessed on September26th2013 Available at: http://www.nif.org.in/

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Tables (1-4)

Table 1:List of organizations supporting grassroots rural innovations.

S.No	Organization	Instituted in the year	Supported by	Objective and support services to grassroots innovations and traditional knowledge holders
1.	National Innovation Foundation (NIF) [http://www.nif.org.in/]	2000	Government of India	Institutional support to the unorganized sector of the society
2.	Honey Bee Network [http://www.sristi.org/hbnew/aboutus.php]	1988-1989	Voluntary organization	Scouting and a networking bridge between formal and informal sector
3.	Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI) [http://www.sristi.org/cms/en/about_us]	1993	Charitable organization	Documentation, dissemination, development of grassroots green innovations, intellectual property rights protection, conservation of local biodiversity, providing venture support, value addition and knowledge network
4.	Grassroots Innovation Augmentation Network (GIAN) [http://www.gian.org/]	1997	Government of Gujarat, SRISTI, IIM Ahmedabad	Incubator for green grassroots innovations and traditional knowledge
5.	Pallesrujana [http://www.pallesrujana.org/]	2009	A nonprofit voluntary society, A.P	Scouting, dissemination horizontally through a telugu magazine " Palle Srujana" on rural knowledge and creativity, chinna shodha yatra, synergistic network, vertical dissemination and linkages, leveraging incubation, IP value creation, validation, recognition and commercialization of GRIs in AP
6.	Agrocrats Society For Rural Development (ASORD) [http://agrocrats.org/]	1995	Non - Governmental Organization (NGO)	Create self employment in the rural population, collection, preservation documentation and registration of bio-diversity, research on natural co-existence for sustainable development
7.	Rural Technology Action Group RUTAG-IIT [http://www.iitrpr.ac.in/rutag]	2011	IIT-Ropar, Punjab	Constitution of working group of innovators, development of useful green rural technologies , refine existing traditional technology, develop entrepreneurship among rural community
8.	Villgro [http://www.villgro.org]	2001	Villgro Innovation Foundation	Encourages innovation and wealth creation in rural areas and enable innovations to impact the poor through social enterprises.
9.	Sustainable agriculture and Environmental Voluntary Action (SEVA)	1992	Honey Bee network	Collaborated with SRISTI, coordinates the regional node in Tamil Nadu "NumValiVelanmai". Sustainable management of rural knowledge systems concerning plants, environmental values

	[http://www.sristi.org /seva/activities.html]			and bio-diversity preservation and conservation traditions; creation of a regional database; training on indigenous knowledge, ethno veterinary and sustainable agriculture practices.
10.	AmaAkhapakha [http://www.sristi.org /cms/en/innovation_club]	2002	Honey Bee network	Facilitates the philosophy of Honey Bee, in oriya the regional language through 21 Inno-clubs (Innovate Orissa Clubs) in the state. Scouting, documenting and diffusing the grass roots innovations and traditional knowledge of Orissa.
11.	Peermade Development Society [http://www.sristi.org /cms/pds]	1980	Non - Governmental Organization (NGO), Kerala	Documentation, IP protection, validation of traditional and local innovations. Value additions and promotion from land to lab through Innovators technology development centre.

*Based on data collected by authors from various sources.

Table 2: Comparison of the Agriculture based technologies emerging from the R&D and GRI sectors.

*Based on the data collected and collated from various sources by authors. [a]Public private partnership; [b] Non-disclosure agreements; [c] Memorandum of understanding.

