

## Technology Transfer and Extension : Towards a Second Green Revolution

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### I. Towards a second green revolution

A series of interventions initiated in mid-1960s that led to the green revolution in cereal production transformed the country from a situation of food deficiency to self sufficiency. The green revolution was however, restricted to productivity improvements in cereals- especially wheat and rice- in the initial decades, primarily grown in irrigated regions. In subsequent decades, productivity increased in other crops, namely oilseeds, sugarcane, cotton, fruits and vegetables. The Green Revolution generally bypassed India's vast rainfed tracts, especially arid zones, hill and mountain ecosystems and coastal regions, thus exacerbating agro-ecological and economic disparities. Although self sufficiency was attained in food grain production, potential of different crop varieties are yet to be attained. The main features of the first green revolution were:

- Exclusive focus on food grains
- Intensive use of water, fertilizer and pesticides to maximize yields from High Yielding Varieties (HYVs)
- Practically no focus on sustainability issues
- Benefited the resource-rich and large farmers and
- Dependent on few technological options focusing on hybrids, changes in plant architecture.

The equity, efficiency and sustainability of these approaches became a matter of serious concern since the 80's. Over a period of time, especially during the last two decades, the course of Indian agriculture has largely been influenced by factors such as globalization, trade liberalization and increasing role of private sector. Apart from these the agricultural sector has been challenged by the following factors:

- Shrinking resource base
- Changes in demand and consumption pattern
- Changes in farming systems including increasing diversification to high-value crops

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*An article presented at Second Green Revolution Summit, Kolkata, December, 2008.  
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- Declining public investments in agriculture
- International developments- WTO (subsidies in agriculture and trade liberalization) and
- Climate change (global warming, seasonal variations, changes in rainfall pattern and increasing occurrence of natural disasters)

The policy approach to agriculture, particularly in the 1990s has been to secure increased production through subsidies on inputs such as power, water, and fertilizer. It also focused on increasing minimum support prices rather than building new capital assets in irrigation, power, and rural infrastructure or improving the standards of maintenance of existing assets. Despite its past achievements, Indian agriculture continues to face serious challenges because of its ever-increasing population, limited land and water availability, and degradation of natural resources. There are wide gaps in yield potential and national average yields of most commodities are low. Although the Green Revolution increased production and productivity of food crops, improved food security and raised rural incomes, India still has a large poor (27.5 % living below the poverty line in 2004-05) and malnourished population.

Although the annual growth rate in total GDP has accelerated from below six percent during the initial reform years (starting 1991) to more than eight percent in recent years, agricultural growth has decelerated. While the non-agriculture sector has witnessed rapid growth, there has not been any significant decline in the labour force employed in agriculture and this has created a serious disparity between the agriculture and non-agriculture sectors and urban and rural India. The output growth of the majority of commodities has decelerated after the mid-90s. And currently Indian agriculture is at crossroads.

Addressing these emerging challenges would require a new approach which has to be distinct from the earlier green revolution approach. Agricultural research and extension therefore need to emphasise the following new dimensions in the second green revolution era:

- Focus on gene revolution, emphasizing application of biotechnology- tissue culture for multiplication of elite germplasm, GM crops, marker assisted breeding etc
- Emphasise use of bio fertilizers, bio pesticides and bio remediation of ground water
- Address issues like sustainability, resource integration and technology integration as the primary focus
- Apply precision farming and mechanization for optimal use of precious resources and human labour
- Linkage with industry, market driven and export oriented agriculture
- Increase application of cutting edge technologies
- Thrust on post harvest, food processing and value addition technology
- Highlight quality in addition to increase in quantity

- Protect IPR and farmers' rights and
- Integrate livestock, fisheries and other allied agro-enterprises with crop production and Exploit advances in information technology.

