Review of Agricultural Extension in India

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Executive Summary

Extension, like agriculture, is at a crossroads in India. Agriculture shows signs of sluggish growth, food price inflation, widening socioeconomic disparities between irrigated and rain-fed areas, and slow development and uptake of new technology. Relatively low average rates of total factor productivity growth in recent decades are among the sources of concern related to food security, sustainability, farm incomes and the scope for poverty reduction. Policies and programs for agriculture and rural development are attempting to address these challenges. Many inputs and enablers are required, extension not the least of them.

In India, as elsewhere, extension has a mixed record of success. During the Green Revolution period, extension, along with improved seeds, fertilizers and irrigation, increased productivity and enhanced agricultural development. In the period since then, the public provision of extension has on balance fallen short of expectations. Research-extension-farmer linkages are absent or weak in many instances while on the other hand there are duplications of efforts among a multiplicity of agents attending to extension work without adequate coordination. Difficulty in attributing impact, high transaction costs and weak accountability to farmers are among the problems affecting the delivery and financing of public extension.

India has gone through important institutional reforms to address this situation. The most prominent reform example of recent times is ATMA, the thrust known as the Agricultural Technology Management Agency. ATMA seeks to integrate extension programs across line departments and decentralize decision-making through 'bottom-up' procedures that attempt to link research, extension, farmers, NGOs and the private sector. ATMA has been scaled up across the country after a successful pilot phase. However, implementation bottlenecks have emerged on account of constraints in qualified manpower, insufficient technical and financial support, lack of a framework for implementing public-private partnerships, and weak links between ATMA and extension units such as Krishi Vigyan Kendras (KVKs) and others. Under Modified Guidelines issued in 2010, the constraints are being addressed, but important institutional and organizational challenges remain.

In addition to the public system, India has a large and growing number of private, 'third sector' (e.g. NGOs and foundations) and informal providers of extension. Input dealers and suppliers as well as buyers of produce are increasingly offering extension, a reflection of the growing importance of agricultural markets and value chains. Mobile phone-based applications in agriculture are promising as the 'up and coming' tool for scaling up and are indeed re-shaping the environment of service provision and linking farmers to markets.

The key unresolved issues are the rate of coverage of small farmers and the public sector's role and effectiveness in extension. The productive potential of small farmers could be multiplied (and sustainably so) with the right technologies, services, mentoring and access to markets. But this is far from happening at the required scale. The task is to expand coverage to all farmers operating under conditions where there is potential for growth through agriculture. This requires stepped up contributions from all providers of extension – NGOs, the for-profit private sector and the public sector. Public and private extension systems should complement each other and operate in partnership rather than at cross-purposes as is sometimes the case or duplicatively at the expense of underserviced areas. Since private extension by for-profit and non-profit actors is on the rise, the public sector's role should become subsidiary in nature, focussing on lagging areas and types of farming, creating conditions to attract the private sector there, and formulating and delivering rules and quality control. Recommendations to this effect are offered in the paper.

Introduction

Extension, like agriculture, is at a crossroads in India. Agriculture (the predominant sector in terms of employment and livelihoods) exhibits sluggish growth, food price inflation, widening socioeconomic disparities between irrigated and rain-fed areas, and slow development and uptake of new technology. Low rates of total factor productivity (TFP) growth in recent decades are among the sources of concern related to food security, sustainability, farm incomes and the scope for poverty reduction. Policies and programs for agriculture and rural development are attempting to address these challenges. The task is formidable, and problems of implementation abound. To be successful, the process of structural transformation in agriculture, which is well underway, requires accelerated and inclusive productivity growth, income convergence between those employed in agriculture and the rest of the economy, and farming methods that produce sufficient food and fibre without undermining the natural resource base further. Many inputs and enablers are needed to achieve this, extension not the least of them.

The purpose of extension is to disseminate advice to farmers. Gaps in knowledge contribute to the yield gap in biophysical and economic settings. Services and purchased inputs such as seeds and synthetic complements are essential productivity-enhancing tools. However, their effective use requires knowledge, which advisors need to articulate and communicate to farmers. The knowledge farmers need goes well beyond production. It includes price and market information, post-harvest management techniques, and an understanding of product quality determinants and safety standards. Some farmers marshal and command the needed knowledge on their own. The 'resource-poor' majority of farmers (growers of a large share of the nation's food) depend on science-based extension from outside to complement their local knowledge for improved farming and prospects for sales. How, therefore, can one best get meaningful advice to farmers and create learning environments that help achieve the desired outcomes and results?

Extension in India has a mixed record of achievement. The literature is clear in recognizing agricultural extension as a factor in promoting productivity increases, sustainable resource use and, more broadly, agricultural development (Singh, 1999). But the public provision of extension has on balance fallen short of expectations. Research-extension-farmer linkages are seen to be absent or weak in many instances. At the same time there are duplications of efforts, with a multiplicity of agents attending to extension work without adequate coordination (Planning Commission, 2008).

India is not alone in this predicament. Delivering meaningful extension is not easy. Farmers living in widely dispersed communities can be difficult to reach. Farmers' information needs vary across locations, making extension challenging. Supply side rationing may be a problem in the sense that there are likely to be too few extension agents relative to the number of farmers. On the demand side, self-selection on the part of larger, more commercial farmers may bias outcomes. Extension service budgets may be inadequate. Issues of motivation, competence, performance and accountability of extension institutions and their agents may affect results (Anderson, 2007).

Many countries have neglected extension in the past. Discomfort with the difficulties and some of the results may be among the reasons why. More broadly, governments around the world have neglected agriculture as a whole (World Bank, 2008), and extension has suffered as a result. But agriculture, and by implication extension, appear to be 'coming back' as governments and other organizations recreate awareness of the sector's role in providing jobs and livelihoods, food security and other benefits. In India, agriculture is back 'on the map' because of much-discussed performance shortfalls that need to be addressed. Extension follows suit. A National Seminar on Agriculture Extension took place in New Delhi in February 2009 to discuss the state of extension and five specific topics: knowledge management for agriculture extension, public extension with a focus on convergence of

extension systems, the role of information and communication technology (ICT) and mass media in agriculture extension, private sector initiatives including public-private partnerships in extension, and farmer-led and market-led extension systems. The well-attended national seminar was the first of its kind in many years. Proceedings were published recently (Ministry of Agriculture, 2010).

