

Best Practices for Sorghum Cultivation and importance of value-addition



Rajendra R Chapke
Vilas A Tonapi



ICAR-Indian Institute of Millets Research
Rajendranagar, Hyderabad 500 030
www.millets.res.in



2016

Citation

Chapke RR and Tonapi VA. 2016. Best practices for sorghum cultivation and importance of value-addition. *Training Manual 2016-17*, ICAR-Indian Institute of Millets Research, Hyderabad, India, ISBN: 81-89335-65-0.

Abstract

This reference book of the model training is a compilation of lectures delivered by the experts on latest aspects of sorghum development including millets on improved production technologies, crop management, preparation and value-added products, sweet sorghum, nutritional benefits, technology transfer and future implications. These apart, practical aspects of new process/methods, production and marketing were also covered. All the articles represented views of the respective contributors and they assume responsibility for any odd/advanced statements and opinions.

Compiled by

Rajendra R Chapke

Book alignment and design

Mr. K Sanath Kumar

Cover design and photo credits

Mr. HS Gawali

Acknowledgements

Constant support and guidance provided by Dr. VA Tonapi, Director, IIMR for organization of the course successfully is gratefully acknowledged. The support and contribution of the scientists, experts, speakers, IIMR officials and all who worked in successful conduct of this programme are sincerely acknowledged. The cooperation of the organizations for deputation of their officials to participate in this training is also sincerely acknowledged. Special thanks are due to the Directorate of Extension, Ministry of Agriculture, Cooperation and Farmers Welfare, Government of India, New Delhi for sponsoring this training.

Published by:

Dr. Vilas A Tonapi
Director
ICAR-Indian Institute of Millets Research,
Hyderabad 500 030, India
Phone: 091-40-24599301, Fax: 091-40-24599304
Web site: www.millets.res.in

BEST PRACTICES FOR SORGHUM CULTIVATION AND IMPORTANCE OF VALUE-ADDITION

Contents

1. Genetic improvement in kharif sorghum and latest kharif cultivars	3
<i>C Aruna</i>	
2. Major sorghum pests and their management	10
<i>PG Padmaja</i>	
3. Improved genotypes and heterosis in rabi sorghum.....	29
<i>Sujay Rakshit</i>	
4. Extension approaches in India: Prospects and challenges	35
<i>S Senthil Vinayagam¹ & Rajendra R Chapke²</i>	
5. Sweet sorghum - An important biofuel crop and technologies for enhancing crop productivity	46
<i>AV Umakanth</i>	
6. Sorghum production technology	60
<i>S Ravi Kumar</i>	
7. Value-addition to sorghum: Potential of sorghum for industrial uses in India and entrepreneurship development.....	69
<i>B Dayakar Rao</i>	
8. Sweet sorghum - A versatile bioenergy crop its juice quality and diversified uses	80
<i>CV Ratnavathi</i>	
9. Sorghum diseases - Importance and management options*	85
<i>IK Das</i>	
10. Alternative uses of millets and scope of entrepreneurship	92
<i>RG Math</i>	
11. Post harvest management of grain sorghum.....	98
<i>G Shyam Prasad¹ & K Srinivasa Babu²</i>	
12. Sweet sorghum for bio-fuel production - Industrial experiences and economics	107
<i>AV Umakanth</i>	
13. Sorghum cultivation in rice-fallows: A new opportunity	115
<i>Rajendra R Chapke¹ and VA Tonapi²</i>	

14. **Prospects for sorghum biofortification**123
K Hariprasanna
15. **Sorghum genetic resources management (2000 – 2015)**.....139
M Elangovan
16. **Sorghum: An important forage crop**.....152
B Venkatesh Bhat¹ & Avinash Singode²
17. **Go green to reduce pollution and retard global warming which is the need of the hour**.....157
KP Rajan
18. **Principles of quality seed production and maintenance in sorghum**162
N Kannababu¹ & Vilas A Tonapi²
19. **Mechanization of sweet sorghum cultivation – An overview**175
Aum Sarma
20. **Millets: Current status in India, nutritional values and health benefits**.....179
RJ Sreenivasa
21. **Supply chain management of dryland agricultural commodities**187
K Kareemulla
22. **Alternate uses of millets and scope for entrepreneurship**194
K Uma Maheswari
23. **Farmers' Rights in the context of Plant Variety Protection**199
K Hariprasanna
24. **Sorghum production technology transfer and its impact**.....226
Rajendra R Chapke