## II. Agricultural Extension and the Second Green Revolution

In the second green revolution context, agricultural extension needs to assume new challenges and reform itself in terms of content, approach, structure and processes. Adequate focus has to be given on effective technology selection, optimization, application and management. Hitherto the extension efforts were largely influenced by the approaches and models that evolved during the 60's to 80's. These are insufficient to deal with the current concerns emerging out of globalization, sustainability, and other dimensions of agricultural development envisaged by the second green revolution.

The framework of strengthening the extension system includes:

- Assessment of existing extension system, approaches and organisations against the backdrop of second green revolution and determine whether these have to be strengthened or restructured and whether new initiatives have to be launched;
- Broadening the technical mandate keeping in view the current demand scenario;
- Promoting pluralism, by involving and integrating public, private, and civil society organizations and through public-private partnerships;
- Development and application of information and communication technology through rural knowledge centres/hubs;
- Location specific, participatory, gender sensitive and customized extension materials and methodologies;
- Effective operational linkages between research, extension, farmer, market and other key stakeholders;
- Farming systems and farmer participatory extension approach and
- Empowering farmers and organizing them into commodity groups/associations and federating them

The working group on agricultural extension for the formulation of XIth Five Year Plan acknowledges the current limitation of public sector extension and emphasizes the following for strengthening agricultural extension. These include:

- Adoption of farming system and farmer participatory approach
- Research –extension farmer and market linkages
- Focus on vulnerable groups

- Up-scaling ATMA to all districts,
- Routing all state and central government extension funds through ATMA
- Support to private extension and public private extension
- Focus on women in agriculture
- Strengthening Kisan Call Centres
- Market led extension and
- Promotion of Agri-clinics and agri-business centres

However, these measures though appear to be important, are not adequate to address the the second green revolution challenges.

### **Changing needs of farmers for extension support**

Due to the changing nature of agriculture, farmers currently have to make a number of complex decisions. Most relevant of them are as follows:

- What technological options could be used profitably in his/her situation keeping in view the potential resource constraints in terms of land, capital, labour and knowledge?
- How to manage various technologies (eg: how to make optimal use of new inputs in his farm)?
- How and when to change his farming systems (eg: diversifying from crop production to mixed farming or vegetable or animal production)?
- For which type of products, is there a good demand in the market?
- What are the quality specifications he should achieve to get good value for his produce and how to achieve them (eg: for export markets, organic farming)?
- How to find quickly the most relevant and reliable knowledge and information?
- What are the feasible off-farm income generation options available for him and how far he could depend on them?
- What are going to be the implications for his farming if input subsidies are phased out and/or if trade in agriculture is further liberalized?

To support farmers in addressing these changing needs, extension needs more diverse types of expertise than what is available at present.

### **Current extension scenario: a critical analysis**

Extension in this context includes all those agencies in the public, private, NGO and community based initiatives that provide a range of agricultural advisory services and facilitate technology

application, transfer and management.. While public sector line departments, mainly the Department of Agriculture was the main agricultural extension agency in the 60's and 70s, the last two decades have witnessed the increasing involvement of private sector, NGOs, community based organisations and media. In the public sector, the extension machinery of the state Department of Agriculture (DoA) reaches down to the block and village level. The village extension workers of the DoA continue to be an important source of information for farmers in India, even though information is clearly targeted at grain production, visits are irregular, and the service is pre-occupied with the implementation of government schemes linked to subsidies and subsidised inputs. With the external support drying up with the end of the T&V (Training and Visit) system of extension in the early 1990s, states have been left to fund their extension machinery and this has led to considerable weakening of public sector extension.

In the case of public sector extension, the major reform in recent years has been the establishment of a district level co-ordinating agency, the ATMA (Agricultural Technology Management Agency), in 28 pilot districts with the World Bank support. Under ATMA, grass root level extension is mainly channelised through the involvement of BTTs (Block level Technology Teams) and FACs (farmer advisory committees), farmer groups/ farmer interest groups and self help groups. ATMA is a district level autonomous agency entrusted with the role of agricultural technology management in the district. The district collector/deputy commissioner heads ATMA Governing Body, with members drawn from the line department, KVKs, farmers and NGOs (Fig 2).

