



# Development Challenges of Indian Agriculture

**Background Technical Papers**  
**The National Medium Term Priority Framework**  
**Government of India and FAO**



# Development Challenges of Indian Agriculture

**Background Technical Papers for the Preparation  
of the National Medium Term Priority Framework  
for FAO and the Government of India**

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This compendium consists of ten sector papers commissioned by FAO in 2008, as a precursor to the white paper and finally leading to the development of the FAO-India National Medium Term Priority Framework (NMTPF). These papers are intended to be comprehensive accounts of challenges and opportunities of the sectors thought to be critical for the development of food and agriculture in India.

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# Knowledge Generation and Management

Prepared by

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## EXECUTIVE SUMMARY

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FAO India is working with the Government of India to prepare a National Medium Term Priority Framework (NMTPF). This paper on Knowledge Generation and Management is an input to the preparation of NMTPF. The paper identifies opportunities for meaningful intervention by international developmental agencies based on identification of weaknesses, gaps and hurdles faced by the sector as reported in several recent studies and reports.

The need for strengthening the generation, management and application of new knowledge has been very well articulated in the Indian context. India has several programmes on knowledge generation and management. While many of them are public sector led, private and civil society initiatives are expanding rapidly. Though a number of

public, private and civil society actors capable of providing different types of knowledge support and services exist in India, many of the programmes implemented by these actors have failed to quickly respond to the rapidly evolving and increasingly complex challenges faced by farmers.

The paper argues that this sector is affected by two major weaknesses. Firstly, those related to institutional issues or its ways of working and secondly, those related to lack of expertise, manpower and finances. The paper identifies capacity development for knowledge generation and management as the most appropriate role international development agencies could play in the Indian context. These include enhancing capacity to deal with new science and technologies, promoting new ways of working, and supporting institutional and policy changes.



## 1. BRIEF OVERVIEW OF THE SECTOR

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Public sector research and extension agencies continue to dominate the knowledge generation and management provision for agriculture in India. Private sector, especially input companies and agro-processors, have become important producers and promoters of new knowledge in the last two decades. The NGOs have also expanded their involvement in agriculture, from promoters of technical knowledge initially to generation of a range of new knowledge covering technology, institutions and policies relevant for agriculture. In addition to these, different forms of media also play an important role in disseminating new knowledge on agriculture. Though there is an increasingly diverse mix of actors currently engaged in knowledge generation and management, this has not resulted in better knowledge use or application at the ground level. This is not a new finding on its own, as several recent reports / studies have pointed to the need for improved generation, management including diffusion, adaptation and integration, and application/use of new knowledge. This is more important than ever before, considering the rapidly evolving nature of Indian agriculture and the new set of challenges it has to currently deal with.

### The challenges of development

India's economic security is heavily dependent on agriculture and more than half of its rural population is still dependent on agriculture for most of its income. Though the Green Revolution increased production and productivity of food crops, improved food security and raised rural incomes, India still has a large poor and malnourished population. Raising productivity as well as farm income through a second green revolution is much talked about. Indian agriculture is currently facing greater challenges from unsustainable use of natural resources and significant threats - as well as opportunities - from opening of agricultural markets. Addressing many of these complex issues requires solutions which are beyond the decision making capacities

of individual farmers. Recent years have also witnessed a deceleration in the growth of agriculture.

There is a growing gap between scientific know-how and field-level do-how. This knowledge deficit would have to be overcome speedily to enhance farm productivity and profitability<sup>1</sup>. There are wide gaps in yield potential and national average yields of most commodities are low. As the sector is dominated by small farms - often with weak bargaining power and limited political voice, new forms of collaboration to ensure collective decisions on resource use and marketing would also become important. A second green revolution is possible only through an integrated use of new knowledge and the real challenge is going to be in finding ways of generating and managing new knowledge and supporting farmers to apply new knowledge in his / her farm.

### Future potential

A sustainable and efficient agriculture is important for India for both alleviating poverty and achieving food and nutrition security at the national level. Agricultural research and extension also needs to tackle the new challenges emerging from climate change, increasing integration with global economy and soaring food prices.

There is considerable scope to increase rural income through a second green revolution that would focus on increased productivity, sustainable use of resources, enhanced competitiveness, value addition and creation of an efficient marketing system. This would require generation, management and application of all forms of knowledge - traditional as well as modern (technological, organizational, and marketing) through an interactive network of organizations involved in research, extension and other support services. Strengthening research, extension and other support arrangements therefore would continue to remain important for transforming Indian agriculture.

## 2. CURRENT PROGRAMMES AND ACTIVITIES

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### Major programmes undertaken by the Governments

Currently the public research system consists of about 100 research centres at the national level, 99 coordinated and network projects and 41 State Agricultural Universities (SAUs) and their several regional and commodity focused research stations. More than 22 000 agricultural scientists spread over a vast network of organizations in the public (Central and State) and private sectors were employed in the National Agricultural Research System (NARS) in the year 2001<sup>2</sup>. Indian Council of Agricultural Research (ICAR) and SAU programmes focus on most of the important crops and livestock and fishery species. ICAR also oversees and regulates agricultural education in India. ICAR and SAUs have been collaborating extensively with several CGIAR centres, especially ICRISAT, IRRI, CIMMYT, IFPRI, ILRI etc. Each SAU is organized into several colleges (imparting agricultural education) and research centres dealing with specific crops and agro-ecological zones. Commodity Boards under the Ministry of Commerce, handles R&D and extension in select commodities like tea, coffee, rubber and spices. Some organizations under the Council for Scientific and Industrial Research (CSIR) are also involved with agricultural research e.g. post-harvest value addition, medicinal plants.

In the public sector, the extension machinery of the State Department of Agriculture (SDoA) reaches down to block and village levels. The village extension workers of the SDoA continue to be an important source of information for farmers in India, even though the visits are irregular, and the service is pre-occupied with the implementation of Government schemes, often linked to distribution of subsidies and inputs<sup>3</sup>. Compared with the SDoA, the animal husbandry and the fisheries departments do not have adequate field level presence. Advisory services in the area of animal husbandry and fisheries therefore do not reach many farmers. About 22 percent of the posts

across agriculture and allied departments remained vacant in 2005-06<sup>4</sup>. Since 2004, a call centre based extension service has been set up wherein farmers can call on a toll free number for farm advice.