4. Extension approaches in India: Prospects and challenges

S Senthil Vinayagam¹ & Rajendra R Chapke²

¹Principal Scientist, ICAR-NAARM, Hyderabad &

²Principal Scientist, ICAR- Indian Institute of Millets Research, Hyderabad 500030

Introduction

Farmers require a diverse range of information to support their farm enterprises. Information is needed not only on best practices and technologies for crop production, but also for post-harvest aspects. Agricultural Extension is an essential pillar for research and development in agriculture. Despite a wide range of reform initiatives in agricultural extension in India in the past decades, the coverage of, access to, and quality of information provided to marginalized and poor farmers is uneven. Approaches to agricultural extension in India and worldwide continue to evolve. Since the Green Revolution the agricultural extension, with its focus on increasing production via technology transfer, has adopted decentralized, participatory, and demand driven approaches in which accountability is geared toward the users (Kokate, 2009). While the call for demand driven agricultural extension has existed for several decades now, new modes of reaching out to farmers could have significant impact in India, as they might better reflect the local information needs of farmers. The diverse nature of the Indian subcontinent, with its wide variety of agro climatic regions and broad range of socioeconomic conditions in the rural population, calls for agricultural extension approaches that are context and situation-specific (Singh and Sharma, 2004)

In India, the role of agricultural extension in improving agricultural growth is today being recognized with increasing investment. India's 10th and 11th five-year plans emphasize agricultural extension as a key to increasing agricultural growth by reducing the yield gap in farmer fields, and therefore stress the need to strengthen agricultural extension in India (Planning Commission 2001, 2005, 2006). However, despite the renewed interest and investment in agricultural extension in India, the coverage of such services is inadequate.

Review of Extension Approaches

Over the years, the country has tried many extension and development strategies that helped increase and enhance farm production, productivity and overall quality of human life. After the independence, first extension direction to agricultural development was Community Development approach (1952). Besides land reforms, the programme tried to assure cooperative credit, improved marketing facilities, large

scale labour- intensive irrigation projects and the efficient use of resources with the help of National Extension Service agency(1953). Though the basic idea of CD programme was to bring overall development of the rural community through community participation but not many positive results were seen due to lack of conviction, commitment and expertise and the compelling situation of food shortages.

During sixties, the agricultural production situation was very critical and intensification of agriculture with the use of high yielding varieties became must and agricultural development became the sole indicator and measure of rural development. The programmes such as Intensive Agriculture District Programme(1960), Intensive Agriculture Area Programme(1964),National Demonstration(1966) and High Yielding Varieties Programme gained momentum. At this point, the sole purpose was of increasing crop yields by using modern means of production like fertilizers, irrigation and high yielding seeds in particular. The strategy was found generally to be unsuitable for the conditions and needs of complex, diverse and risk prone agriculture. These approaches, though paid good dividend, generally failed to help especially the poor farm households and reduce inequity.

During seventies, the emphasis was broadened from agricultural development to rural development and various programmes like Small Farmers Development Agency, Marginal Farmers and Agricultural Labour development agency,Drought Prone Area Programme, Integrated Rural Development Programme etc. were launched.These programmes laid substantial emphasis on participatory approach for organizing and mobilizing poor farmers to enable to take advantages of the technology and services on a continual basis.