This paper builds on that discussion. The objective is to review the issues and performance, attempting – to the extent possible – to derive policy and action implications by looking at extension from the dual point of view of primary production and linking farmers to agricultural and food value chains. The paper recognizes that extension has become pluralistic in India in the sense that a large number of private, 'third sector' (i.e. NGOs, foundations) and informal service providers now co-exist with the public system. Market-based extension offered by agrodealers, input suppliers and buyers of products is on the rise – a phenomenon that is promising, given the emergence of supply and value chains as drivers of an increasingly complex sector.

The paper is organized as follows: Section 1 discusses the role of extension in achieving productivity growth in agriculture. Calculations for India are reported that have implications for the state-wise and crop-wise allocation of public expenditure on research and agricultural extension. Section 2 maps extension models and evolving needs in India. Sections 3 and 4 discuss modes of extension delivery by the public sector, the commercial sector and NGOs. Section 5 discusses mobile applications in agriculture, the 'up and coming' tool for scaling up and linking farmers to supply chains. Scale up of innovations and links to markets for the majority of small and marginal farmers remains a serious problem. In the concluding section, the paper develops recommendations to resolve this challenge.

1. Knowledge, Information and Agricultural Productivity Growth

Four types of technologies have raised yields in agriculture and animal husbandry in the past: better crop varieties and livestock genetics, fertilizer and feed, mechanization, and chemicals underpinning crop protection and animal health. Knowledge and information constitute the necessary fifth ingredient for technical progress to take hold. Knowledge and information include agronomic and animal husbandry know-how and data on such aspects as soil characteristics, the weather, and markets and prices.

How important is knowledge as a determinant of productivity growth? The studies that attempted to answer this question found the contribution to be vital, as common sense would suggest. For example, Evenson and Fuglie (2009) determine that country-level TFP growth rates in agriculture are significantly influenced by 'technology capital', an index that measures both the capacity to develop or adapt new technology and 'the capacity of users (farmers) to master the new techniques'. The authors' 'technology mastery' sub-index, which includes the number of extension workers per 1000 hectares as a component, clearly contributes to TFP growth in their model, beyond certain thresholds of public investment in R&D. This suggests that both aspects of technology capital are needed to drive TFP growth in farming: the capacity to develop technology and farmers' ability to use it. The latter can be enhanced by extension advisory services, in addition to schooling more broadly.

The literature on yield gaps is similarly clear about the role of knowledge and information in reducing gaps in the real world of farmers' fields.[1] For Ladha et al. (2003), crop management (which reflects the state of farmers' agronomic know-how, at least to a degree) is an important category of causes of the gap between potential and farmer-achieved yields in rice-wheat growing systems of the Indo-Gangetic Plains. The yield depressing factors named in this study that are at least in part amenable to treatment by improved organization and

[1] Yield gap can be defined as the difference between realized productivity and the best that can be achieved with current genetic material and available technologies and management.

know-how include low water use efficiency, water logging, nutrient mining, imbalanced fertilizer use, and pests that are not adequately addressed.

A team at Wageningen University studied yield gaps for major crops and world regions recently, defining five production constraints and inviting a group of experts to assign weights to them to reflect their relative importance. The experts were experienced crop specialists from national and international research institutions: see Hengsdijk and Langeveld (2009) for methods and results.

Figure 1 shows the Hengsdijk and Langeveld estimates of the contribution of their five production constraints to the yield gap for maize in different parts of the world, including South Asia. The constraints are (i) limited water availability, (ii) limited nutrient availability, (iii) inadequate crop protection, (iv) insufficient or inadequate use of labour or mechanization, and (v) deficiencies in knowledge that result in inadequate crop management. It is instructive according to this study to see that in South Asia the knowledge constraint (which agricultural extension, presumably, could ease) accounts for about one-fourth or 2 tons/hectare of the estimated yield gap of close to 8 tons/hectare for maize.[2] The authors acknowledge the difficulty of measuring and comparing yield potentials and actual yield across a range of conditions. Their results are indicative in character. But the relative contribution of the different factors accounted for in Figure 1 seems plausible, and the point about knowledge as a constraint on yield is clear.

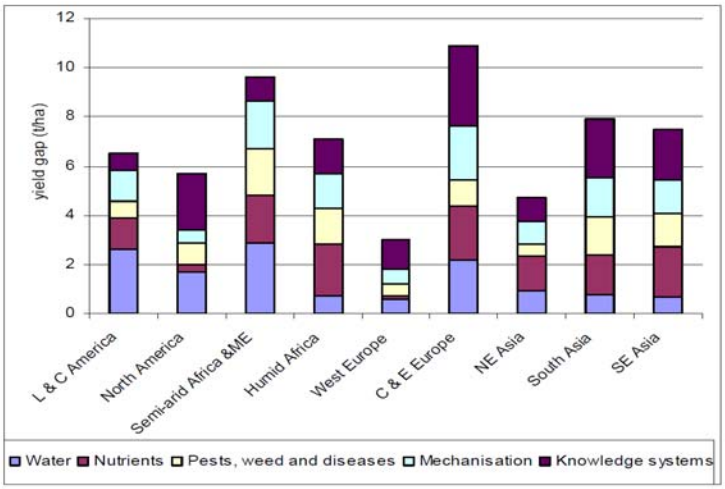


Fig. 1 Maize yield gap by region and contribution of five production constraints (Hengsdijk & Langeveld, 2009)

In their analysis of yield gap among rice growers in North Eastern zone of Tamil Nadu, Lekshmi et al. (2006) find that gaps are likely due to degraded, less fertile soils, pockets of endemic cropping systems, and a low adoption rate of high yielding technologies by farmers. On the latter point, the study notes that 'the intervention of technically sound, well trained and equipped extension personnel at the grass root level is lacking'. The study then states that the cost of agricultural inputs is high and positively correlated with yield gaps of paddy.

Studying cereal yield gaps globally, Neumann et al. (2010) distinguish between growth-defining, growth-limiting and growth-reducing factors while stressing the importance of management and, by implication, extension, to contain the latter two. Labor is a determinant of agricultural production, the authors note. Its quality as shaped by education and agricultural support services, including extension, is critical to the success of the farm enterprise. Other factors tested by Neumann et al. for their effects on yield include irrigation,

[2] The potential yield against which region-specific average actual yields were compared was derived from simulations by the IMAGE model in the Global Agro-Ecological Zoning Project (see Hengsdijk and Langevelde, 2009).

land and slope management, and access to markets. Crop production is only profitable if it is not too distant from markets, the authors contend, implying that agriculture tends to be less productive in more remote regions.