In the case of extension, the major reform in recent years has been the establishment of a district level coordinating agency, the ATMA (Agricultural Technology Management Agency), initially in 28 pilot districts in seven states with the support of the World Bank. The ATMA model was upscaled in May 2005 across the country as a Centrally sponsored scheme. So far 567 districts have been covered by ATMA (Box 1).

To incentivize the States to increase public investments in agriculture, the Central Government in 2007 introduced a new scheme, the Rashtriya Krishi Vikas Yojana (RKVY). It provides flexibility and autonomy to the States in planning and executing programmes for agriculture to achieve the goal of reducing the yield gap and maximize returns to farmers. The State Department of Agriculture is the nodal department and the total allocation under the Eleventh Plan is Rs 25 000 crores. RKVY makes it mandatory for States to prepare district and State level agricultural plans. Resources under RKVY can be potentially used for supporting extension activities and it encourages convergence with other programmes such as NREGS, SGSY and BRGF. States have initiated attempts to bring about convergence, but the progress is less than satisfactory mainly due to the apparent reluctance of different departments to share resources, lack of adequate consultations and lack of empowered authority to coordinate and facilitate convergence at the district level<sup>7</sup>. These initial hiccups are expected to be resolved in the coming years.

Two other programmes, namely the Backward Regions Grant Fund (BRGF) implemented by the Ministry of Panchayati Raj in 250 backward districts, have provision for capacity building

## BOX 1:

### Agricultural Technology Management Agency (ATMA)

Agricultural Technology Management Agency (ATMA) is a decentralized participatory and market driven extension approach pilot tested in India in 28 districts during 1998-2005. It is a district level autonomous agency constituted for (i) integrating the extension programme across all key line departments and other extension agencies; (ii) link research and extension activities in a district; and (iii) decentralize extension decision making through a participatory programme planning process involving all categories of farmers.

All the research and extension units within the district such as KVKs, Zonal Research Stations, Department of Agriculture, Horticulture, Animal Husbandry, Fisheries, Sericulture, Marketing, etc. are constituent members of ATMA. These bodies have been created mainly to facilitate farming systems approach by working closely with different developmental departments at the district and block levels. Under ATMA, grassroot level extension is mainly provided through the involvement of Block Level Technology Teams, Farmer Advisory Committees, farmer groups/ farmer interest groups and Self Help Groups. To provide HRD support, State Agricultural Management and Extension Training Institutes (SAMETI) have also been established in each State. The district collector/deputy commissioner heads ATMA Governing Body, with members drawn from the line departments, farmers and NGOs. This model was subsequently replicated in all the districts of India with central government funds.

The performance of ATMA model during the pilot phase has been considered a success. However, ATMA is currently facing several operational difficulties at the district level such as lack of dedicated staff, handholding support and staff training, and limited success at convergence during this expansion phase. ATMA has a few positive outcomes and these include:

- development of mechanisms for participation of farmers in deciding priorities (strategic research and extension plans);
- identifying and implementing programmes (farmer advisory committees); and
- bringing additional funding for extension activities (exposure visits, demonstrations, farm schools, farmer awards, exhibitions etc). Moreover, it also provided a space for nurturing some new ideas such as public-private partnerships and user contribution for extension.

of staff of panchayats/ municipalities in planning, implementation and monitoring. These programmes also have a provision for recruiting a trained community level person for agricultural extension activities. Similarly, the Swarnajayanti Gram Swarozgar Yojana (SGSY) programme implemented by the Ministry of Rural Development through the District Rural Development Agencies (DRDAs) has provision for skill development, marketing and technology support.

The National Horticultural Mission (NHM) has provision for funding technology generation activities appropriate to each region / State keeping in view the specific agro-climatic and socio-economic conditions.

These funds could be accessed by public and private organizations having capability for implementing research programmes. The NHM also supports establishment of Precision Farming Development Centres (PFDCs) to promote development of regionally differentiated technology validation and dissemination activities. Human Resource Development through trainings and demonstrations is an integral part of the Mission. Under this, programmes for training of farmers, field level workers and officers are taken up.

During the last two decades, the number of Krishi Vigyan Kendras (KVKs) established and funded by the ICAR has increased. KVKs mainly

focus on technology testing, assessment and application under farmers' condition through conducting on-farm trials, demonstrations and training. But due to its weak links with other agencies, its effective reach is limited <sup>8</sup>. ICAR has also established Agricultural Technology and Information Centres (ATICs) in some of the SAUs and ICAR institutes mainly to serve as a single window offering the institute's technology, advice and products.

The Department of Information Technology (DIT), Government of India has proposed to roll out over 10 000 Common Service Centres (CSCs) across the country, primarily in rural areas, that would cover at least 40 percent of the Gram Panchayat locations in every district of a State. The objective is to develop a platform that can enable Government, private and social sector organizations to align their social and commercial goals for the benefit of the rural population in the remotest corners of the country through a combination of IT based as well as non-IT based services <sup>9</sup>. The Government intends to use these CSCs as Gyan Choupals, providing quality information and advice to the farmers. This would however necessitate developing a framework for linking extension machinery and development of appropriate software resources. Initiatives such as e-Choupal from ITC and experiments such as e-Sagu in Andhra Pradesh provide several lessons on application of ICTs for agricultural development.

The quality and strength of the knowledge generation and management sector depends strongly on the quality of the agricultural education system. At present, there are 41 SAUs, 4 deemed Universities, and 1 Central University directly involved in agricultural education. In addition there are a few Central universities having a strong agricultural faculty. At any point, there are over 75 000 students studying in SAUs. In addition to these there are large numbers of private colleges both affiliated and non-affiliated to SAUs which also annually admit large number of students <sup>10</sup>. ICAR has the mandate of regulating agricultural education in the country. This responsibility is discharged

through partnership with SAUs. To ensure quality assurance in higher education, ICAR has put in position a number of initiatives and reforms which include -

- establishment of an "Accreditation Board" for quality assurance;
- faculty competence improvement through training;
- library strengthening, institution of scholarship and fellowships; and
- measures for reducing in-breeding and infrastructure support for library, hostels and laboratories.