	Attributes	Sector	
S.No		Research and Development Sector	Grassroots Rural Sector
1.	Type of technology	Bench Scale [Conventional laboratory technologies (CLTs)]	Need based innovations [Grassroots rural innovations (GRIs)]
2.	Organization	Laboratory bench -Public Sector Organizations /Academic Institutions / Universities /Private sector organizations	Grassroots Rural Innovators
3.	Developers	Scientists, Professors, Researchers, Students	A single or a group of rural innovators
4.	Character of developers	Proper formal education with more research orientation	No formal education, often school dropouts or illiterates
5.	Resources	Infrastructure and man power provided by supporting organizations	No specific resource availability, lack technical capabilities and self supporting
6.	Funding	Base organizations, Projects, Department of S&T, Central and State Governments	Meager or no funding sources, limited loans from banks
7.	Capacity Building	Training, workshops, practical demonstrations, empowerment of researchers	Training is minimal from few Public sector organizations, NGOs, Voluntary organizations
8.	Research and Development	On job learning, strategies, protocols, methodologies	Ideas are worked upon trial and error methods without specific strategies
9.	Up scaling	Upgrading the technologies, designing of prototypes, assessment procedures	Mostly at proof of concepts stage only
10.	Modes of tech transfers	Incubation, Collaborations, licensing, startups, PPP[a], NDA[b], MoU[c]	No formal mechanism in place
11.	IP Portfolio	Ownership-Organization	Less information on IP protection and inability to maintain IP grants
12.	Eco friendliness	May be a criterion	Tend to be more eco friendly
13.	Markets	More often urban	Mostly rural
14.	Constraints	Policy issues, transferability, administrative setbacks mostly in public sector organizations	Lack of funding and awareness about available opportunities, minimal or no education
15.	Affordability	Often expensive	Low cost, more reachable to marginal and poor people
16.	Supporting factors	Organizational ecosystem, Funding agencies, Research team	Informal mode of support
17.	Institutional system	In place for technology transfer	Not in place ; Only few emerging recently

Table 3: Labor input cost for zero tillage cultivation of maize.

With present technologies			With Guravaiah's herbi sprayer cum seed drill	
Agricultural procedures per hectare	No. of Laborers	Input cost per hectare in INR[b]	No. of Laborers	Input cost per hectare in INR[b]
a)Seeding procedure[a]	10	3000	NA[c]	NA[c]
b)Herbicide spraying after 48hrs	05	1500	NA[c]	NA[c]
c)Fertilizer dispersion after 15 days	05	1500	NA[c]	NA[c]
a+b+c	NA[c]	NA[c]	02	60
Total	20	6000	02	60

*Data collated by authors.
[a]includes furrow making, seed dispensing and furrow closure; [b]Wage of a laborer @300 INR /day; [c]NA stands for not applicable.

Table 4: Comparative economics of hyacinth removal manually and by machine

Attributes	Manual operation	Operation by hyacinth cutting machine
Number of men required	06	05
Time required	100 days	10 days
Wage for the labor	3,00,000INR[a]	25,000INR[a]
Cost of machinery	NA	60,000 INR
Cost of fuel for machinery	NA	1,500 INR
Total expenditure	3,00,000 INR	86,500 INR

*Based on data collected and inferred calculations by authors.[a]wage of a laborer @ 500 INR/day; [b]NA stands for not applicable.

Appendix-A

Questionnaire
(Questions raised during discussion with innovator)

- What was the innovation?
- Why was the rural technology created?
- What were the inspirational / motivation factors?
- How did the innovator reach to the concept?
- When was the concept put to practice in designing a model?
- How long did it take to create the technology?
- Where the innovation was tried and how was its impact?
- When it was first recognized?
- How did the innovator cater to financial support?
- Who were the ultimate stake holders for their technologies?
- Was the innovation helpful to them?
- How was the innovation useful in their places?
- Was there any improved economic benefit for the innovator and people around them?
- Was the innovation a proof of concept/ prototype/working model?
- Who were the supporting players in working for the technology?
- Was the innovation commercialized?
- Which enterprise or organization supported?
- Were the innovations/technologies given on license to third parties or sold out rightly?
- How did the innovator get to know about NIF/ Honey Bee AP/ Pallesrujana?
- How were the organizations helpful to them?
- Did the innovator participate in any such exhibitions or presentations?
- Was the innovation patented?
- Any other innovations were done?
- Has the innovator received any awards or felicitations?
- Personal Information :Family background; profession; land holdings; social community; economic status; agricultural /other related experiences;
- Other information: Village; district; socio-cultural and economic structure and practices of that region.

(Recurring)

831 **Total Non – Recurring**
Expenditure
(Equipments and works)

i)

ii)

iii)

823 **Total**
(830 and 831)

NA

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:

Co-Investigators 1.

Signature & Comments of the Head
Of the Division/ Section

Project Targets completed

Signature & Comments of the
Joint Director

डा.आर. कल्पना शास्त्री
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Project - Completed

Signature & Comments of the
Director

19/1

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