If knowledge and other factors such as agricultural research investment are important to reduce yield gaps and promote productivity growth, and if extension helps disseminate technology and knowledge, then is there enough public investment in research and extension to bring out the full potential effect of these forces on productivity growth? A study by Chand et al. (2011) concludes that the answer is negative for key crops and regions across India, but that there are also important instances of crops and states where productivity growth is high. The econometric analysis of TFP growth in this study includes 'research stock' and 'extension stock' as arguments, defined as the sum of weighted (public) research investment of five years and extension investment of three years over the periods reviewed. Chand and co-authors use this analysis to map TFP growth by crops and states, providing a basis to prioritize public research and extension resource allocations (Table 1).

Table 1 Trends in total factor productivity growth in various crops in selected states of India, 1975-2005

Crops	Total factor productivity growth category				
	Positive				Negative
	<0.5% (Stagnant growth)	0.5-1% (Low growth)	>1-2% (Moderate growth)	>2% (High growth)	
Cereals					
Rice	KN, MP, HY BH, OR, WB	AS, KR, UP	AP, TN	PB	
Wheat	BH, WB	MP, RJ	HY, PB, GJ, UP		HP
Maize	MP	UP	BH	AP	HP, RJ
Jowar		TN	MH, AP		MP, RJ, KN
Bajra		UP	HY	RJ, TN, GJ, MH	
Pulses					
Gram	MH, MP, UP		HY	BH	RJ
Moong			AP	RJ	MP, MH, OR
Arhar		GJ, KN	MH, MP	AP	TN, UP, OR
Urad	MH	UP	AP	RJ	MP, OR, TN
Oilseeds					
Rapeseed & mustard	UP	AS	RJ	MP	WB, PB, HY
Groundnut			MH, GJ, AP	OR	TN, KN
Soybean		MP, RJ	UP		MH
Cash crops					
Sugarcane					BH, KN, HY, AP, MH, TN, UP
Fibre crops					
Cotton	PB	HY	GJ, MH	AP	
Jute	AS	WB, OR, BH			

Notes: AP: Andhra Pradesh, AS: Assam, BH: Bihar, GJ: Gujarat, HP: Himachal Pradesh, HY: Haryana, KN: Karnataka, KR: Kerala, MP: Madhya Pradesh, MH: Maharashtra, OR: Orissa, PB: Punjab, RJ: Rajasthan, TN: Tamil Nadu, UP: Uttar Pradesh, WB: West Bengal (Source: Chand et al., 2011)

The table distinguishes between five productivity growth categories for combinations of crops and states: negative, stagnant, low, moderate and high. If we take the first three as priorities for stepped up investment in agricultural research and extension, then the action implications for public resource allocation by crop and geography are clear: rice productivity, for example, is lagging in nine states that are identified in the table; pulses are lagging in six states; oilseeds in ten; fiber crops in six; and maize, wheat and other cereals in eight. Resource allocation decisions for public research and extension must be based on multiple criteria to be sure, but the information in Table 1 is a good place to start.

Like TFP growth, crop yields vary greatly between states as demonstrated in Table 2. The table (which implies that the scope to raise yields is in general rather large) offers data on the partial productivity measure of production per unit of land at a particular point in time. A simple way to spot the lagging states is to look for those reporting below-average yields. Since, intuitively, knowledge gaps are among the factors contributing to yield variations in similar agro-climatic zones, there is scope for states to learn from each other and share know-how on narrowing the differences in yield and the factors underpinning it, such as extension. Extension clearly does not work equally well across states.

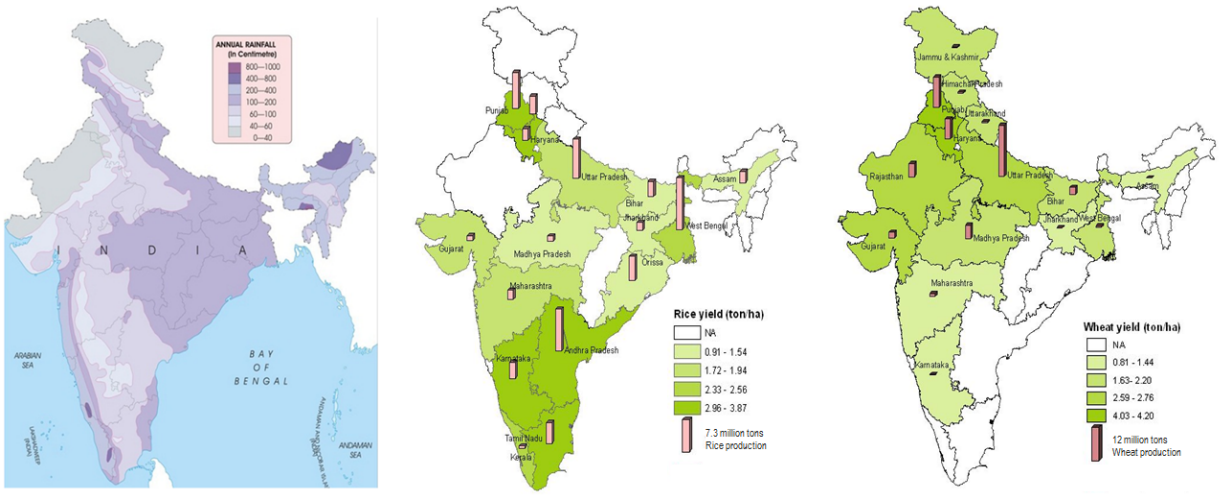
In some states such as Punjab where landholdings are large and irrigation is practiced widely, yields are high, and raising them further can be challenging. Technological breakthroughs are needed to increase (if not even just to sustain) the current level of TFP. In other areas, where holdings are small and irrigation restrictive (e.g. West Bengal, Orissa), the pressing need is to make existing knowledge and know-how reach large numbers of farmers. Each state's challenges are different, and there are large disparities within states, too, often linked to irrigation capability and (as suggested above) the proximity of production catchment areas to markets. The incentives to adopt high-yielding technology improve with irrigation and the proximity to cities and markets, raising the returns to extension, particularly in high-value crops. In remote areas where market access is limited, the choice of crops is constrained and extension needs to focus more on staples such as pulses and grains.

