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Role of Agricultural R&D Policy in Managing Agrarian Crisis in India[1]

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Abstract

The study has revealed that agricultural research and development (R&D) has potential to offer long-term solutions to the problems of Indian agriculture. With the changing environment and supply-side constraints, the role of R&D has become more important. This realization alongwith past performance of agricultural R&D has convinced the government to commit a significant proportion of its resources for developing appropriate technologies. The ICAR-SAUs system has come out with a number of improved agricultural technologies for major agro-climatic conditions. The paper has provided a list of some of these technologies, which are capable of making farm operations easy, provide savings in resources, reduce production losses, improve product quality and increase shelf-life of products, etc. These technologies eventually provide higher availability of quality foods and higher farm income, including maintaining productive capacity of agro-ecosystems. Since some of the new technologies are information-intensive, the role of ICT has become more important alongwith empowerment of farmers with scientific know-how.

Introduction

The loss of dynamism in the agriculture sector is the major cause of crisis in Indian agriculture. This can be attributed to a wide range of problems including poor growth in the agriculture than non-agriculture sector. More specifically, the sector is facing problems of declining output and total factor productivity growth, emerging climate change and supply-side constraints, etc. Reverting declining factor productivity requires concerted efforts in refining the available technologies and developing new technologies. The emerging climate change points towards the proper management of resources like land and water to meet the food-security goals. Persisting problems of poverty, debt-trap, poor access to credits, etc. are dragging the sector into distress condition. Other sets of issues like large post-harvest losses and weak linkages (both forward and backward) are also causing problems in agriculture. How to cope up with these alarming crises is a real technology and policy challenge?

Research and development (R&D) has potential to offer long-term solutions to the problems of agriculture sector. The concerted efforts in agricultural R&D have helped in up-scaling the potential and provided options to derive the same or even higher benefits at lower cost per unit of output (Kalirajan and Shand, 1997). Advancement in post-harvest management technologies facilitates reduction in post-harvest losses and helps in value addition. The large amount of production losses occur in agriculture (Alam *et al*., 2002; Ali, 1998). Managing these post-harvest losses and adding value to the produce is a direct contribution towards increasing total agricultural production, lowering its

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cost of production and contributing to the national economy. Although the technology alone is not capable to provide complete solution for managing the crisis of the sector, it is capable of offering better solutions. Hence, the role of agricultural R&D is critical in managing agrarian crisis, particularly in India.

Although the development of agricultural technologies and increased awareness about them among farmers have resulted in adoption of improved practices and technologies, their partial and poor adoption due to various socio-economic constraints (Douglas *et al*., 2005; Singh, 2000) has not been able to reduce the disparity between the rich and poor farmers. Also, equity and efficiency issues have become more relevant in today's complex agriculture. While the adoption of technology is scale neutral, the main problems are dissemination of knowledge about the improved technology, poor resource endowment and its poor access to farmers. How to educate farmers on the benefits of improved technology and ensure its continuous access and adoption is a major challenge?

It is believed that research system in the India is relatively strong in technology generation than technology transfer to its end-users. The weak linkage between research and extension is more apparent in today's context of agriculture, which is knowledge-and capital-intensive (Laxmi *et al*., 2007; Swaminathan, 2001). It requires new kinds of arrangements to handle the problems. This paper has described the role of agricultural R&D in managing crisis in the Indian agriculture. The contributions of agricultural R&D in increasing production and the role of information and communication technology (ICT) have also been described.

Structure of Agricultural R&D in India

Presently, agricultural R&D in India is being managed under a three tier system, viz. (i) Indian Council of Agricultural Research (ICAR) at the apex level, (ii) State Agricultural Universities (SAUs) at the state level, and (iii) Private sector at both sector and commodity levels. The status of agricultural R&D system in India, shown in Table 1, reveals that it is mainly under central and state aegis. In addition, there are some institutions in central Departments of Agriculture, Council of Scientific and Industrial Research (CSIR), departments of Science and Technology, Fertilizers and Chemicals, Commerce, etc. also which contribute to the national efforts through R&D (Jha and Kumar, 2006).