The number of KVKs (Krishi Vigyan Kendras) funded by the ICAR has increased during this period. Presently 571 KVKs are established in the country. The motto is to cover each district with one KVK with a mandate of technology application through OFTs, demonstrations and training. It is an institutional approach and is comprehensive in nature. It functions on farm based model with a built in research-extension linkage through a multi-disciplinary team. It ensures feedback and feed-forward through participatory management. It is the largest research based extension body in the country by the ICAR at the district level. However, the effective reach of these KVKs is marginal mainly due to inadequate linkages with other development agencies. Moreover, their main focus is on technology testing, assessment and application under farmers' condition through conducting on-farm trials, demonstrations and training.

Extension services in the case of animal husbandry and fisheries continue to remain weak. While public sector extension arrangements have weakened, the number and diversity of private extension service providers has increased during last two decades. These include NGOs, producer associations, input agencies, media and agri-business companies. Many provide better and improved services to farmers, but their effective reach is limited and many of the distant and remote areas and poor producers are neither served by the public nor the private sector.

Based on the experiences gained from the pilot district, the Ministry of Agriculture, Government of India in 2004-05 decided to expand the ATMA model across all the districts in the country. Apart from bringing some additional resources for extension activities to be decided at the district level in consultation with farmer representatives, ATMA is yet to fully address many of the institutional constraints affecting extension performance.

Extension continues to be funded as part of central and state level schemes/programmes without much operational freedom at the local level, though the strategic research and extension plans (SREP) under ATMA envisage bottom up planning for extension. While the farmers require a wider range of support to address the emerging challenges, extension mainly functions as an agency for technology dissemination. Most of the organizations including the public sector departments continue to work in isolation. Marketing extension has been a recent addition but is understood and implemented mostly as provision of output price information in various markets and this is highly inadequate to address the challenges in marketing. Other extension support facilities created include, farmer training centres at the district level; SAMETI (State Agricultural Management Extension and Training Institute) at the state level, EEI (Extension Education Institute) at the regional level; and MANAGE (National Institute for Agricultural Extension Management) at the national level.

**Table 1: Critical analysis of capacity to deal with second GR challenges**

Sl. No.	Extension organisations	Functions/Roles/Capacity	Gap/Limitations
1	ATMA	Aimed at decentralized decision making and bringing convergence among extension providers in a district: Promotion of commodity interest groups; Development of a strategic research and extension plan: Provide additional funds to these agencies for key extension activities such as farm schools, demonstrations, exposure visits and trainings	No dedicated manpower; Limited resources, Convergence limited to activities undertaken with the specific budget for ATMA (Rs.80-100 lacs an year)
2	KVK	Technology application (technology assessment and refinement) through on-farm trials, front-line demonstration and training	Limited reach; Several vacant positions Inadequate operational funds; Weak linkages with other development agencies in the district; Poor technology and methodological back stopping from the host institution; Non availability of critical facilities like soil and water testing facility, farming system models, demonstration units etc in some KVKs
3	State line departments (Agriculture, Animal Husbandry, Fisheries, etc)	Regulatory role; Implementation of development programmes that involve distribution of subsidies and subsidized inputs; Organising and village level; Large extension programmes	Only the Department of Agriculture has staff assigned upto block number of vacancies, especially in remote and distant regions; Grass root level VEWs lack technical competence to deal with emerging challenges; Lack expertise on cutting edge technology, organizational, management and marketing aspects; Implementation of