Superimposed on TOT approach was the T & V system (1974) with emphasis on the role of extension in technology transfer to encourage utilization of research results. T & V approach was found to be too narrow in its approach and not suitable for small farms and rain-fed areas, which are surrounded with so many uncertainties. Mean while, the ICAR launched its extension programmes namely, Operational Research Project (1975), KrishiVigyan Kendra (1974) and Lab to Land (1979). During 7th plan,all these programmes including National Demonstration (ND) were later merged under the programme of KVK. The farming system research and extension programme was also started through KVKs. These programmes did receive some success, but could not make much impact, particularly in ensuring people's participation. It was realized that the modern technologies did not match with the farmers' need and resources, and therefore, farmers' participation was partial in the programmes. The situation demanded an emphasis on farmers' need-based and problem-oriented technology

generation with active participation of the farmers. The need for technology assessment, refinement and transfer was felt and IVLP (Institute Village Linkages Programme) based on participatory methodology was launched (1995) in selected locations in the country. In addition, National Watershed Development Programme for Rain-fed Areas was also launched by Govt. of India in selected states with basic consideration of people's participation. National Agriculture Technology Project (NATP) integrated the activities of public and private agencies in some selected districts under Agriculture Technology and Management Agency (ATMA) using bottom up planning approach (1999). The project continued upto 2005 with refinement based on field experiences. This has resulted to launch Centrally Sponsored Scheme of "Support to State Extension Programmes for Extension Reforms) during 2005-06 and continuing till date in 630 districts of India.

POLICY GUIDELINES FOR EXTENSION PROGRAMMES

The extension programmes are implemented on the basis of National Agricultural Policies, National Policy for Farmers and Five-Year Plans of Planning Commission. The following are the action points were highlighted under agricultural extension in National policies (Chandre Gowda, 2013)

National Agricultural Policy, 2000

- Strengthen R-E-F linkages
- Broad-base and revitalize the extension system.
- Encourage KVKs, NGOs, Farmers Organizations, Cooperatives, corporate sector and para-technicians for organizing demand driven agricultural extension.
- Organise capacity building and skill upgradation programme for all extension functionaries.
- Move towards a regime of financial sustainability of extension services through a more realistic cost recovery of extension services .
- Mainstreaming
- Gender concerns in agriculture

National Policy for Farmers, 2007

- KVKs would take up training and lab-to-land demonstrations to provide skilled jobs in villages.
- Strengthening the State extension machinery and promote farm schools
- Convergence of extension efforts at state level , district level and below .

- Linkage with Common Service Centres (CSCs) of the Department of Information Technology, Government of India for inclusive and broad-based development.
- Empowering farmers with the right information at the right time and place is essential for improving the efficiency and viability of small and marginal holding.

Five-year Plans of Planning Commission, Government of India:

Five Year Plans had many implications particularly for initiating new government programmes, policies and procedures.

The **Sixth Five Year Plan** period coincided with the operations of T&V system.

The **Seventh Five Year Plan**, the World Bank assisted National Agricultural Extension Projects I to III were in operation. A major effort had been to broad-base the extension activity by moving away from the narrow individual crop orientation to farming systems approach.

The **Eighth Five Year Plan** more emphasis were given on development of rainfed areas, using adoption of dry land farming system approach; involvement of NGO and Voluntary organizations in Extension, Women in Agriculture, and integration of six extension schemes of ICAR under KVK.

The **Ninth Five Year Plan** basically addressed the issue of food security. A regionally differentiated strategy based on agro-climatic zones to take into account agronomic, climatic, and environmental conditions to realise the full potential of every region was emphasised.

The **Tenth Five Year Plan** emphasised on reforms to make extension services demand driven, for which encourage the role of the non-government sector in agriculture extension and an innovative approach in the field of television/ radio broadcast, Communication networking, Strengthen the ACABC scheme to establish agri-clinics / agri-business centres / ventures by the agricultural graduates etc.

The **Eleventh Five Year Plan** reiterated the key role to be played by Public extension system in educating farmers and helping them to take right decisions. Infrastructure below district level is needed to support capacity building of farmers by up-scaling ATMA to all development districts through convergence. Promotions of research—

extension– farmer -market linkages, .Public-private partnership (PPP) in extension were also envisaged.