The present ICAR-SAUs system is supported by All India Coordinated Research Project (AICRP), which is based on the principle of inter-disciplinary and inter-institutional collaborations. Starting with the first AICRP on maize in 1957, the ICAR had 76 AICRPs in 2007-08, covering several disciplines and commodities, viz. soils, water, crops, horticulture, livestock, fisheries, home science, agricultural engineering, education, etc. AICRPs related to crops have delineated the operational area based on ecological conditions. This set-up enables AICRPs to effectively utilize natural resources in man and material to solve the national, regional and local problems in a coordinated manner according to predetermined priorities and strategies. In addition, private sector R&D has come forward to build R&D infrastructure and harness opportunities. As per latest estimates nearly 500 R&D units have been established by the private sector to meet its R&D needs.

Investment in Agricultural R&D

(a) Status of Public Agricultural R&D

In India, the public sector plays a major role in agricultural R&D. The sector has helped in meeting social goals of removing hunger and poverty, ensuring food and nutritional security, diverting dependence of population from farm to non-farm sector, conserving limited natural resources of soils and water, etc. The status of public sector has been studied in terms of public expenditure on agricultural research and education (R&E) and scientific manpower resources engaged in R&D activities. Public expenditure on agricultural R&E has been discussed in terms of share between central and state system including investment intensity. The scientific manpower resources have been described considering number, its quality and allocation across crop groups and agro-climatic regions.

Table 1. Status of agricultural research system in India: 2007-08

Institutions	Number
1. Public sector	
(i) Central	
National Institutes (Deemed Universities)	5
Central / Other Institutes	43
National Bureaux	5
Project Directorates	12
National Research Centres	32
All India Coordinated Research Projects	76
Central Agricultural University	1
Krishi Vigyan Kendras	558
Zonal Coordination Units	8
(ii) State	
State Agricultural Universities	41
Agricultural / Zonal Research Stations	343*
2. Private sector	
Research units/ stations	494#

*includes 126 zonal research stations, # relate for the year 2001.

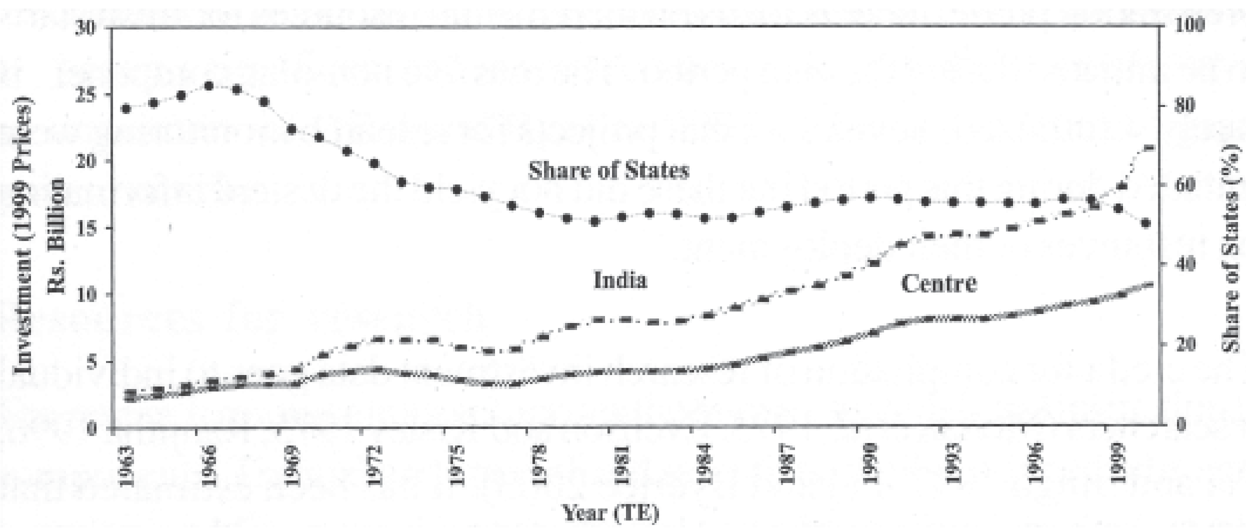
Source: ICAR (2008), Jha and Kumar (2006), and Ghosh (1991)