Table 2 Yields of key crops in major producing states, 2008-09

State	Rice	Wheat	Maize	Jowar	Bajra	Gram	Arhar	Rapeseed & Mustard	Groundnut	Sugarcane	Cotton
	ton/ha	ton/ha	ton/ha	ton/ha	ton/ha	ton/ha	ton/ha	ton/ha	ton/ha	ton/ha	ton/ha
Andhra Pradesh	3.25		4.87	1.56	1.02	1.41	0.46		0.88	78	0.43
Assam	1.61	1.09						0.54		38	
Bihar	1.60	2.04	2.68			0.93	1.18	0.96		44	
Chattisgarh	1.18					0.83					
Gujarat	1.74	2.38	1.48	1.20	1.37	1.01	0.99	1.14	1.40	70	0.51
Haryana	2.73	4.39		0.51	1.77	1.04		1.74		57	0.69
Jammu&Kashmir		1.74	2.01		0.59						
Jharkhand	2.03	1.54	1.41				0.62				
Karnataka	2.51	0.92	2.83	1.18	0.70	0.55	0.53		0.59	83	0.36
Kerala	2.52										
Madhya Pradesh	0.93	1.72	1.36	1.19	1.37	0.98	0.80	1.03	1.14	42	0.23
Maharashtra	1.50	1.48	2.38	0.88	0.77	0.68	0.60		1.12	79	0.26
Orissa	1.53			0.63		0.66	0.86		1.16	60	
Punjab	4.02	4.46	3.40					1.22		58	0.74
Rajasthan		3.18	1.74	0.58	0.83	0.78		1.23	1.67		0.41
Tamil Nadu	2.68		4.39	0.83	1.48		0.61		1.99	106	0.28
Uttar Pradesh	2.17	3.00	1.50	1.01	1.61	1.01	0.91	1.12	0.71	52	
West Bengal	2.53	2.49	3.78			1.04		0.76		93	
All India	2.18	2.91	2.41	0.96	1.02	0.90	0.67	1.14	1.16	65	0.40

Source: NSSO (2005) and Agricultural Statistics at a Glance 2010

Rainfall is often referred to as a factor limiting production, but according to the rainfall map of India (see Figure 2), nearly half the country receives rather copious precipitation in excess of 1000 mm per year, although the distribution of that rain may be erratic. The high rainfall regions include states with less than average yields of rice and wheat and irregular production between years. If rainfall is not fully determining, what other factors contribute to the observed low levels of yield? Farmers' practices and state of knowledge are part of the answer. Consider rice as an example, where farmers are frequently following paddy rice practices (e.g. flooding, puddling and transplanting), even though the conditions under which they work may not be suited to this. Under rainfed conditions (especially in upland and medium areas), drought spells can be fatal for rice. Farmers may not be aware that there are better ways, such as direct seeded rice on unpuddled soil and aerobic rice. China is very active in developing and spreading these. Improved methods are stuck in research institutions in India and do not spread. Extension is needed to disseminate the right practices among farmers.



(a) Annual rainfall (b) Rice yield & production (c) Wheat yield & production

Fig. 2 Rainfall distribution and rice and wheat yields and production (Source: Agricultural Statistics at a Glance, 2008) Rice and wheat yield and production levels are two-year averages for 2005-07.

Extension is a conveyor belt that brings knowledge and information to bear on farming. The effectiveness of extension varies across states and is influenced by the presence or absence of irrigation and the location of areas of production in relation to the market, among other factors. Given the acknowledged contribution of knowledge and information to agricultural productivity growth, stepped up public investment in research and extension for the benefit of productivity-lagging states and underperforming agricultural activities may well be called for, as suggested by Chand and co-authors. However, additional funding in and of itself is unlikely to be enough. As demonstrated later in this paper, it is also necessary to reform the methods and ways by which research and extension are planned and delivered.

2. Extension Models and Evolving Needs

Agricultural extension practice has evolved over time, following similar patterns and trends across the globe. The Training and Visit system (T&V) was an early anchor in the past 40 to 50 years. Promoted by the World Bank from the 1970s, T&V reflected a belief in the role of the state as the main actor in development. Under the unified, top-down, approach of T&V, existing efforts and organizations were merged into a single national service to promote the

adoption of high-yielding ('Green Revolution') technologies. The system experienced success in a number of countries, including India, at least for a period of time. It took a 'campaign approach' to raising food production that resonated in settings where farmers' needs and the promoted technologies matched up. But there are indications that, in time, T&V failed to generate impact on the promised and required scale. In good measure, this may be so because it was a supply-driven system that promoted messages developed by research scientists with little input from farmers, the users of technology. T&V was abandoned, or at any rate became toothless, in the 1990s.

Since then, agricultural extension has evolved towards pluralistic models and modes (Birner and Anderson, 2007; Neuchâtel Group, 2000). New thinking includes the delivery of extension services in the context of decentralization, and aspects such as outsourcing, cost-recovery, and the involvement of the private sector and NGOs. This is mapped in Table 3, which shows the possible combinations of provision of extension services and financing. Extension can be offered by public sector bodies such as Ministries of Agriculture, the private sector (for example, consulting firms, seed and input companies, and buyers of products), and non-profit entities such as NGOs, commodity boards or farmer-based organizations. Financing can come from the public purse, donors, user charges paid by farmers, or private firms. The latter may provide extension in the context of product sales to farmers or stewardship schemes to reduce agricultural input supply risk.

Table 3 Options for providing and financing agricultural advisory services

Provision of Service	**Financing of Service**				
	Public sector (various levels of decentralization possible)	**Private sector: farmers (individuals)**	**Private sector: companies**	**Third sector: nongovernmental organizations (NGOs)**	**Third sector: farmer-based organizations (FBOs)**
Public sector (various levels of decentralization possible)	(1) Public sector extension (various degrees of decentralization)	(5) Fee-for-service extension, provided by public sector	(9) Private companies contracting public sector extension agents	(11) NGOs contracting public sector extension agents	(15) FBOs contracting public sector extension agents
Private sector: companies	(2) Publicly financed contracts or subsidies to private sector extension providers	(6) Private extension agents, farmers pay fees	(10) Information provided with sale of inputs or purchases of outputs	(12) Extension agents from private company hired by NGOs	(16) FBOs contracting extension agent from company
Third sector: NGOs	(3) Publicly financed contracts or financial support to NGOs providing extension	(7) Extension agents hired by NGO, farmers pay fees		(13) Extension agents hired by NGO, service provided free of charge	
Third sector: FBOs	(4) Public financial support to supplied to extension provision by FBOs	(8) Extension agents hired by FBO, farmers pay fees		(14) NGO financing extension agents who are employed by FBO	(17) Extension agents hired by FBO, service free to members

Source: Birner and Anderson (2007), adapted from Anderson and Feder (2004), Birner et al. (2006), and Rivera (1996)

The challenge in the case of pluralistic approaches is to identify the mix of possibilities and business models best suited to supporting agricultural and rural development cost-effectively in ways that take local conditions into account and recognize the role of farmers in innovation (Anderson, 2007). Farmer participation in the development and dissemination of technology has emerged as an important theme in extension practice over the years. This finds expression in Farmer Field Schools, for example, and the Agricultural Knowledge and Information Systems approach (AKIS), which stresses the merits of direct links between farmers and agricultural scientists. The Farmer Field School model revolves around group-based learning and was originally devised to teach integrated pest management to rice

farmers in Asia. Versions of Farmer Field Schools operate in many countries, including India, but not usually as an organized nationwide system of extension (Davis, 2006). Participatory methods seek to convey knowledge to enable farmers to become self-teaching experimenters and effective trainers of other farmers (Anderson, 2007). Farmer Field Schools differ from earlier 'T&V' technology transfer-based extension because they are 'participatory' as opposed to operating from premises that expect farmers to adopt generalized recommendations formulated outside the community.