Sl. No.	Extension organisations	Functions/Roles/Capacity	Gap/Limitations
			schemes/programmes leave little time for extension. Extension is weak in animal husbandry and fisheries departments.
4	FTC	Training farmers on new technologies	Defunct in most places, Acute shortage of funds and manpower.
5	SAU (Directorate of extension)	Implement extension programmes of the SAU and oversee activities of KVK	Staff and fund shortage; Weak state support; Inadequate links with development departments; No adequate field presence.
6	NGOs	Exhibit wide diversity in terms of reach, credibility and capacity; Have good knowledge and networks with communities in villages they operate; Present in difficult and remote regions; Innovative in their approaches; Can potentially complement approaches of the public sector extension.	Effective reach restricted to select villages in their areas of operation. Many of them do not have adequate technical capacity. Wide variation in credibility and track record.
7	Private Agri-business firms	Agri-input firms mainly involved in product demonstrations; Agroprocessing and marketing firms mainly commodity oriented but do provide integrated support (inputs, technical support and marketing) for contact growers;	Present in only select regions; Narrowly focused on business interest; Lack focus on long term capacity development of farmers
8	Media	Dissemination of information on new technologies	Low literacy levels constrain penetration of print media; Poor content, inadequate coverage and little telecast time through television channels; Potential of media yet to be fully realised due to lack of integration of mass media with other extension programmes/approaches
9	Private consultants	Support large farmers growing cash crops and high value horticulture	Limited to select crops and regions Affordable only by large farmers
10	MANAGE	Training senior and middle level extension managers Conduct studies on extension systems and policies Conducts management educational programmes in agriculture Provide Consultancy	Need greater focus on extension systems research and policy initiatives Limited faculty and funding Need to establish international linkages

Sl. No.	Extension organisations	Functions/Roles/Capacity	Gap/Limitations
11	SAMETI	Training middle level extension staff at the state level Conduct studies on extension systems at the state level	Lack of infrastructure, expertise (faculty); Inadequate focus on extension studies; Weak links with actors outside the public sector
12	EEI	Training middle level extension managers at the regional level	Inadequate infrastructure Inadequate training capacity, linkages and autonomy.

### III. Way forward: Critical Issues and Recommendations

To deal with the challenges of the second green revolution, the extension organizations need to gear up their capacity in terms of manpower, expertise, finance, structure, institutional linkages; and the kinds of methods, approaches and delivery systems they employ. The major recommendations to be taken up for strengthening transfer of technology and extension system to address the challenges of the second green revolution are grouped under the following heads.

- I. Farmer empowerment and farmer organizational development
- II. Institutional issues
- III. Public-private partnerships
- IV. Technology backstopping, integration and management
- V. Frontier areas for extension, HRD and skill development
- VI. Policy issues

#### I. Farmer empowerment and farmer organizational development

Addressing the complex challenges of bringing about the second green revolution would require solutions which are beyond the decision-making capacities of individual farmers. This would necessitate new forms of collaboration as the agriculture sector in India is dominated by small farms. Collective decisions on resource use and marketing would necessitate forming new forms of collaboration and this is particularly important as this sector is dominated by small farms — often with weak bargaining powers and limited political voice. To deal with the new set of challenges, farmers need a wide range of information and support and these include aspects related to technologies, organizational development, entrepreneurial development and access to appropriate financial services. This would necessitate a reformulation of the objectives of extension.

#### Recommendation

1. **Reformulate the objective of extension as farmer empowerment and farmer organizational development.** Programmes and activities should focus on:

- Facilitating adoption of improved knowledge on production, value addition and marketing by farmers
- Farmer organizational development including leadership development and supporting farmer organizations to take up new initiatives (technology application, networking, financing and marketing including supporting producer companies)
- Organise special programmes for women in agriculture to achieve the above two objectives

## II. Institutional Issues

Extension faces several institutional challenges. These include: rigid hierarchy and centralized modes of planning; a tradition of assessing performance in terms of technology adoption; history of working independently; a mistrust of other agencies; and a tradition of upward accountability for resource utilization rather than output achievement and client satisfaction. For instance, lack of dedicated manpower, functional autonomy and attitudinal barriers at all levels have constrained ATMA in its effective functioning. Still most of the line department and extension functionaries are not clear about the approach and ways of integrating extension activities through ATMA. The KVKs are 100% funded as a centrally sponsored programme under plan budget. The functioning of KVKs is mostly limited to the central grant only as there is no corresponding matching grant either from the state or the host organisation. This has led to lack of ownership of KVKs and lack of accountability resulting in improper manpower deployment, delay in sanction and utilization of the budget, and non-establishment of required infrastructure. These institutional issues currently constrain integrated delivery of support and services at the district and block levels. ICAR has recently suggested a framework developed by ICAR for technology development and delivery system (Fig 3). It illustrates the roles of different organizations and the functional linkages among them and is worth considering in this context.