Public Expenditure on Agricultural R&E

The total public expenditure on agricultural R&E has increased significantly over the past four decades. The expenditure increased in real terms (at 1999 prices) from Rs 2.5 billion in 1961 to Rs 7.9 billion in 1980, and further to Rs 25 billion in 2000 – a ten-fold increase in past forty years. In 2005, India invested nearly Rs 31 billion on agricultural R&E. An increasing trend has been observed for both central and state R&E expenditures. However, increasing centralization of public investment in R&E is a major concern. Analysis has shown that the share of states in total R&E investment has fallen from 69 per cent in 1971 to 50.5 per cent in 2000 (Figure 1). The local institutions have failed to emerge as the major players and supporters of agricultural R&D in India. This has been a major weakness which has not been well appreciated. The central system continues to press for obtaining incremental resources. States either do not bother or lack capacity to argue their cases. This phenomenon needs to be understood and requires immediate attention.

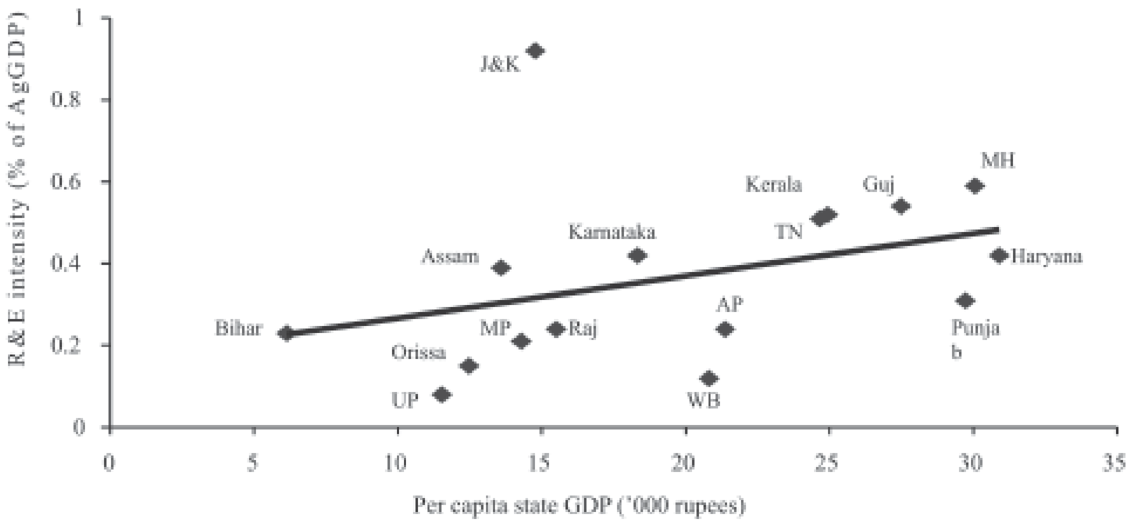
Investment Intensity Ratio

Another way to look at the status of public expenditure on agricultural R&E is to estimate investment intensity. The ratio is computed as investment on R&E to value of agricultural gross domestic product (AgGDP). It was found that this ratio increased significantly during 1960s (0.20%) and 1980 (0.36%), but remained around 0.40 per cent during 1990s. The slowdown in investment intensity is a cause of worrisome in relation to the average



Note: For data source, *see* Pal and Byerlee (2003)

Figure 1. Public expenditure on agrucultural research and education



Source: Based on data in Pal and Byerlee (2003)

Figure 2. Per capita state domestic product and research & education intensity

intensity of 0.60 per cent for all developing countries and of 1 per cent globally. The investment intensity ratios for Latin America and Africa are more than double of India (Pardey *et al.*, 2006). Further, a considerable variability in public R&E intensity has been observed across states of India during TE 2004 (Figure 2). Figure 2 shows that with the exception of few states, commitment to investment in R&E was not strong and in some states, the situation was more disturbing. This analysis has clearly shown a situation of under-investment in public expenditure on agricultural R&E in the country.

Manpower Resources and their Attributes

Scientific manpower is the most critical resource in R&D. It has been estimated that there were about 22,000 scientists engaged in agricultural R&D in 2001 in India (Jha and Kumar 2006), of which nearly 96 per cent were in the public sector (Table 2). In-depth scrutiny has shown that the ICAR-SAUs system which is the major entity of the national agricultural research system (NARS), employed 83 per cent of agricultural scientists, in which share of scientists in the SAUs system was nearly 62 per cent. The share of scientists in other public and private sectors was 13 per cent and 4 per cent of the total scientific manpower, respectively. It has been observed that the SAUs system has lost 24 per cent of scientists during the period 1992-2002 (Jha and Kumar, 2006). It is an important policy issue and needs attention.