Other thinking in extension, compatible with the AKIS and Farmer Field School approach, stresses innovation systems and market-based, demand-driven extension. The innovation systems concept proposes inclusive ways of thinking about the participants and the institutional context in which the generation, diffusion and use of new knowledge take place (Rajalahti, 2008). Demand-driven systems (which may be managed and financed by farmers themselves) seek to make sure that innovation follows the market's lead. Swanson and Rajalahti (2010) use the term 'farmer-based extension organizations' to refer to demand-driven systems which, they note, may as a downside come to be dominated by large-scale, commercial farmers who do not necessarily represent the priorities and needs of their smaller peers. Bringing the rural poor into these schemes is likely to require special efforts and skills.

Market-oriented extension for specific crops (sometimes referred to as 'commodity-based advisory systems') may be provided by contractors, parastatals, farm cooperatives and others (in particular, agribusinesses) with a stake in the value chain. Participating farmers may pay for the advisory services and underlying research, with fees based on the quantity and value of products sold. The cotton-based advisory system in Mali is an example. The Gujarat Cooperative Milk Marketing Federation, a state-level association of milk cooperatives in Gujarat, provides extension services and training to 2.8 million members who pay for the services through the price they receive for their milk.

Market-oriented extension is relevant in economies that are experiencing growth and changes in consumer preferences that create markets for high-value products. It is the growing market (not new technology) that stimulates the uptake of innovation in this case. China and, to a lesser extent, India have been effective in making some of their extension market-driven (Swanson, 2009). Rapid economic growth in their non-agricultural sectors has boosted demand for high-value products that create new opportunities for farmers. Extension workers may find themselves challenged under these circumstances if they lack training in marketing, methods of farm and post-harvest management, and financial services. Success under the market-driven approach manifests itself when farmers can organize themselves as producer groups or sales cooperatives, access knowledge and needed resources, and sell profitably into predictable supply chains.

Different extension models and approaches exist around the world. Birner et al. (2006) argue that there is no single best method for providing need-specific, purpose-specific and target-specific extension advice. The right approach depends on the policy and infrastructural environment, the capacity of potential service providers, the farming systems and potential for market access, and the characteristics of local communities, including their willingness and ability to cooperate with agents of agricultural extension. Different approaches can work for different sets of conditions. To fit a particular situation, agricultural extension needs to be flexible and able to accommodate local needs (Raabe, 2008).

In India today, these local needs have everything to do with the rapid transformation of agriculture that is visible almost everywhere one looks. Market liberalization and globalization are driving Indian agriculture out of the staple-based subsistence system of the past towards a high-value, information-intensive commercial enterprise (Adhiguru et al., 2009). In this new world of agriculture, farmers are interacting with different information sources to help them produce and sell products and deliver safe commodities of good quality to consumers. As

noted by Adhiguru and co-authors, the information requirement that ensues is demand-driven and as such different from the supply-led public information system that was appropriate during the Green Revolution era. The grand challenge now is (i) to improve farmers' access to the right kind of timely knowledge and information and (ii) to reach all farmers. There is a role for both public and private information systems in this situation, as illustrated in Figure 3 where public providers in India appear in the boxes on the left-hand side of the diagram and private sources of extension in those on the right. Public and private information systems should complement each other and operate in partnership rather than at cross-purposes or duplicatively at the expense of underserviced areas. To the extent that private extension by for-profit and non-profit actors is on the rise, the public sector's role should become subsidiary in nature, focus on lagging areas and types of farming, create conditions to attract the private sector there, and formulate and deliver rules and quality control. 'Cyber extension' and cell phone-based applications are there to support the process.

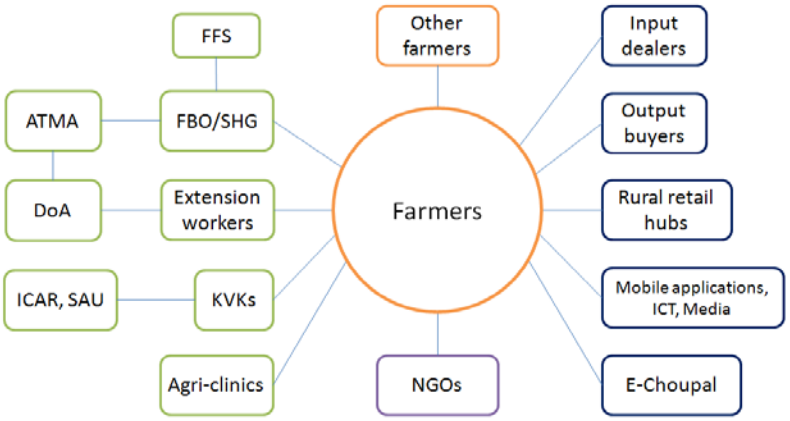


Fig. 3 Information exchange between extension and farmers in India (adapted from Glendenning et al., 2010)

Notes: Information flow is the line between the boxes. Green boxes refer to the public sector, and blue ones to the private sector. ATMA = Agricultural Technology Management Agency, DoA = Department of Agriculture, ICAR = Indian Council for Agricultural Research, FFS = farmer field school, FBO/SHG = farmer-based organization / self-help group, SAU = state agricultural university, KVK = Krishi Vigyan Kendra (farm science center), NGO = non-governmental organization.