### Recommendation:

#### 2 Improve integrated delivery of support and services at the district and block levels through strengthening the capacity for improved interaction and joint functioning of KVKs, ATMA, BTT, FIAC and Panchayat Raj Institutions (PRIs).

Measures include:

- Create platforms for regular interaction at the district and block levels and fix accountability on these forums
- Provide additional funding only for joint programme proposals
- Monitor programmes for institutional bottlenecks and address each as it arises
- Implement similar approaches for improving extension performance at the zonal and sub-zonal levels

### **III. Public private partnership issues**

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 from 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, centered around teams, free from conventional bureaucratic control with incorporation of inbuilt project planning, implementation and monitoring arrangements. For example, a viable partnership among NDRI (National Dairy Research Institute), NDDB (National Dairy Development Board), Dairy co-operatives and the state Department of Animal Husbandry in the field of dairying can potentially lead to a successful technology generation, support, transfer and application for dairy development.

Similar arrangement could be worked out in the area of production and marketing of agricultural commodities. Big corporate players like Reliance, ITC, Pepsico and Bharati, have entered the business of marketing agricultural commodities. Partnership arrangements with the public sector for technological support in the areas of production, value addition, cold chain management etc at the farmer end can ensure farmers from receiving holistic benefit from such partnerships. Lack of a common platform to broker such alliances has led to non-operationalisation of PPP in practice. Under present circumstances, a suitably conceived and operated PPP arrangement will certainly will help the country to address the second green revolution challenges, promote client centered extension, and lessen the burden on government exchequer.

#### **Recommendation:**

### **3. Promote public private partnerships through**

- Explore options for PPP in district plans and SREPs
- Senior staff to be made accountable for operationalising PPPs

- Establish a separate cell for promoting industry and market driven extension
- Orient the staff at various levels on the advantages of PPPs and lessons from experiences so far and
- Address bureaucratic delays that constrain partnerships

#### IV. Technology backstopping, integration and management

The most important and neglected area of the present extension system is its limited ability to integrate different kinds of technologies. As a result, farmers adopt such technologies in isolation and blames extension and research system for its failures. This has resulted in confusion at the field level and erosion in extension's credibility on technological aspects. Therefore, an arrangement has to be evolved by the extension system for selection and integration of technologies. Promoting sustainable agriculture involves adopting an integrated approach keeping in view the nutrient status, water availability, crop animal combinations, pest and disease build-up, labour, markets, and availability of other support. Approaches such as INM (integrated nutrient management), IPM (integrated pest management), integrated soil and water management, etc involves integration of a wide range of technologies relevant to each area. Extension therefore needs to take up the challenge of integrating suitable technologies focusing on specific issue of agricultural development. One potential approach is as follows:

- Decide on the problem and what needs to be improved
- measure the current status against the desired status
- analyse the root causes of the problem
- analyse the merits and demerits of potential solutions
- test different combinations through on-farm trials and demonstrations
- implement solutions and monitor long term improvements on sustainability parameters.