The Twelfth Five Year Plan envisaged National Mission on Agricultural Extension and Technology (NMAET) in which amalgamation of 17 different schemes of the Department of Agriculture & Cooperation will be done under the umbrella of Agriculture Technology Management Agency (ATMA).NMAET consists of 4 Sub Missions:

- (i) Sub Mission on Agricultural Extension (SMAE)
- (ii) Sub-Mission on Seed and Planting Material (SMSP)
- (iii) Sub Mission on Agricultural Mechanization (SMAM)
- (iv) Sub Mission on Plant Protection and Plant Quarantine(SMPP)

The common threads running across all 4 Sub-Missions are Extension & Technology.

The aim of the Mission is to restructure & strengthen agricultural extension to enable delivery of appropriate technology and improved agronomic practices to the farmers. This is envisaged to be achieved by a judicious mix of extensive physical outreach & interactive methods of information dissemination, use of ICT, popularisation of modern and appropriate technologies, capacity building and institution strengthening to promote availability of quality seeds, mechanization, plant protection etc. and encourage the aggregation of farmers into Farmers Interest Groups (FIGs) to form Farmer Producer Organizations (FPOs) etc.

Farmers' skill trainings and field extension as contained in all 4 Sub Missions of NMAET (Viz. SMSP, SMAE, SMAM and SMPP) will be converged with similar farmer-related activities going on through ATMA. Five-tiered modes(TV, Newspapers, Booklets, KCC, Internet, SMS) of extension will also be carried out in broadcast or interactive electronic modes in all the four Sub Missions.

Technical, legal, administrative & regulatory functions and other components (not related to farmer centric extension) will continue to be discharged independently under the respective Sub-Missions.

Support to State Extension Programmes for Extension Reforms (ATMA Scheme)

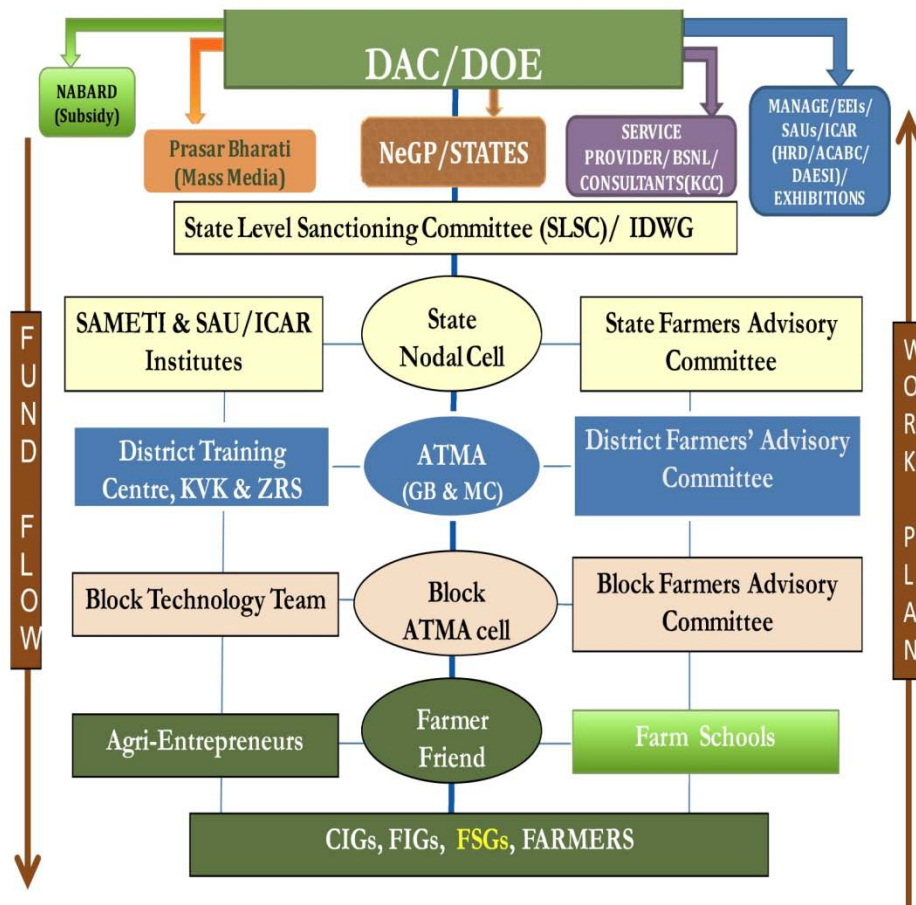
This Scheme shall focus on the following key extension reforms:

- Encouraging multi-agency extension strategies involving Public/ Private Extension Service Providers.
- Ensuring an integrated, broad-based extension delivery mechanism

consistent with farming system approach with a focus on bottom up planning process.

- Adopting group approach to extension in line with the identified needs and requirements of the farmers in the form of CIGs & FIGs and consolidate them as Farmers Producer Organisations;
- Facilitating convergence of farmer centric programmes in planning, execution and implementation.
- Addressing gender concerns by mobilizing farm women into groups

The above objectives shall be met through strengthened institutional arrangements, dedicated manpower, Innovative Technology Dissemination component and revamped strategy. The organizational structure at various levels has been depicted in the following diagram:



Extension through Krishi Vigyan Kendra

The Krishi Vigyan Kendra (KVK), or farm science center, is a multidisciplinary educational institution situated at the district level, with funding and technical supervision from ICAR. There are 631 KVKs, almost one for each district in India. Each center is under the administrative control of a state agricultural university, State Department of Agriculture, NGO, or central research institute. The performance of KVKs may vary depending on the administrative control. Each KVK is in one of 15 agro climatic zones and created a niche for themselves as the front line extension system performing the vital role of linking research-extension-farmers systems.

Extension through Private Sector

The private sector is increasingly playing a role in extension services in India. It develops context-specific models and using ICT tools to bring information directly to the farmer. Most of the agricultural input companies have an element of extension through various approaches. A few private companies have initiated 'one-stop farm solution centres' for their extension services. Some of them are

Mahindra Krishi Vihar: Mahindra and Mahindra Limited has established one-stop solution centres with the establishment of Mahindra Shubhlabh Services subsidiary, since solution centres operate on a franchise basis and provide quality inputs, 2000. The one-stop solution centres operate on a franchise basis and provide quality inputs, rent farm equipment, credit in partnership with banks, farm advice by trained field supervisors who visit fields, and arrange contracts with processors for off-take of crop produce.

Tata Kisan Sansar by Tata Chemicals Ltd. Has a franchise-based 'hub and spokes' model of outlets. The extension services offered by these one-stop shops include soil testing, remote diagnostics and house brands for seeds, cattle feed, pesticides and sprayers.

Godrej Agrovet has chain or rural outlet and run in partnership with other companies to extend its products range. Its 'one-stop solutions' model offers agricultural equipment, consumer goods, technical services, soil and water testing, veterinary, financial and post office services, and pharmaceuticals

Although few empirical studies have been carried out, the performance of private extension is said to vary widely; it tends to focus its services on areas with sufficient resources and is limited to a few crops and areas where profits can be assured (Sulaiman and van den Ban 2003). The private sector serves a corporate interest, working with individual farmers, so social capital is not built. Moreover, private extension can only work well if farmers are willing and able to pay. One option suggested by Swanson (2008) is that the private sector could serve the needs of

medium-size and commercial farmers, while the public sector could work in remote areas, which are currently not serviced well. This sort of system would require public-private partnerships that currently at initial stages in India.

Extension through NGOs

Considering the large number of marginal and small land holdings in India, Farmers organizations and SHGs could play important roles in articulating the needs of farmers to knowledge intermediaries. They can operate side by side with either NGOs or the public sector, but challenges exist in both sectors. Public capacity to build FBOs and SHGs is limited, while NGOs, which are not numerous, rely on donor funds and would need public support to develop the technical skills to facilitate the groups (Swanson 2006; Sulaiman and Hall 2004). Within FBOs or SHGs, problems related to social identity, including gender and caste, mean that these organizations may not be completely inclusive and are subject to elite capture problems. When farmer groups interact with other institutions, social identities and other social status perceptions mean that they may be too weak to articulate their concerns (Sulaiman and Hall 2004). Building the capacity of such groups, and promoting the development of leadership and management skills so that farmers can demand the information they need, is therefore an important component of agricultural extension approaches.