The sources of information and extension advice accessed by farmers in India are varied and suggestive of some interesting patterns.[3] Some 40 percent of farmers of all sizes access information on modern agricultural technology from one source or another, according to all-India data collected by the NSSO (Table 4). As reported by Adhiguru et al., and with reference to the table, access to information from any source increases with farm size. Progressive farmers, input dealers and mass media (radio, TV, newspapers) are the most important sources of information. Sources such as (public) extension workers, primary cooperative societies and output buyers/processors are much less important on average according to this source and are in the case of extension workers and cooperative societies biased towards larger farmers. Other public programs, including government demonstrations, village fairs, farmers' study tours and KVKs (Krishi Vigyan Kendra farm science centers) are of minor importance as sources of extension and are clearly biased against small farmers in this all-India assessment. The private sector in the form of progressive farmers and input dealers is more important than the public sector as a source of extension information for all farmers, including small farmers. The NGOs' reach of farmers is modest according to this source and displaying somewhat of a bias against small farmers, too.[4]

[3] This discussion is based on Adhiguru et al. (2009) and analysis of farm level data collected by the National Sample Survey Organization (NSSO) in its 59th round in 2003.
[4] In the NSSO survey, small farmers were defined as operators farming up to 2 hectares of land.

The role and importance of the different surveyed sources of extension information varies in relation to the type of information sought. The main aspects of cultivation on which farmers seek information refer to seed, fertilizer application, crop protection and harvesting/marketing, according to the NSSO. In animal husbandry, health care and feeding practices top the list. At the national level, extension workers stand out as a relatively important source of information on seed, along with progressive farmers, the mass media, and input dealers, according to the NSSO. On fertilizer and animal feed, input dealers are consulted more frequently than any other source. Newspapers and radio are the important sources for obtaining information on plant protection chemicals. The main reported source of information on 'harvesting/marketing' is newspapers, followed by progressive farmers. The role of extension workers is negligible here (cf. tabular analysis in Adhiguru et al., not shown). The NSSO survey did not investigate the role of mobile phone-based sources of information, which (as demonstrated in section 5) constitute an increasingly important guide to harvesting and marketing in agriculture and livestock production.

Table 4 Access to information from different sources across farm-sizes in India (percent)

Sources	Farm-size			
	Small	Medium	Large	All India
Any source	38.2	51.0	53.6	40.5
Other progressive farmers	16.0	20.2	20.8	16.8
Input dealers	12.6	14.8	18.3	13.2
Radio	12.4	16.4	16.8	13.1
TV	7.7	15.3	22.4	9.4
Newspaper	6.0	10.3	15.9	7.0
Extension workers	4.8	9.8	12.4	5.8
Primary cooperative societies	3.0	6.2	8.0	3.6
Output buyers/food processors	2.1	3.6	3.4	2.3
Government demonstrations	1.7	3.4	4.6	2.1
Village fairs	2.0	2.4	2.38	2.0
Credit agencies	1.6	2.8	3.4	1.9
Others	1.6	2.1	2.0	1.7
Participation in training programs	0.7	1.9	2.3	0.9
Krishi Vigyan Kendras	0.6	1.0	1.7	0.7
Para-technicians/private agencies/NGOs	0.5	1.0	0.8	0.6
Farmers' study tours	0.2	0.3	0.6	0.2

Source: Adhiguru et al. (2009)

The NSSO survey suggests that the paradigm of pluralism in extension (involving both public and private actors) is practiced in India to an extent. But, worryingly according to this source, only about 40% of farmers access off-farm information regarding improved components of technology at the all-India level. Progressive farmers and input dealers, and thus the private sector, stand out as sources of information, as mentioned, but questions may at times be raised about the quality of the information they supply. The public sector is present, as discussed in the next section, but farmers' access to its mechanisms and resources, including extension workers and KVKs, seems to be low. This is a matter deserving attention as we proceed.

3. Public Extension in India

Public extension has a long and distinguished history in India going back to the pre-Independence and the pre-Green Revolution eras. Extension went through distinctive stages over time, evolving with national priorities (Singh and Swanson, 2006). Thus, the food crises starting in the late 1950s prompted a refocusing of extension from 'rural development' to agricultural production intensification and food security. The combination of Green Revolution technologies in the late 1960s and the 'single line of command' T&V system from the mid-

1970s helped bring about food self-sufficiency during the 1980s and beyond. Analyzing some of the effects of T&V in advanced agricultural regions, Feder and Slade (1986) found that the method greatly increased the number and frequency of contacts between farmers and extension workers, who were an important source of knowledge about farming practices. T&V helped make possible yield increases in wheat and rice. After allowing for other factors affecting farmers' performance, and solving the attribution problem with a research design that included control groups, Feder and Slade found yield differences of about 7 percent over three years that were attributable to T&V. T&V strengthened the state-level extension machinery and energized a young and growing extension staff. It was a movement that for a time revitalized the system of agricultural research and extension in the face of significant challenges – just what is needed again today.

As mentioned in the previous section, however, doubts about the methods and extension value of T&V began to creep in for a number of reasons, including the apparent limitations of the approach in less well endowed agricultural settings. Poverty and malnutrition remained widespread in lagging rural areas and indeed grew, prompting a search for new solutions in the 1990s. Many state-specific and centrally driven innovations were introduced (Sulaiman, 2003, provides an overview). Subsequent Plan documents explored the role of extension under a liberalized regime. Extension implications for agribusiness sub-systems were among the concerns, as was the role of extension in addressing crop-wise and region-wise disparities in growth, natural resource degradation, and vulnerable areas and people (Academic Foundation, 2004).

A breakthrough of sorts emerged in the form of ATMA, the Agricultural Technology Management Agency, as the 21st century dawned. ATMA was piloted through the Innovations for Technology Dissemination component of the World Bank-supported National Agricultural Technology Project (NATP) that became effective in 1998 and concluded in mid-2005. The new thrust represents a decentralized approach that emphasizes local solutions, diversification, market-orientation, and farm income and employment growth, operating through state-level and local institutions. This is very different from T&V, except in one respect: like T&V, ATMA is intended as an organizing framework, a unifying thrust that would encourage coherence and convergence among extension actors and create incentives not only for institutional reform, but for improved performance of processes and institutions. The approach would integrate extension activity across the line departments and decentralize decision-making through 'bottom-up' procedures that would link research and extension and involve farmers, NGOs and the private sector in planning and implemention at the block and district levels (Singh and Swanson, 2006). We look at ATMA and other drivers of public extension in this section and assess system performance, including the aspect of public-private interaction in extension.

ATMA

ATMA is an autonomous organization registered under the Societies Registration Act of 1860, able to receive and dispense government funds, enter into contracts, maintain revolving funds, collect fees and charge for services. A Governing Board determines program priorities and assesses impact. The heads of individual ATMA jurisdictions (Project Directors) report to the Board. The project directors chair the respective ATMA Management Committees, which include the heads of all line departments and the heads of research organizations within the district, including the Krishi Vigyan Kendra (KVK) farm science centers and Zonal Research Station (ZRS). The original organizational structure of ATMA is given in Figure 4.