Establishment of ICT centres involving corporate sectors under Corporate Social Responsibility (CSR) schemes can be thought of to popularize ICT mode extension initiatives. These centres however have to be linked to the state agricultural universities and research institutes for technology and methodological backstopping. Content development for each technological area is a must. ICT centres need to be supported by content, technological inventories and methodological issues by the research partners. For instance, the ITC's *e-chaupal* initiative has got a strong technological and methodological support from Central Tobacco Research Institute (CTRI/ICAR) and ILTD Division of ITC with respect to tobacco production technology. It is one of the strong successful cases of public-private partnership in agricultural extension through ICTs. Similar arrangements could be thought of in other sectors too. For instance, NDRI-NDDDB-Dairy co-operatives can come together to establish ICT networks for the benefit of dairy farmers. Similarly partnerships between commodity boards and farmer association can establish ICTs in their respective areas of operation. Sustained technological and methodological backstopping arrangement among partners

having similar interest is a pre-requisite for the successful implementation of ICT based agricultural extension. As discussed earlier, clear cut assignment of responsibility and freedom from bureaucratic hurdles are necessary for bringing dynamism in its operation.

#### **Recommendation:**

#### **4. Strengthen technology backstopping, integration and management.** Options include:

- Improve the ability of extension organization to integrate technologies, test and develop integrated packages for different areas and monitoring performance
- Improve technological backstopping through partnerships and contracting arrangements
- Use the full potential of ICTs to bring together different types of knowledge and technologies from public and private sources
- Promote distance learning and virtual extension through ICTs
- Exploit the advances in mass media to improve reach and relevance and obtaining feedback

#### **IV. Frontier areas for extension, HRD and skill development**

Lack of quality manpower dedicated to the cause of agricultural development is a serious constraint and challenge encountered by the system. Agricultural extension should to an agri-business extension mode and this is possible only if the system recruits personnel who can bring in different kinds of expertise. For instance expertise related to cutting edge technologies, organizational development, market development, legal issues related to farmer rights, IPR etc are crucial for extension. This would also involve some de-learning of its conventional technology dissemination approach and learning new ways of doing things. Extension is weak in animal husbandry and fisheries sector and this would need considerable strengthening. Strengthening of national and regional level training facilities for continuous skill up gradation of extension professionals is to be taken up immediately. Assessment of the quality of extension personnel is a must and a national level mission mode approach is needed in this regard.

#### **Recommendation:**

#### **5. Strengthen expertise of extension organization in the following areas:**

- Frontier areas of technology
- Resource conservation and management
- Market development, linking with markets and export development
- Quality and standards
- Organic agriculture

- Enterprise/entrepreneurship development,
  - Skill development in horticulture, seed and plant material production
  - Research and extension in response to adaptation to climate change and risk management
  - Financing and insurance
  - Extension for resource conservation and management
  - Extension management techniques (programme/project management- PERT, CPM, log frame, 5-S etc)
  - Legal and regulatory issues (farmer rights, IPR)
  - Promotion of public-private partnership
  - Application of ICTs, content development and updating
  - Skills related to farmer organizational development and farmer empowerment
6. **Strengthen extension in animal husbandry and fisheries sector**
  7. **Initiate manpower planning in extension organizations, create new positions and fill existing vacancies based on manpower planning**
  8. **Address HRD and skill development in extension organizations through the following strategies:**
    - New recruitments,
    - Contract arrangements,
    - Consultancies,
    - Staff trainings
    - Partnering with organizations having expertise

## **V Policy Issues**

Several organisations implement extension programmes with very little co-ordination. Co-ordination is lacking even among public sector organisations. Establishment of a national extension authority (similar to the National Rainfed Area Authority), can potentially bring about the much needed integration for effective planning and delivery of extension programmes. Integration of extension activities at the district level also needs policy support. Several initiatives that were successful at the pilot stage had failed when external support was withdrawn. Another major constraint is the declining financial support for extension. Enhanced funding is crucial for improving the ability of extension to deal with the complex challenges of the second green revolution. Extension also needs crucial