To tap the expertise of a large pool of agricultural graduates in the country, the Ministry of Agriculture in association with NABARD and MANAGE is implementing the Agri-Clinics and Agri-Business Centres (ACs & ABCs) Scheme. The objectives of this scheme are as follows:

- a) supplement the efforts of Government extension system;
- b) make available supplementary sources of input supply and services to needy farmers; and
- c) to provide gainful employment to agricultural graduates in new emerging areas in the agricultural sector.

Agricultural graduates are provided a two-month training in agri-business development through institutions in the public/private sector. The entire cost of training and handholding is being borne by the Government of India. The trained graduates are expected to set up ACs & ABCs with the help of bank finance. Till December 2006, more than 11 500 graduates were trained resulting in establishment of 3 750 centres in various parts of the country spread across 36 categories of agri-ventures <sup>11</sup>.

NABARD has a farmer's club programme. Farmer's clubs are organized by rural branches of banks in their operational area with the support and financial assistance of NABARD. NABARD provides financial support to these clubs for formation, maintenance

and for organizing meetings with experts. By March 2006, 28 226 farmer clubs were organized.

More than 110 million women are engaged as workers in rural India, where agricultural based opportunities form their major livelihoods. While 36.5 percent of them are cultivators, 43 percent work as agricultural labourers <sup>12</sup>. Women's role in agriculture got attention in Indian policy circles in the Seventh Five Year Plan (1985-89). After that several programmes for women in agriculture were implemented in India. These include -

- special donor assisted programmes on women in agriculture in select states;
- the central sector women in agriculture programmes; and
- Women Component Plan adds to the on-going initiatives for gender mainstreaming.

Rural livelihood programmes of the Central and State rural development departments and the microfinance initiatives through women Self Help Groups (SHGs) implemented by Government and NGOs also supported rural women in organizing themselves and accessing capital and other resources. A National Gender Resource Centre in agriculture has been set up by the Ministry of Agriculture within its Directorate

of Extension to work as a focal point for convergence and coordination of gender related issues.

### Donor initiatives

The World Bank is currently supporting the National Agricultural Innovation Project (NAIP) of ICAR and it focuses on promoting collaboration among public research organizations, NGOs, the private sector and other stakeholders. IFAD co-finance NAIP. Another important initiative is the US-India "Knowledge Initiative on Agricultural Education, Research, Service and Commercial Linkages". Biotechnology and food processing are two important areas of knowledge-sharing under this initiative. ICAR and ACIAR are collaborating on a joint five-year programme (2008-2103) on the application of marker-assisted selection as a tool to achieve greater efficiency in wheat breeding.

DFID, IFAD and WFP programmes have a broader livelihood focus. Improving agriculture is a priority in these programmes only in cases where it can potentially improve livelihoods and nutrition. For DFID, supporting rural livelihoods is currently a priority in Madhya Pradesh, Orissa and West Bengal. It also funds research on climate change, agriculture, water resources, forestry and adaptation. IFAD funds projects on rural

## BOX 2:

### Private and civil society programmes in India - an overview

Private industries, NGOs and research foundations are also engaged in technology development and promotion - the former comprising the input sector (seed, fertilizer, pesticides and machinery) that is involved with basic, applied and adaptive research and the latter dealing mainly with adaptive research. Recent estimates reveal that the private sector bears 15 percent of agricultural R&D expenditure costs in India <sup>13</sup>. Many of the private agribusiness firms procuring raw materials from farmers are also providing inputs, advice and marketing support to the farmers.

The last two decades have witnessed the increasing involvement of civil society - including research foundations, NGOs and producer associations - in agricultural research and extension. Many have been working with the poor and have a broader approach to generation, adaptation, diffusion and application of new knowledge (collectively known as innovation) thereby helping the poor access, adapt and apply new information, knowledge and technology <sup>14</sup>. India also has strong and articulate industry associations (e.g. FICCI, CII, ICC) and they play a very important role in influencing agricultural policy.

development, tribal development, NRM, women's empowerment and rural finance and the main purpose is to strengthen people's capacities to establish and manage their own institutions. WFP focuses on addressing malnutrition and improving food security of poor women, at-risk children and poor forest-dependent population. The activities focus on capacity development of India's own schemes to reach its nutritional objective. FAO's programmes in India focus on plant

protection, pro-poor livestock policy, forestry, fisheries, nutrition, food quality and safety, and it supports the States by way of providing specific technical assistance. One of its recent initiatives "Solution Exchange" has created a platform for exchanging knowledge and experiences on a number of issues related to food and agriculture. USAID implements programmes related to promoting bio-safety regulations, use of biotechnology and reforming agricultural markets in India.



### 3. DEVELOPMENT STRATEGIES

#### Core development strategies

Development strategies of different actors involved in knowledge generation and management are indicated in Table 1. Most of these organizations focus on development of new technologies, distribution of inputs/subsidies, and technology dissemination activities, leaving other important functions

needed for knowledge application unattended. Many of these organizations work in isolation and have weak links with other intermediaries and knowledge users dealing with other kinds of knowledge and services related to credit, inputs, markets, value addition, entrepreneurship development and policy.