Another important factor observed in the study was the aging of scientists in the NARS. The estimated average age of 44 years denoted the level at which scientific productivity starts declining. More than 45 per cent of scientists are above the average age. Therefore, there is a need to induct young blood in the agricultural sector. The Indian NARS contained qualified scientific manpower. Estimates have revealed that two-thirds of the scientists were holding doctorate degrees and rests were Masters. In ICAR-SAUs system, the skill level was better (70-76%).

Analysis has revealed that agricultural scientists accord high priority to research (47.5%), and those in ICAR and private institutions spend relatively more time. Teaching is the next in importance (26.6%) and SAUs and deemed universities under ICAR pay more attention to teaching. Frontline extension gets third rank in time allocation by scientists (18.8%). Further, a large amount of

Table 2. Profile of agricultural scientists

Particulars	Number
Total scientists	21,869
a) ICAR	4,539
b) SAUs	13,633
Average age (years)	44.0
Ph.D. holders (per cent)	67.7

Source: Jha and Kumar (2006)

scientists' time (11%) is allocated to administration. This considerable time allocation to non-R&D activities (administration and management) is another worrying factor.

Resource-use Efficiency

It has been argued that research goals have become more complex now and it has become necessary to use the limited scientific resources efficiently. Efficiency of scientific resources was observed in terms of full time equivalents (FTEs) in relation to the economic importance of different commodities measured as per the value of product (VOP). The allocation of resources to individual commodities depicted Figure 3 has been found to be in line with their relative economic importance. Figure 3 also indicates that in some cases (cereals, vegetables, and livestock), small adjustments are needed, while relatively large shifts are needed for oilseeds, and pulses. But, before taking any readjustment decisions, policymakers need to consider other parameters like food and nutritional security, future demand, etc.

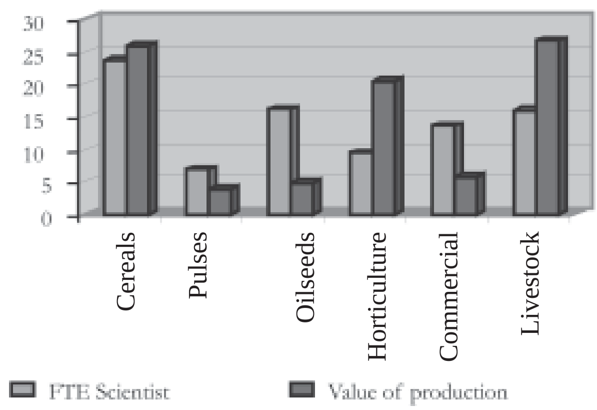


Figure 3. Allocation of scientists by commodity groups

Rationality of research resources was also studied at the regional level. This issue is important in R&D planning due to strong interactions between technology with agro-climatic regions and socio-economic conditions. The study has indicated paying of more attention in terms of allocation of manpower resources in the Gangetic Plains, and semi-arid tropics in order to create a more rational allocation profile (Figure 4).

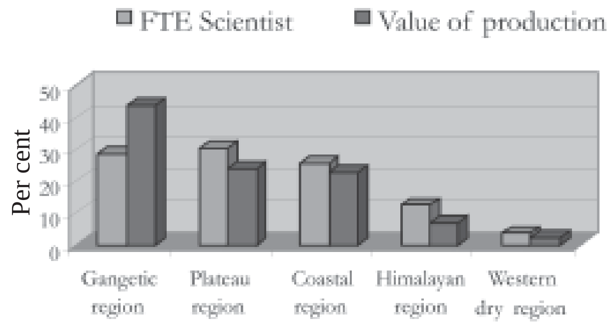


Figure 4. Allocation of scientists by regions

(b) Role of Private Sector in Agricultural R&D

In India, the entry of private sector into agricultural R&D started with the development of seed sector during mid-1980s and picking up its momentum in late-1990s, as incentives for private investments in R&D were made lucrative. The number of private sector players is on increase and in a few commodities, they are playing significant roles and their presence is expected to increase rapidly with time (Pal and Byerlee, 2003). However, private sector has invested in those activities/ crops like sugarcane, cotton, etc. where returns are quick, relatively higher, and less risky (Pardey *et al.*, 2006). In few cases, the private sector has come forward to capture futures markets and has invested huge resources in developing R&D infrastructure. The driving force behind entry of the private sector into agricultural R&D is its enormous potential and several relaxations are being offered by the government. The private sector accounts for about 14 per cent of the total research funding in agricultural R&D (Pal and Byerlee, 2003).