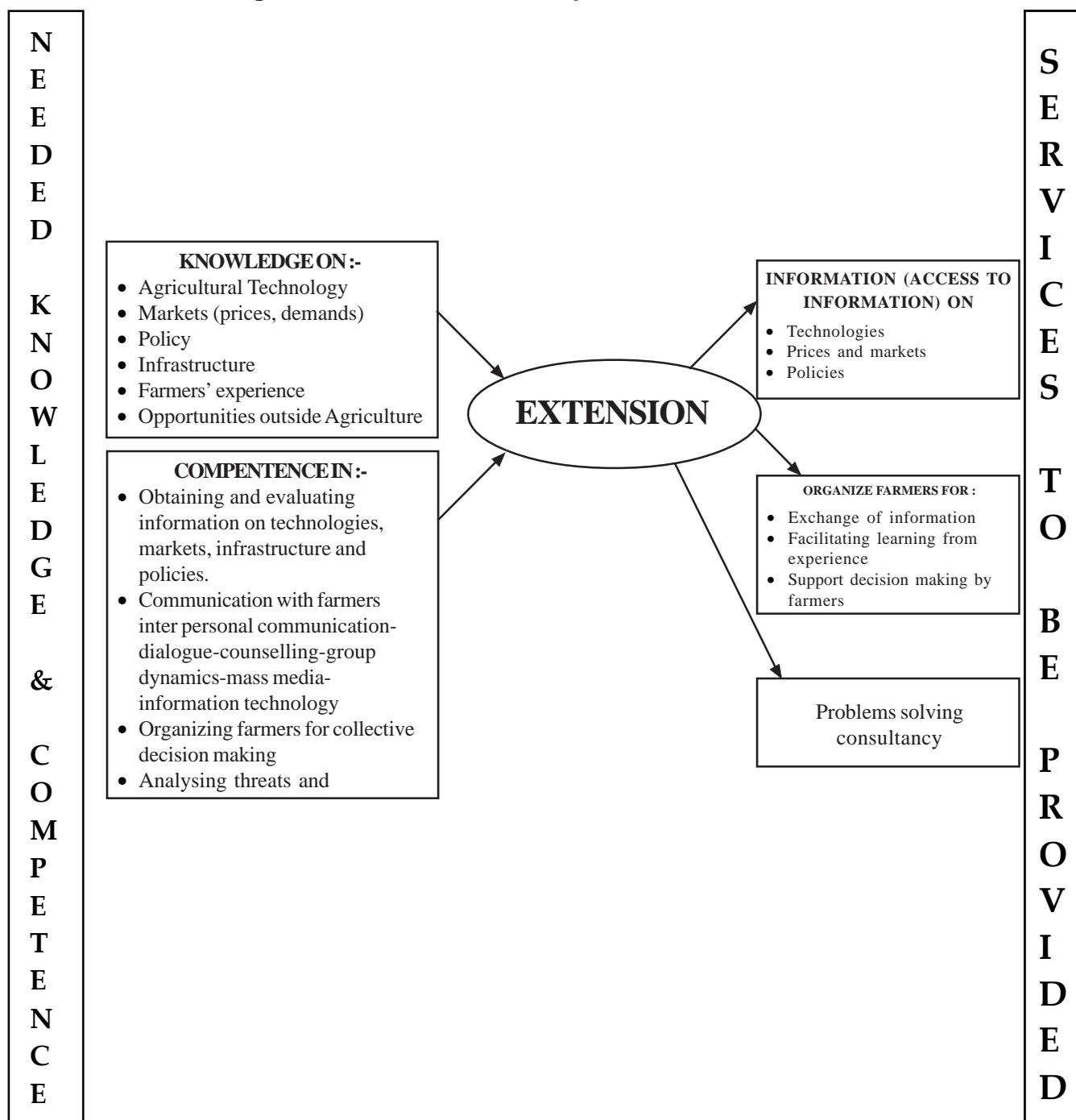
research backup on new approaches, methodologies and management techniques relevant for different situations.