**TABLE 1: Development strategies of key organizations in knowledge generation & management**

Organizations	Development strategies
<b>ICAR Research</b>	Main focus is on technology development. Themes include, germplasm conservation, varietal /breed improvement, soil and water; power and machinery, feeding practices; processing/value addition; and socio-economics.
<b>KVKs</b>	Main focus is on on-farm trials, front-line demonstration and training.
<b>SAUs</b>	Main focus is on teaching and research. Undertakes extension activities on a limited scale. Technology development activities are similar to those undertaken by ICAR (as discussed under ICAR research).
<b>Private R&amp;D</b>	Agro-chemicals (including fertilizers), seed and machinery and food processing; more recently growth in plant breeding, biotechnology, animal health and poultry. Input companies focus on product demonstrations.
<b>Commodity Boards</b>	Rubber, tea, coffee, spices; conduct research and implement extension programmes.
<b>MoA (DAC and DoAH &amp; F)</b>	Formulation and implementation of national policies and programmes and central sector extension and development programmes; support national and regional extension institutions such as MANAGE, NIAM and EELs that conduct training and handholding support to States.
<b>NABARD</b>	Support establishment of farmer clubs by banks in rural areas.
<b>State line departments</b>	These include departments related to agriculture, horticulture, animal husbandry, fisheries, sericulture etc. These organizations focus on implementation of development and extension programmes and manage State, regional and district level training centres.  DoH manages horticultural farms, DoAH runs veterinary hospitals, polyclinics and AI services; DoF runs fish seed farms; Sericulture department organizes supply of cocoons and planting materials. Rural development departments and PRIs implement several employment and development programmes, some of these include agriculture.
<b>DRDAs</b>	Implement SGSY programme. Organize SHGs and provide technical training and market development support.
<b>PRIs</b>	Panchayat Raj Institutions (PRIs) implements several programmes including National Rural Employment Guarantee Scheme (NREGS). Closely involved with development of village, block and district plans.

Contd.

<b>TABLE 1: Development strategies of key organizations in knowledge generation &amp; management</b>	
<b>Organizations</b>	<b>Development strategies</b>
<b>Agri-business</b>	Provide integrated support - inputs, technology and markets - to contract growers.
<b>CSO/NGOs</b>	Have good networks with communities/villages they operate in and have evolved innovative approaches to provide integrated support and services to the poor.
<b>Media</b>	Newspapers, farm magazines, radio and TV channels. Specialist monthlies, one page every week on agriculture in most of the vernacular dailies; daily programmes on agriculture in radio and TV channels.
<b>Producer cooperatives</b>	Producer cooperatives, e.g. dairy, sugar, grapes, provide a number of services - inputs, advice and marketing - to farmers.
<b>Donors</b>	<ul style="list-style-type: none"> <li>- direct support to agricultural research through ICAR and SAUs (World Bank); - ACIAR and CGIAR institutions partner with NARS;</li> <li>- specific technical assistance to technology development and promotion (FAO); - indirect support to technology promotion through broad based livelihood support (IFAD, DFID, WFP);</li> <li>- research on climate change impact and adaptation (DFID), support for agri-market development; marketing extension;</li> <li>- improving bio-safety regulation and development and promotion of bio-engineered products (USAID).</li> </ul>

### Overall sector policy and the Centre - State dichotomy

According to the Indian Constitution, agriculture is a State subject though Ministry of Agriculture at the Centre lays down the major policy guidelines. For administration of agriculture, every State has a separate Department of Agriculture (SDoA), and for research and teaching, there are one or more state agricultural universities. However, the Central government substantially influences research, education and extension activities at the State level, through funding research activities (ICAR and some Ministries), overseeing agricultural education (ICAR), and designing, financing and monitoring several Central sector extension and development programmes and laying down all major policy guidelines.

### Views of different stakeholders

The need for strengthening the knowledge generation, management and application has been very well articulated in the Indian context. Sustained long run growth depends

critically on technological progress and steps are therefore needed to strengthen research and extension support in agriculture<sup>15</sup>. To overcome the prevailing technological fatigue, new productivity enhancing technologies are required and this would need increasing application of biotechnology, ICTs, renewable energy technologies and nano-technology<sup>16</sup>. The need for strengthening public sector research capacity in employing new generation science and technologies e.g. biotechnology, bioinformatics and nano-technology is more relevant than ever before due to changing ownership rules on new technologies. 'Incase, the public sector in India doesn't generate and put its claim on technologies that can be generated using modern tools of science, the country would become heavily dependent on developed countries and the private sector which may involve very serious implication and heavy price in future'<sup>17</sup>.

The need for greater resources to strengthen infrastructure, HRD for research, extension and teaching faculty and greater partnership with the private sector are also emphasized<sup>18</sup>. We

need to reorient the training of our agricultural graduates to give them more professional touch in molecular breeding, genomics, bioinformatics, integrated natural resource management, technology transfer and IPR management <sup>19</sup>. There is a need to strengthen the extension machinery through re-training and retooling of existing extension personnel and for promoting farmer to farmer learning by setting up Farm Schools in the fields of outstanding farmers <sup>20</sup>.

While the need for integrating different kinds of knowledge in the process of technology generation and promotion are

clearly evident, there is an overall reluctance among the public research and extension organizations to work with CSOs and the private sector <sup>21</sup>. Many of the successful experiences emerging from informal R&D facilitated / carried out by civil society organizations remain unnoticed for want of support systems and incentives required for its upscaling <sup>22</sup>. This would necessitate bringing about institutional changes in research and extension organizations <sup>23</sup>. A key lesson from implementation of NATP is that deliberate investments in partnership building and shared governance are required to speed up technology adaptation and dissemination <sup>24</sup>.

#### 4. SPECIFIC NEEDS AND POTENTIAL AREAS OF INTERNATIONAL COOPERATION

##### **Weaknesses, gaps and implementation hurdles**

Though a number of public, private and CSO actors capable of providing different types of support exist, it is quite astonishing to note that the rural producers do not get adequate support in addressing their expanding and complex challenges. Though several new schemes are introduced and more funds are committed for overall agricultural and rural development, the overall performance of these schemes has suffered due to

lack of complementary linkages among different agencies and lack of convergence of schemes. Though efforts are currently being made to support development of locally relevant schemes through district and State level plans, staff shortages, fear of loss of power and control on resources, and lack of capacity in designing locally relevant programmes, are constraining real convergence. The Government of India is keen to achieve convergence among these different programmes and a number of initiatives are currently attempted to achieve this <sup>25</sup>.