NGOs such as BAIF , Basix and PRADAN operate in numerous states and have been active in extension services for many years.

The Bharatia Agro-Industries Foundation (BAIF) BAIF is a Gandhian organization committed to imparting livelihood opportunities to the rural underprivileged families. BAIF currently works in round 50,000 villages in 12 states of India. BAIF 's areas of work include water resources development, sericulture, agro forestry, post-harvest product management and marketing cattle feed ad forage production. BAIF facilitated the formation of farmers' cooperatives and federations of self-help groups.

Basix: Basix strategy is to provide a comprehensive set if livelihood promotion services which include Financial Inclusion Services (FINS) agricultural/Business Development Services (Ag/BDS) and institutional Development Services (IDS) to rural poor households under one umberall. Extension services for farmers is being provided. According to Basix its services reach around 800,000 farmers and involve productivity enhancement, risk mitigation, local value addition and alternative market linkage for synthetic bio-inputs and outputs.

PRADAN: A majority of the families that PRADAN works with belongs to the Schedule Tribes and Schedule Castes. PRADAN promotes the Integrated Natural

Resources Management (INRM) of land, water, forest and biological resources to achieve and sustain potential agricultural productivity

Extension through ICT applications:

Kiisan Call Centres (KCC) to harness the potential of ICT in agriculture, Ministry of Agriculture took the initiative of launching an innovative scheme “Kisan call Centres” on January 21, 2004 aimed at offering solutions to farmers’ queries on a telephone call.

aAqua (‘Almost All Question Answered’) is an internet based discussion portal initiated in 2003 by the Developmental informatics Lab of the Indian Institute of Technology in kiosks and cybercafés in Pune. A farmer can ask a question on aAqua from a kiosk or cybercafé other farmers or experts view the question and reply (in English, Hindi or Marathi).

Avaaj Otaalo is a voice-based system for farmers to access and discuss relevant and timely agricultural information by phone. The system itself is a voice-XML based interactive Voice Response system. When a farmer calls in, he/she hears audio prompts and is asked to enter a number from the keypad or say a word in order to navigate.

Digital Green is a non-profit organization with funding from the Bill and Melinda Gates Foundation and the Deshpande Foundation. It disseminates agricultural information to small and marginal farmers through digital video.

e-Choupal is an initiative by the agri-division of ITC Ltd, the Indian Tobacco Company, Each e-Choupal is equipped with a computer connected to the internet. A local person acting as a sanchalak (coordinator) runs the village e-Choupal. Farmers can obtain daily updates on crop prices in local mandis, procure seed, fertilizer, and other products including consumer goods, and sell their crops for prices offered by ITC.

Extension through Farmers Organizations and Agri-preneurs

Agri-Clinics&Agri-Business Centres (ACABC) is a Central Sector Scheme under implementation since 2002. The scheme promotes the involvement of agri-preneurs to supplement the efforts of public extension system by way of setting up of agri-ventures in agriculture and allied areas. Agri-Clinics are envisaged to provide expert advice and services to farmers on various technologies, Agri-Business Centres are commercial units of agri-ventures established by trained professionals.

Mahagrapes It is a Partnership firm of 15 co-operative societies, the main aim being to export grapes and other fresh produce to different parts of the world. Formation of co-operative societies has helped to reach every farmer.

Producers Companies: Producer Companies are the legal institutions, registered under GOI's Producer Company Act, or Companies (Amendment) Act, 2002. It is a hybrid of cooperative and private Company Act, 1956. Members have to be necessarily primary producers i.e., persons engaged in an activity concerned with or related to primary produce. Minimum 10 members must come together to form the producer company and there is no upper limit for number of members.