Contributions of Agricultural R&D

Over the years, several agricultural technologies have been developed by the ICAR-SAUs system. A list of some such potential technologies has been provided in Table 3. These technologies cover a wide range of areas from improved crop production to resource conservation and value addition. A perusal of Table 3 also reveals that technology is not the main constraint in managing the crisis in agriculture sector. The main problem is their poor and partial adoption on farmers' fields due to various socio-economic and management problems. At the first

Table 3. Some potential agricultural technologies in Indian context

Sl No.	Name of technologies	Expected benefits
1	**Crop improvement**	
	Hybrid rice	Provides additional yields of 1.0-1.5 t/ha, and is becoming popular in low-to-medium yield areas of eastern India.
	Quality protein maize	Contains 40.7 per cent higher tryptophan and is suitable for growing in maize zones I and IV.
2	**Improved crop management**	
	Integrated water management	Provides extra rice yield of 13 per cent in summer and 15 per cent in *kharif* and water-use efficiency of 28.7 per cent and 52.8 per cent, respectively over flooding method.
	Integrated nutrient management	Balanced use of fertilizers (120 kg N, 60 kg P_2O_5, 20 kg K_2O, 20 kg S and 5 kg Zn/ha) has increased wheat yield by 15-24 per cent in Madhya Pradesh. Skipping per ha use of P and S has resulted in yield losses.
	Diversified farming (consisting of crops, horticulture, livestock & fisheries)	Provides higher profitability (3-4 times) over monoculture, and opportunity for increasing employment, income and nutritional security.
3	**Resource conservation**	
	Zero-tillage	Saves water by 11.3 per cent, and increases wheat yield marginally over the conventional sowing technique.
	Micro-irrigation	It (ferti-irrigation) improves banana quality and yield. The drip system improves overall profitability of the system.
	Pressurized irrigation system	Pressurized irrigation (sprinkler and drip) increases yield by 40-50 per cent, and saves water by 30-70 per cent, depending on the crop. Sprinkler irrigation is suitable for all crops (except rice and jute), while drip is more effective in horticultural crops, cotton and sugarcane.
4	**Improved livestock methods**	
	Artificial insemination (AI)	AI improves conceptions in cattle and buffaloes by 20-25 per cent.
	Supplementation of deficient minerals	It improves the productivity of livestock by 10-15 per cent.
	Use of urea ammoniation technology	Its proper use improves the nutritive value of roughages and thus, production by 5-8 per cent.
	Livestock healthcare management	Feed blocks sustain the production, and can be transported to places of acute feed shortage.
	Diagnostic kits and vaccines	Capable in controlling diseases and parasites like foot and mouth disease (FMD), infectious bovine rhinotracheitis (IBR), *peste des petitis* ruminants (PPR), bovine viral diarrhea (BVD), bluetongue and avian influenza.
5	**Improved machines**	
	Production operations	
	Rotavator	Saves time (30-35%), water (30%), and cost of operation (20-25%), as compared to tillage by cultivator and harrow.
	Raised bed former	Useful for wheat after soybean, maize or cotton; saves on cost of operation (20-30%), seeds (25%), fertilizer (25%) and irrigation water (20-30%).
	Ridge seeder	Most suitable for dryland farming and for planting ragi, gram and pearlmillet. Its use gives an additional yield of 15 per cent, against conventional method.
	Sugarcane cutter planter	Suitable for cutting and planting sugarcane setts and application of granular fertilizer in single operation. Its use reduces labour requirement by 78 per cent and time of operation by 50 per cent.
	Potato planter	Useful for potato planting and also for inter-culture and earthing operation.

Contd.