Under the NATP project, the ATMA program was implemented as a pilot in 28 districts in seven states. By 2006 ATMA had been adopted in some 60 districts (about 10 percent of the total) and was programmed to be expanded to all rural districts within five years (Singh and Swanson, 2006).

Perhaps not surprisingly, however, implementation bottlenecks began to emerge. According to Kapoor (2010), these include qualified manpower constraints at block and village level, lack of formal mechanisms to support delivery below the block level, insufficient technical and financial support (the support provided during the pilot stage having weakened over time), and lack of a clear operational framework for implementation of public-private partnerships. Additionally, according to this source, the links between ATMA bodies, ICAR, the SAUs and the KVKs are weak. ATMA, therefore, is not the hoped for 'magic bullet' some may have believed it might become. As a framework, ATMA is arguably on the right track, but it has to cope with problems of alignment of stakeholders and partners. A question one may ask is whether the incentives and capabilities built into the thrust are compatible with the need for flexibility and responsiveness on the ground.

In view of the system's implementation constraints, the government issued new guidelines on ATMA in June 2010. The *Guidelines for Modified Centrally Sponsored Scheme* 'Support to State Extension Programmes for Extension Reforms' note that the system does 'not provide the dedicated manpower support at State, District and Block levels' that is required (Government of India, 2010). The new guidelines, therefore, provide for modifications to strengthen specialist and 'functionary' support at different levels; making sure that the 'farmer friend' model (linking farmers and extension agents) works in practice, in particular by filling block-village gaps; revising the 'ATMA Cafeteria' (or list of extension activities to choose from); better enabling Farmers' Advisory Committees to advise administrative bodies at the different jurisdictional levels about extension needs; and delegating powers to State Level Sanctioning Committees for them to approve the state extension work plans (SEWPs). (This is required for the release of ATMA funds.) The guidelines include a new organizational chart that articulates sets of activity and fund flow at State, District and Block levels (Figure 5).

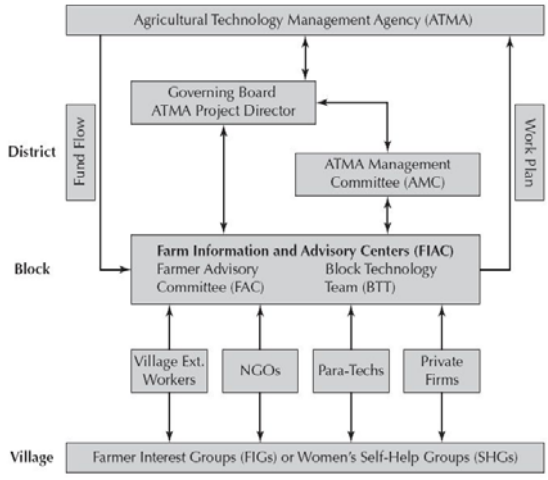


Fig. 4 Original organizational structure of ATMA (Singh, Swanson and Singh, 2006)

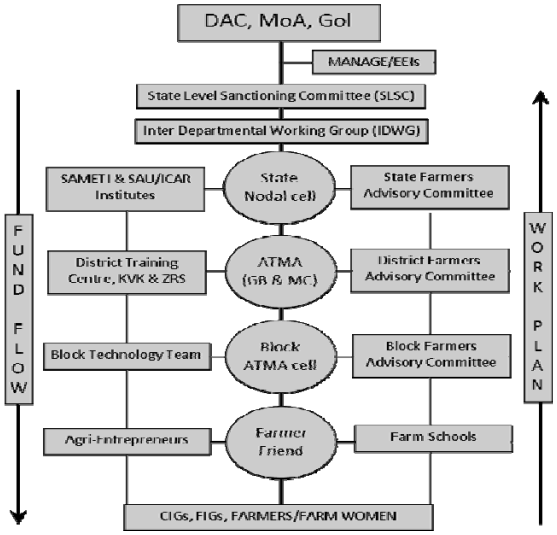


Fig. 5 Organizational structure of ATMA reforms (Government of India, 2010)

Note: DAC = Department of Agriculture and Cooperation, MoA = Ministry of Agriculture, GoI = Government of India, GB = Governing Board, MC = Management Committee, CIGs= Commodity Interest Groups, FIGs = Farmer Interest Groups, SAU = State Agricultural University, ICAR = Indian Council of Agricultural Research, SAMETI = State Agricultural Management and Extension Training Institute.

The guidelines provide for convergence in four areas: manpower and extension-related work under different programs and schemes; public agricultural research and extension at different levels of implementation; convergence with development departments to ensure that the extension activity forms a coherent whole; and convergence with and involvement of the non-governmental sector. The intention in this latter area is to 'ensure promotion of multi-agency extension strategies, and to implement scheme activities in Public-Private-Partnership (PPP) mode'. A minimum of 10 percent of 'scheme allocation on recurring activities at District level'

is meant to be incurred through the non-governmental sector, i.e. NGOs, farmer organizations, Panchayati Raj institutions, cooperatives, para-extension workers, agri-entrepreneurs, input suppliers and the corporate sector (Government of India, 2010).

The guidelines also clearly attempt to increase the system's responsiveness to farmers' needs, including the needs of small and marginal farmers, among other aspects by strengthening the 'farmer friend' provision. With respect to both convergence and responsiveness, therefore, the guidelines convey a sense of the government's dedication to improvements in agricultural extension. Nevertheless, implementation – the quality of which varies by state – will remain as the central issue. Ways and means will need to be found to overcome the inherent challenges besetting public extension that derive from the scale and complexity of the problem, the challenges of instilling a culture of accountability to farmers in a multi-tier extension organization, the difficulties of alignment between knowledge generation and extension, and the dependence of extension impact on the broader policy environment.

Comparison with China

To gain perspective, a comparison with China may assist. With ATMA, India is decentralizing public extension and adapting it to local needs, partnering with non-governmental providers and other organizations, setting the stage for improved quality control, and (as far as the central government is concerned) operating as a residual force. This appears to be the way China is going (see Annex I), although there are many differences in agriculture and agricultural extension between the two countries, as well as the levels and nature of government spending in the sector.

One of the differences between the two countries is that in China, technology, agriculture and extension have evolved to the point where extension no longer needs to focus primarily on staple grains and basic aspects of technology such as improved (often hybrid) seeds, fertilizer, and crop protection. Farmers know about these sources of support; average grain yields in China being twice what they are in India. Extension focuses on new frontiers in the production and marketing of high-value products. Delivery appears in general to have been fairly effective, but (as argued in Annex I) this is not to say that all is well. Soil and water stewardship are two very important issues that extension needs to address more effectively in both countries, and new approaches must be found to foster the environmental sustainability of farming.