##### **BOX 3:**

##### **Gender and agricultural extension: current status and limitations**

- Despite considerable focus on women in agriculture from Seventh to Tenth Five Year Plans, the approach mainly remained as that of considering farm-women as an uniform category.
- Though SHGs have created space for women to come together and network and access small informal loans, a great majority of the micro-enterprises initiated by the SHGs lack sustainability. Most of the SHGs are severely affected by marketing problems and lack of technical and managerial skills. SHGs continue to engage in traditional stereotyped, low return activities and the fundamental livelihood concerns of the rural poor woman remain largely un-addressed.
- Though the Women Component Plan (WCP) implemented from Eighth to Tenth Five Year Plan, quantified and earmarked funds for programmes for women, most of the ministries and departments designated as women related have not achieved their obligations fully and not provided separately a women component in their programmes.
- The Mid-Term appraisal 2005 of the Planning Commission has indicated that women still remain largely untouched by gender-just and gender-sensitive budgets as well as by the mechanisms of the WCP.
- The compartmentalization of schemes and activities for women implemented by different Ministries and Departments address various facets of women's empowerment in a fragmented manner. In the absence of convergence among various schemes (even within the Ministry of Agriculture), the impact on women's economic empowerment in agriculture, at best, may remain scattered and isolated, hence not very substantial.

The status of implementation of existing government programmes reveals three major concerns -

- lower than the stipulated allocation and gap between targets and achievements;
- limited coverage especially, in terms of direct beneficiaries despite large coverage of States and districts; and
- seemingly low impact in terms of economic and overall empowerment.

*Sources: 1. Planning Commission (2006) - Approach paper of sub-group on gender concerns in agricultural extension; 2. Planning Commission (2006) - Report of sub-group on gender and agriculture.*

Though several programmes for women in agriculture have been implemented, it is becoming increasingly clear that, many of these programmes and projects are not formulated based on the diversity of women groups or women's interest or based on consultations with other agencies that are also interested or are working for rural women (Box 3). Research also indicates that there is a clear lack of vision about the institutional support required to turn activities into real livelihood opportunities. Even if the opportunity exists, there is lack of innovation within organizations to realize the potentials. Thus opportunities remain unchallenged and unexplored. All of these would involve fresh thinking, and an overhauling of the design, resource mobilization and implementation machinery<sup>26</sup>.

The faculty, infrastructure, curricula and teaching methods in agricultural education institutions directly impact the quality of professionals coming out of these institutions. Though ICAR is responsible for regulation of agricultural education, it has not been able to effectively play this role because of lack of statutory powers. As a result there has been a vertical and horizontal expansion of universities and colleges in total disregard of adequate financial resources leading to poor quality education in agricultural and allied areas<sup>27</sup>. The Fourth Deans Committee on Agricultural Education in India constituted by the ICAR in its report acknowledged that the current UG and PG curriculum neither offers experiential learning and required skills nor the entrepreneurial mindset to prepare scholars for taking up self-employment. There is also no link of curriculum to employment in private agri-business and processing industries and meeting the demands of extension. The Fourth Deans Committee has made several important recommendations for improving agricultural education and it remains to be seen how far these recommendations would be implemented in letter and spirit.

Though the country has made a beginning in the adoption and generation of biotechnologies, it is far behind the world

leaders in biotechnology. Biotechnological interventions, including (i) *transgenics* which can integrate foreign or synthetic genes of interest into target organisms across species barriers; (ii) *molecular* breeding for targeted improvement of specific traits in crops, livestock or fish; (iii) *molecular diagnosis and vaccines* for effective control of diseases; and (iv) nano-technology for biosensor development and precision farming, have tremendous scope for revolutionizing agricultural production and farmer income.

With the increasing role of the private sector in commercialization of biotech products, the public system needs to redefine its niche in the spectrum of activities starting from identification of problems, basic research and discovery, technology incubation and dissemination in biotechnology<sup>28</sup>. Immediate emphasis has to be laid on strengthening R&D and developing human capital in frontier scientific areas.

Despite repeated emphasis on collaborative extension efforts involving public and private agencies, this approach is yet to get adequate attention. There are very few successful partnerships in the country. Some of the critical constraints related to establishment of successful public-private partnerships (PPPs) include –

- bureaucratic hurdles;
- delays in decision making;
- hoarding of information/technologies;
- fear of operational compatibility;
- lack of a common platform to get into an operational MoU among partners;
- lack of initiatives and mission mode approach;
- unwillingness to share credit among partners; and
- reluctance for investments by private players.

Suitable partnership among national and regional players involving commodity boards, research institutes, farmer organizations and business houses will certainly prove to be successful, provided such partnership

arrangements are made on professional terms and conditions, centred on teams, free from conventional bureaucratic control with incorporation of in-built project planning, implementation and monitoring arrangements <sup>29</sup>.

The major weaknesses associated with this sector could be broadly classified into two. Firstly, those related to institutional or ways of working and secondly, those related to resources and these include resources related to expertise, manpower and finances (Table 2).

<b>TABLE 2: Implementation hurdles in knowledge generation and management</b>		
<b>Type of weaknesses / gaps and implementation hurdles</b>	<b>Current initiatives trying to address these</b>	<b>Limitations</b>
<b>A. Institutional</b>		
Isolated functioning of research and extension agencies and the difficulties in nurturing and promoting public-private partnerships.	NAIP is promoting a wider consortia led approach to solve technical problems through competitive research grants.	Other than some of these Central initiatives (NAIP, ATMA), there is little progress on the ground as institutional reforms are not attempted at the State level.
Mistrust of other actors, narrow evaluation norms and weak accountability with State level actors further strengthen isolated functioning.	ATMA is trying to promote public-private partnerships in extension.	Lessons from implementation of new institutional innovations are yet to be used effectively to stimulate institutional and policy changes.
Complementary knowledge and expertise therefore remain locked in different organizations (e.g., production and value addition, extension and marketing etc.)	Convergence being tried as part of several Central sector programmes.	
Other crucial set of activities like intermediation/brokering, technology adaptation needed for knowledge application remain unattended.		
Lack of convergence leading to sub-optimal utilization of funds and expertise.		
<b>B. Resources (expertise, manpower and finances)</b>		
<b>Expertise</b>		
<i>New science/technologies/themes:</i> Nano-technology, precision agriculture, horticulture, biotechnology and bio-safety testing, high-tech horticulture, agri-business, climate change impact and adaptation.	Training under Indo-US Knowledge Initiative: refresher courses, summer and winter schools sponsored by ICAR/ NAARM.	HRD efforts on new science/ technologies/ themes yet to get adequate attention.
<i>New approaches:</i> Facilitating public-private partnerships.	Only NAIP and ATMA focus on public-private partnerships.	Importance of promoting new approaches hasn't received adequate attention.
Community mobilization, enterprise development, market development.		