### **Recommendation**

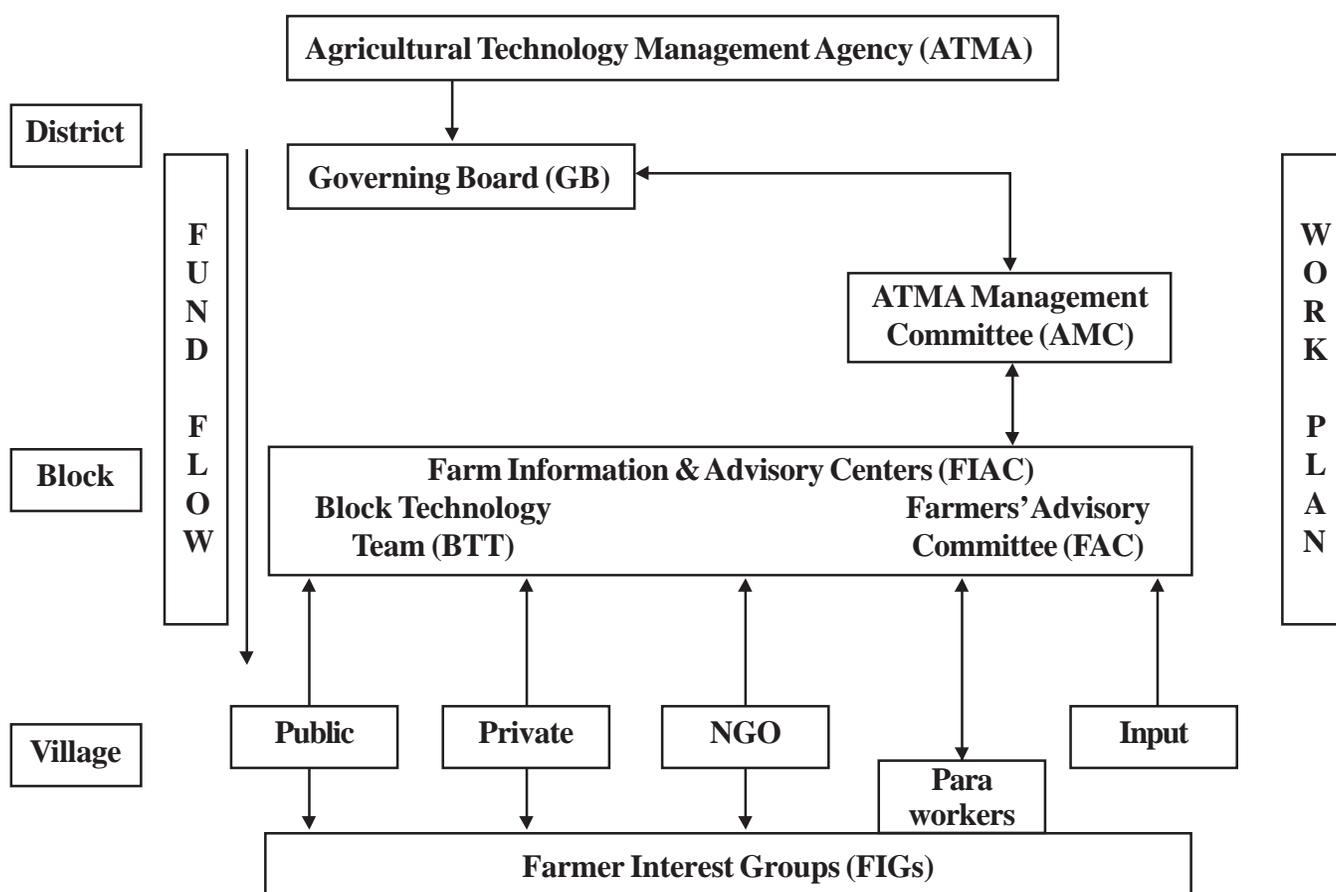
**9. Address policy issues in extension.** This includes:

- Enhanced funding
- Strengthen research in extension
- Establish a national extension authority
- Developing strategies to improve sustainability of pilot initiatives and
- Strengthen mechanisms for district level planning

Fig 1 : Future Role And Competencies For Extension



**Fig 2: Organizational Structure of Agricultural Technology Management Agency (ATMA)**



**Fig. 3. A Framework for Technology Development and Delivery System (Source: ICAR)**