Vegetable and Fruit Promotion Council Keralam (VFPCCK) is an ISO 9001-2000 certified company registered under section 25 on Indian Companies Act 1956 and has been established to bring about overall development for fruit and vegetable sector in Kerala. VFPCCK is managed by a result oriented multidisciplinary team of professionals. VFPCCK is a company with majority stake of farmers and the government and financial institutions as the other major shareholders.

Farm School to promote Farmer-to-Farmer Extension: Farm School under ATMA scheme is an attempt to institutionalize the concept of farmer-to-farmer-extension. These 'Farm Schools' are to be operationalized at Block/Gram Panchayat level and are set up in the field of achiever farmer who are the 'Teacher' in the Farm School.

Conclusion

Due to changing agricultural conditions—including climate change, increasingly degraded and marginalized land coming into production, limited water availability, increasing use of inputs, rising fuel costs, and unknown market opportunities—farmers require access to timely, reliable, and relevant information that can support the complexity within which their farm enterprises operate. Although agricultural extension today has a broad mandate, this review shows that despite pluralistic extension approaches in India, the coverage and use of these services are limited. Considering the large number of marginal and smallholder farmers, particularly in rain fed regions, a major need is to build the capacity of farmers to demand and access information to increase their productivity, profitability, and incomes. The information must be reliable and timely. The public-sector extension system still receives significant investment from the central government and is increasingly pushed as the major source of knowledge through a presumed transfer of technology. ATMA is a key component of the system. The KVKs also face challenges that limit their ability to meet farmer's needs. Pluralistic extension system in India; with the public sector, private sector, and third sector all playing some roles. Public-private partnerships; for example, through the agri-clinic and agri-business center (ACABC) scheme; are one aspect that could be strengthened and

encouraged. The public extension system dominates the provision of knowledge and information to smallholder farmers, especially in rainfed agricultural communities and largely concentrates on on-farm activities. The private-sector e-Choupal initiative and various small-scale models have tried to provide farmers with information not only regarding on-farm production but also regarding prices and accessing markets. However, these approaches work only for specific crops and regions where farmers have the incentive to take risks and are willing to pay for services. The impacts of the multiple ICT approaches are not documented and tend to work in small communities. Despite the variety of agricultural extension approaches that operate in parallel and sometimes duplicate one another, the majority of farmers in India do not have access to any source of information. This severely limits their ability to increase their productivity and income and thereby reduce poverty. Understanding the behavior of farmers in seeking information for their enterprises and communication through social networks will assist in the development of appropriate agricultural extension strategies. The existence of context-specific and relevant information for farmers also needs to be considered.

References

- Chandre Gowda ,M. J. (2013) Innovations in Extension Delivery in India .Paper presented at National Seminar on Futuristic Agricultural Extension for livelihood Improvement and sustainable Development, ANGRAU, Hyderabad .Jan 19-21,2014
- Kokate ,K.D.(2009) Developing Farmer –led and Market –Led Extension System:Paradigm Shift and Experiences .Presented in National Seminar on Agriculture Extension 2009. Directorate of Extension, Department of Agriculture & Cooperation, Ministry of Agriculture, New Delhi
- Singh ,B.and Sharma,P.(2004) ,Extension Approach For Agriculture Needs Re-Orientation,Paper presented at National Workshop on Communication Support for Sustaining Extension Services. 17-18 February 2004, Department of Extension Education, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, (India).
- Sulaiman, R and A. Hall, 2004. India: The emergence of Extension-Plus: Future for extension beyond technology transfer? In Extension reform for rural development: Case studies of international initiatives, Vol. 1. Washington, D.C.: World Bank and the U.S. Agency for International Development.
- Sulaiman, R., and A.W. van den Ban (2003), Funding and delivering agricultural extension in India, *Journal of International Agricultural and Extension Education* 10(1). [11]
- Swanson, B. (2006), The changing role of agricultural extension in a global economy, *Journal of International Agricultural and Extension Education* 13(3). [12]