Contd.



<b>TABLE 2: Implementation hurdles in knowledge generation and management</b>		
<b>Type of weaknesses / gaps and implementation hurdles</b>	<b>Current initiatives trying to address these</b>	<b>Limitations</b>
<p>Innovation systems perspectives,</p> <p>Linking poor farmers to high value markets technological forecasting, incubation and commercialization.</p> <p>Producer companies, new generation cooperatives - sector coordination.</p>	<p>Training on mobilization, enterprise and market development handled by different agencies.</p> <p>Other new approaches listed are not addressed by any programmes.</p>	<p>Promoting new ways of working needs an action research approach with facilitation, hand-holding and lesson learning.</p> <p>Need training for policy makers on new approaches and client-oriented programme development.</p> <p>Staff shortages at the field level and ban on recruitments leading to sub-optimal utilization of trained manpower.</p> <p>Faculty shortages in training organizations and lack of expertise in emerging areas affect quality of trainings.</p>
<b>Manpower</b>		
<p>Less researchers working on livestock (15.8 percent) and fisheries (2.5 percent)<sup>30</sup>; livestock and fisheries extension virtually non-existent.</p> <p>Lack of qualified extension personnel to deal with new technologies and pilot new approaches (need this expertise at block/district levels).</p> <p>Vacancies in field level extension staff (average 22-25 percent).</p> <p>Vacancies in staff positions in SAUs.</p>	<p>No special programmes to address these issues available currently.</p>	<p>Lacks clear cut strategy on manpower development.</p> <p>Poor financial health of States constraining recruitments.</p>
<b>Finances</b>		
<p>Limited funding.</p> <p>Agricultural research and education expenditure as percent of Ag GDP now at 0.53percent<sup>31</sup> (The demand for increasing it to atleast 1percent hasn't got attention so far).</p> <p>Less research resources allocated to livestock (15 percent) and fisheries (5 percent)<sup>32</sup>.</p> <p>SAU finances in poor health<sup>33</sup>, limited operational funds for extension (line department and KVKs).</p>	<p>NAIP and National Fund for Basic and Strategic Research brought some additional funding for research.</p> <p>NHM support for horticultural research.</p> <p>More funds for extension and capacity building through ATMA, RKVY, FSM, BRGF, NHM.</p>	<p>These are inadequate considering the current state of affairs in State level research and extension organizations.</p>

## Requirements of the Governments

The need for new technologies, new frameworks, e.g. innovation systems <sup>34</sup> and new ways of working, e.g. public-private partnerships and linking the poor to markets are clearly articulated in several policy documents. Though agriculture is a state

subject, as indicated earlier, the Centre has considerable influence on supporting and reforming research and extension and the Centre and the States will be able to appreciate the importance of this activity. However, it is important to engage with the states and select organizations from the design stage itself. This is important to obtain the much needed state level ownership.

## 5. COMPLEMENTARY INPUTS FROM INTERNATIONAL AGENCIES

India has a relatively robust architecture for knowledge generation and management, though its effectiveness and efficiency have weakened over the years due to lack of resources and lack of institutional changes. Programmes explicitly addressing some of these weaknesses are already under implementation. International cooperation for knowledge generation and management should focus on capacity development of the system with a network of different organizations involved and complement some of these existing approaches. The capacity development agenda should focus on the following three aspects:

- a) Upgrading skills and expertise to deal with new science and / technologies through training.
- b) Promoting new ways of working like consortia, partnering with private sector and CSOs, ways of integrating technologies, integrated extension delivery etc. through trainings and facilitated institutional learning experiments.
- c) Supporting institutional and policy

changes through training senior staff at the policy and managerial level and building their capacities to appreciate alternative approaches experiment and learn from pilot change initiatives.

### Capacity development support

This would ideally follow a two-pronged approach. It should add value to existing initiatives and should also support development of new initiatives (Table 3).

### Prioritized list for potential support

1. Synthesis of best practices and preparation of lesson learning documents on:
  - a) Ministry of Agriculture initiatives to bring about convergence of various development and extension programmes at district and State levels.
  - b) Institutional innovations - producer companies, linking the poor to high value markets, integrated extension support, application of ICTs, research consortia, public-private partnerships.

**TABLE 3: Types of support which international agencies should provide**

Major themes	Adding value to existing initiatives	Support development of new initiatives
<b>Application of new science and technologies</b>	ICAR on-going network projects on transgenic, gene pyramiding, marker assisted breeding, application of micro-organisms.	<u>Conduct a scoping study to understand gaps and better ways of designing and supporting application of new science and technologies.</u>
	<u>Donors to partner with the above initiative by bringing international expertise, funding and linkages.</u>	CGIAR organizations have a comparative advantage over other donors in supporting these initiatives. Donors to partner with CGIAR centres and their national partners (mainly ICAR/SAUs) in developing expertise and negotiate property rights among different knowledge sources in these areas.
	Climate change impact, modeling and adaptation studies (ICAR, DFID, MSSRF and other NGOs).	
	<u>Donors to find specific niches not attended under this broader theme and partner with these initiatives to support these niches.</u>	