Table 3. Some potential agricultural technologies in Indian context — *Contd*

Post-harvest processing	
Rice mills	Gives outturn of rice 70-72 per cent, against 65-68 per cent from the traditional huller. Its use provides additional 2.0 million tonnes rice bran and gives 0.25 million tonnes high quality rice bran oil (RBO).
Modern ginneries	Modernizing cotton ginning using variable speed double roller (VSDR) saves 30 per cent energy and increases lint efficiency, including competitiveness in lint production.
Biomass energy plant	
Biogas plants (solid waste)	It requires 75-100 per cent less water, produces up to 30 per cent more gas, needs one-fourth space for slurry storage/ drying and costs 10 per cent more than of the common design.

Source: ICAR (2007)

instance, the need is to refine these technologies to make them area-specific. Another important need is their transfer to the farmers and the capacity development of farmers for their adoption. The next important requirement is development of appropriate infrastructure for managing problems like yield gap, post-harvest losses, depleting natural resources, changing climate, IPR issues, global competitiveness, etc. It requires huge investment of money in this sector. There is also the need of reliable databases on different aspects of agriculture at the level of agro-ecological region. To generate such information, a large number of frontline demonstrations are to be conducted, which would require large amount of resources (man and material). Sustainability of natural resources (land, water and biodiversity) also needs strong infrastructural support and awareness generation campaigns.

Farmers need continuous and updated information on climatic conditions, improved technology and marketing for crops, livestock, fisheries, agro-forestry and agro-processing. The new approach to productivity improvement and employment generation is also knowledge-intensive (Laxmi *et al.*, 2007).

Dissemination of demand-driven and value-added information, which is time-and location-specific is equally important. Apart from it, rural women and men need access to information on healthcare. Increasing expenditure on healthcare is one of the major causes of farmers' indebtedness, leading occasionally even to suicides. Information dissemination on health status of livestock and poultry, on-farm and off-farm livelihood options and market-led entrepreneurship opportunities for the poor and the marginalized farmers in rural India needs attention. There is also a need to promote functional literacy among the adult illiterates and make learning joyful and useful for the young through interactive pedagogic methodologies.

Experience has shown that rural women and men can have access to information and communication technologies (ICT) with ease and confidence, provided there is opportunity for learning by doing and the contents are dynamic and location specific. ICT would be more meaningful to the rural households if generic information is converted to a location-specific one. If properly designed, ICT can help in converting scientific know-how into field-level do-how. Bridging the digital divide helps in knowledge and skill empowerment, and also helps in bridging gender divide by enhancing the self-esteem and self-confidence of rural women.

Summing-up

Agricultural R&D has enormous potential to provide solutions to the persisting problems. To meet the social goals and reaching the unreached, a strong public R&D system is needed. The public investment intensity of R&E is only 0.4 per cent as against 0.6 per cent in the developing countries and 1 per cent globally. A wide variability has been noticed in public expenditure on agricultural R&E intensity ratios across states of India. Apart from financial, human resources in SAUs have also reduced by 24 per cent during 1992-2002. Aging of scientific manpower has been found another problem. These facts have clearly shown under-investment in the agricultural R&D.

The efficiency of manpower resources in relation to value of product is broadly on line of economic importance, while its allocation in regional context suggests some readjustments in favour of Gangetic Plains and semi-arid tropics which are important from food security point of view.

In the wake of globalization and liberalization of economies, the policies promoting to agriculture are also changing fast. With the entry of private sector, the issues of providing technology and distribution of incentives have come at the central stage. These situations are beneficial for resourceful farmers and allow them to harness opportunities. But, the poor farmers are not able to get the benefits. This important issue is becoming hindrance in adoption of potential technologies developed by the private companies.

Technology development process has moved from the method of plant introduction to hybridization and better plant type for various agro-climatic conditions. The ICAR-SAUs system has developed several improved technologies over the years and these have good potential to increase income and employment and make farming a profitable source of livelihood. There is a need of developing appropriate mechanism and providing support for their adoption.

The fast-changing situation and policies have made agriculture complex and more knowledge-intensive. In the regimes of trade liberalization and IPR, farmers need more education and recent information to get the benefits. Besides farming, information on healthcare is equally important for managing crisis. The role of ICT has been found meaningful in providing generic information under the local situation and empowering farmers with scientific know-how and information on markets and prices.

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