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TABLE 3: Types of support which international agencies should provide		
Major themes	Adding value to existing initiatives	Support development of new initiatives
<b>Promote new ways of working</b>	<p>NAIP consortia projects (public, private and CSOs); ATMA public private partnerships in extension; district level convergence through RKVY; District Poverty Initiative Project (DPIP), Madhya Pradesh - experiments on community empowerment, local self-government and decentralization of decision making especially at the grassroots level; pro-poor rural innovations from CSO sector; new generation cooperatives and producer companies linking poor to markets; agribusiness extension initiatives of private sector.</p> <p><u>Donors to support lesson learning and influence policy through:</u></p> <ul style="list-style-type: none"> <li>-Evaluation studies</li> <li>-Policy dialogues</li> <li>-Lead / participate in organizational and management reviews of research and extension agencies.</li> </ul>	<p><u>Support establishment of consortia as experiments to address specific technical and institutional issues.</u></p> <p>Some of the themes are as follows: linking the poor to markets; new models of integrated extension delivery; climate change adaptation in vulnerable ecosystems; linking extension to common services centres established by the Department of Information Technology.</p> <p><u>Implement challenge programmes on select themes.</u></p> <p>Target organizations capable of piloting these interventions and support them to play a major role in building this capacity.</p> <p><u>Reform and upgrade the ability of extension management.</u></p> <p>Development banks (World Bank, ADB) to design new programmes to promote new ways of working.</p>
<b>Support institutional and policy changes</b>	<p><u>Support lesson learning and evaluation of institutional innovations currently in place (list given below) and link this to policy through organizing policy dialogues and consultations.</u></p> <p>New ways of funding and delivering research and extension (research consortia, contracting); recent reforms in organization of cooperatives and markets (farmer markets, changes to market acts, producer companies); decentralization-district level planning, convergence (ATMA, RKVY); development of new forms of organizations (e.g. KHDP/VPCK); pro-poor livestock policy development (FAO-PPLPI); contract farming, leasing policies, sustainable resource management.</p>	<p>Facilitate change management process in Central and State agricultural development and extension agencies; support organizational and management (O &amp; M) reviews and policy reviews of research and extension organizations; experiment with new sector coordination experiments; support organizations with business planning and development; training on new ways of organizing research and extension targeted at policy makers/ senior management (e.g. FAO extension reform course); introduce learning based monitoring mechanisms; training on client oriented programme development, and new approaches for funding and delivery of services.</p>

2. Organize training programmes for policy-makers and senior management staff in extension organizations on new ways of organizing extension services, drawing experiences from across the world.
3. Support State level review of extension organizations and facilitate institutional reforms and capacity development.
4. Training on client oriented programme design and learning based monitoring.
5. Facilitate experimenting with new sector coordination mechanisms linking farmers, research, extension, input agencies and output markets.
6. Organize policy dialogues and consultations to support cross learning among major stakeholders.
7. Support the efforts of NARS in enhancing access to new technologies by way of international expertise and linkages to different sources of new generation science and technologies.
8. Assistance for preparation of proposals for sectoral reform by working with other donors / development banks.
9. Support curricula development and faculty improvement in emerging areas in agricultural education drawing from experiences available globally.
10. Initiate new programmes on specific themes to primarily bring about institutional changes.

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## REFERENCES

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1. **Government of India.** 2007 National Policy for Farmers ([www.agricoop.nic.in/NPF/npff2007.pdf](http://www.agricoop.nic.in/NPF/npff2007.pdf)).
2. **Jha Dayanatha & Pandey, S.K.** 2006. *Research Resource Allocation in Indian Agriculture, NCAP Policy Paper 23*, National Centre for Agricultural Economics and Policy Research (NCAP), New Delhi.
3. a. **Sulaiman, V. R.** 2003. *Innovations in Agricultural Extension in India*, SD Dimensions-Knowledge, June 2003, FAO.  
b. **Desai, G. R. & Manohari, P. L.** 2008. *Report on Revitalising Public Extension Systems (Part-1)*, National Institute of Agricultural Extension Management (MANAGE), Hyderabad.
4. **Tiwari, R. K.** 2008. *National Agricultural Extension System - Strategy for Revitalization*, Paper presented at the National Conference on Agriculture, Kharif Campaign, 29 February 2008, New Delhi.
5. **Singh, J. P., Burton E. Swanson & Singh K. M.** 2006. *Developing a decentralized, market driven extension system in India: The ATMA model*, In A.W. Van den Ban and R.K Samanta (Eds) *Changing Roles of Agricultural Extension in Asian Nations*, B.R Publications, New Delhi.
6. **Sulaiman, R. V. & Andy Hall.** 2008. *The fallacy of universal solutions in extension: Is ATMA the new T&V LINK News Bulletin*, September 2008, Learning Innovation Knowledge (LINK) ([www.innovationstudies.org](http://www.innovationstudies.org)).
7. **NIRD.** 2008. *RKVY Monitoring, Presentation at the Conference on Convergence in Agricultural Development - Special Focus on Rashtriya Krishi Vikas Yojana(RKVY)*, 6 December 2008, New Delhi.
8. **ICC.** 2008. *Technical Paper on Technology Transfer and Extension; Issues and Recommendations, Vision Document for Second Green Revolution*, Indian Chamber of Commerce, Kolkata and Indian Council of Agricultural Research, New Delhi.
9. **Ministry of Information Technology.** Government of India ([www.mit.gov.in](http://www.mit.gov.in))
10. **ICAR.** 2006 *Report of the IVth Deans Committee*, Indian Council of Agricultural Research, New Delhi.
11. **Planning Commission.** 2007. *Recommendations of Working Group on Agricultural Extension for Formulation of Eleventh Five Year Plan*.
12. **Government of India,** Census 2001.
13. **Pal, Suresh & Dayanatha Jha.** 2007. *Public-Private Partnerships in Agricultural R & D; Challenges and Prospects*, In Viswa Ballabh (ed.) *Institutional alternatives and Governance of Agriculture*, Academic Foundation, New Delhi.
14. a. **Sulaiman, R. V.** 2006. *New insights into promoting pro-poor rural innovation: lessons from civil society*, Paper presented at the GLOBELICS Conference 2006 (4-7 October, 2006), Centre for Development Studies, Trivandrum.  
b. **Development Alternatives.** 2006. *Civil Society in Poorest India, Stories of Innovation and Change*, PACS Programme, Development Alternatives, New Delhi.
15. **Planning Commission.** 2006. *Towards faster and more inclusive growth: An approach to the 11th Five Year Plan*, Draft approach paper to the XI Plan, Government of India, New Delhi.
16. **Planning Commission.** 2007. *Report of the Working Group on Agricultural Research and Education for the XIth Five Year Plan (2007-2012)*, Planning Commission, Government of India.



17. **Planning Commission.** 2007. *Report of the sub-group on Adoption and Generation of Relevant Technologies and their Dissemination to the Farmers.*
18. **Planning Commission.** 2007. *Recommendation of Working Group on Agricultural Extension for formulation of XIth Five Year Plan (2007-2012),* Planning Commission, Government of India.
19. **Planning Commission.** 2007. *Report of the sub-group on Adoption and Generation of Relevant Technologies and their Dissemination to the Farmers.*
20. **Government of India.** 2007. *National Policy of Farmers,* ([www.agricoop.nic.in/NPF/npff2007.pdf](http://www.agricoop.nic.in/NPF/npff2007.pdf))
21. a. **National Knowledge Commission.** 2008. *Report of the Working Group on Knowledge Applications in Agriculture,* National Knowledge Commission, October 2008, New Delhi.  
b. **Hall, A. J., Yoganand B., Rasheed Sulaiman V., Raina, R. Prasad, S., Naik, G. & N. G. Clark,** (eds). 2004. *Innovations in Innovation: Reflections on Partnership and Learning,* ICRISAT, Patancheru, India and NCAP, New Delhi, India, 238 pp.
22. **WASSAN.** 2007. *Support Systems for up-scaling successful experiences - a case study of NPM programme in Andhra Pradesh,* Presentation by N.K Sanghi to the National Knowledge Commission, Sub-Committee on Knowledge Applications in Agriculture, Watershed Support Services and Activities Network, Hyderabad.
23. a. **Pal, Suresh, Mruthyunjaya, Joshi, P. K. & Raka Saxena** (eds). 2004. *Institutional Change in Indian Agriculture,* National Centre for Agricultural Economics and Policy Research, New Delhi. Government of India (2002) National Agricultural Policy.  
b. **Rajeswari S. Raina & Rasheed Sulaiman V.** 2007. *From Technology Development and Dissemination to Learning Approaches: Institutional Change for Rural Development,* In Vishwa Ballabh (ed) *Institutional Alternative and Governance of Agriculture,* Academic Foundation, New Delhi and Institute of Rural Management , Anand, Gujarat.  
c. **ICAR.** 1998. *National Agricultural Technology Project: Main Document.* Indian Council of Agricultural Research, New Delhi.  
d. **Paroda R. S. & Mruthyunjaya.** 1999. *NARS in the Asia Pacific Region; A perspective,* APAARI, FAOP, RAPA, Bangkok.  
e. **Sulaiman & Hall.** 2004. *Towards Extension-Plus, Opportunities and Challenges,* Policy Brief, 17, National Centre for Agricultural Economics and Policy Research, New Delhi.  
f. **Hall, A. J., Rasheed Sulaiman V., Clark N. G. & Yoganand B.** 2003. *From measuring impact to learning institutional lessons: an innovation systems perspective on improving the management of international agricultural research.* *Agricultural Systems* 78 (2003) 213-241.  
g. **Several papers presented at the Workshop on Agricultural Policy. Redesigning R & D to Achieve the Objectives,** sponsored by the National Academy of Agricultural Sciences, New Delhi, on 10-11 April, 2002, and Papers at the session on *Institutional reform in agriculture,* at the *Annual Conference of the Indian Society of Agricultural Economics,* New Delhi on 19-21 December 2002, discussed issues related to institutional change in Research and Extension.
24. **ICAR.** 2006. *NAIP Main document, NAIP Project Implementation Plan,* Indian Council of Agricultural Research, New Delhi.
25. **Nandakumar, T.** 2008. *Convergence in Agricultural Development,* Presentation at the Conference on Convergence in Agricultural Development - Special Focus on Rashtriya Krishi Vikas Yojana (RKVY), 6 December 2008, New Delhi.
26. **Planning Commission.** 2006. *Report of sub-group on Gender and Agriculture.*

27. **ICAR.** 2006. IVth Deans Committee Report, Indian Council of Agricultural Research, New Delhi.
28. **Planning Commission.** 2007. *Report of the sub-group on Adoption and Generation of Relevant Technologies and their Dissemination to the Farmers.*
29. **ICC.** 2008. *Technical Paper on Technology Transfer and Extension; Issues and Recommendations*, Vision Document for Second Green Revolution, Indian Chamber of Commerce, Kolkata and Indian Council of Agricultural Research, New Delhi.
30. **Jha Dayanatha & Pandey, S. K.** 2006. *Research Resource Allocation in Indian Agriculture*, NCAP Policy Paper 23, national Centre for Agricultural Economics and Policy Research (NCAP), New Delhi.
31. **Suresh Pal.** 2008. *Agricultural R&D Policy and Institutional Reforms: Learning from the experiences of India and China*, Economic and Political Weekly, June 28, 2008.
32. **Planning Commission.** 2007. *Report of the Working Group on Agricultural Research and Education for the XIth Five Year Plan (2007-2012)*, Planning Commission, Government of India.
33. **Planning Commission.** 2007. *Report of the Working Group on Agricultural Research and Education for the XIth Five Year Plan (2007-2012)*, Planning Commission, Government of India.
34. a. **National Knowledge Commission.** 2008. *Report of the Working Group on Knowledge Applications in Agriculture*, National Knowledge Commission, October 2008, New Delhi.  
b. **World Bank.** 2006. *Enhancing Agricultural Innovation: How to go beyond the Strengthening of Research Systems*, World Bank, Washington, D.C.