In India, there is a continued need for extension to focus on grains, pulses and oilseeds in lagging areas, while at the same time covering high-value products in the supply chains that already exist or are being formed. Infrastructure such as electricity and roads is less well developed than in China, reducing the relative effectiveness of extension, however well conceived. But the two countries display similarities in the sense that decentralization as well as reliance on multiple extension participants are on the agenda. Studying the two approaches comparatively may be instructive for planners of extension as ATMA runs its course under new guidelines.

KVKs and State Agricultural Universities

Farmers face a range of extension providers in the public and the cooperative sector, including those under ATMA, the state Agriculture Department village extension officers, public radio broadcasts, crop fairs, IFFCO extension by the Indian Farmers Fertilizer Cooperative, and KVKs and SAUs. The mission of the KVK farm science centers of ICAR is to test and transfer technology to farmers. KVKs, of which India currently has about 570 (on average about one per district), serve the purpose of linking research and extension. They are ICAR's leading vehicle for extension, but most KVKs are small institutions with some 20 scientific and administrative staff operating under a program coordinator. The effective reach of KVKs is therefore very limited, as seen in Table 4 above. Their method of operation,

focusing on adaptive research, field trials, testing, and field demonstrations seems well suited to the task. But districts are large and heterogeneous as far as agricultural conditions are concerned, and KVKs would have to be more numerous and better endowed to make their mark on the required scale.

The State Agricultural Universities are much larger entities than individual KVKs, with fully-fledged agricultural research capability, but they, too, are a limited resource compared with the size of the farm population that should be reached. The extension activity of the SAUs operates through state-level agricultural entities, but sometimes reaches out to farmers directly. The organizational structure varies by state. Like KVKs, the SAUs are important, but under-resourced elements in public extension.[5] According to the National Academy of Agricultural Sciences (2005, quoted in Glendenning et al., 2010), aspects of concern related to SAU extension include 'centralized agendas' and information that does not adequately reflect local needs. Similarly, as with KVKs, the extension focus of SAUs tends to be limited to aspects of primary production, at the expense of the post-harvest and marketing dimension.

Evidence from the field

Two recent studies of parts of Uttar Pradesh and Madhya Pradesh shed light on agri-services (including extension) in those areas, pointing up issues for analysis and policy design (Reardon, et al., 2011a&b). The purpose of the studies, among other aspects, was to analyze what types of suppliers farmers obtain their inputs and services from, including extension. The role of rural business hubs (such as those described in the next section) was a subject of the investigation. Samples of 810 farm households were drawn from three study zones in UP and MP, respectively, in or near the catchment areas of business hubs. The samples were not intended to be representative at state level. Field work was carried out in 2009. Key findings related to extension are as follows (quoted from source):

The UP survey shows that only 18 percent of households from all farm sizes had access to extension from any source, public or private, during the period surveyed. This differed between regions, with the more commercial areas in West and Center showing higher levels of access to extension than East. Many respondents indicated that they were unable to find extension advice at the right time. Those who did get extension generally reported a high satisfaction rate, so the main issue seems to be access. Of total uses of extension, only 7 percent were from state extension officers. Other public extension taken together (i.e., KVK, all-India radio, university extension, plant protection unit) amounted to 18 percent, meaning that of the meager quantity of extension accessed by farmers, only 25 percent came from the public sector. The UP study states that 'on paper' public extension is in place. The recommendation is to make it more effective and accessible.

The MP survey yielded rather more favorable conclusions, perhaps because the sample included the Malwa plateau, which is dominated by commercial agriculture with volumes of high value vegetable production. Eighty percent of households reported using extension from some source (public or private), with little variation over sampled regions. Non-use, the study states, seemed to be driven by low farmer demand in sampled West and Central zones whereas in the East it was more due to delivery and quality problems in extension. (The share of state extension workers in all extension was less in the East [29 percent] than in West and Central zones [41 percent]). Smaller farmers used extension slightly more than larger farmers, but farmers not using extension were more likely to be small. Reported satisfaction with extension was very high, with timeliness identified as the main 'major

[5] The Eleventh Plan document states that the SAUs are important loci of regionally relevant research, but are so poorly funded by their own state governments that many of them are in chronic overdraft and almost all rely mainly on ICAR funding for research (Planning Commission, 2008).

bottleneck' in all zones. Public extension from extension workers and KVKs emerged as relatively significant at 49 percent of all direct extension uses, the remainder being covered (i) by public indirect provision such as radio and (ii) the private sector, which clocked up 25 percent of uses.

Many questions arise from these results, some of which (specifically, the high extension coverage and satisfaction) are somewhat surprising for a state such as MP with low reported productivity growth on average in key crops. It should be noted, however, that the sample covered some of MP's more developed parts. Farming conditions and the farmer clientele vary widely within and across states – compare Bundelkhand and Malwa for evidence on this. Could there be bias in how public extension responds? Is public extension more dynamic in commercially vibrant agricultural settings than in lagging ones? (It probably is.) Does it compete with the private sector in commercial areas? Does it modernize itself in the context of such competition and/or cause the private offer to be sharpened? Or is it complementary, filling information needs that the private sector fails to cover or is not trusted to supply? Are there thresholds of public extension that need to be attained before farmers switch to private sources of extension? The above example from underserved UP, where (like in MP) the sample was drawn from relatively more developed areas, does not seemingly confirm this: what little extension there was came disproportionately from the private sector, specifically input companies, rural business hubs and sugarcane processors in this case. A question begging to be asked is what extension looks like in the poorer parts of UP if it is as limited as reported in the more developed parts.[6]

Public extension may be lagging because of leadership shortfalls at the local level even as funds are available – just as it may be excelling with the right coincidence of drive and motivation. Unpublished evaluations of extension under ATMA by governmental entities find fault with many aspects in some states, including (according to one such evaluation) insufficient percolation of the planning process down to village level, insufficient focus and attention to extension in districts, haphazard and inadequate mobilization of farmer and community interest groups, failure to link ATMA structure at the district level to the corresponding KVK, failure to create synergy between line departments, tardy allocation and release of funds impacting extension at district and block levels, overburdening of project directors of ATMA with 'multifarious' activities, and neglect of opportunities to create synergy with the private sector. This is a long list and one hastens to add that there are instances of favorable evaluative assessments, too.

One such instance has been documented with reference to agricultural reform in Bihar (Singh et al., 2009). Based on data generated from 540 farmers over a period of three years (2005-2007), this study judges the extension reforms introduced during the NATP period of ATMA (i.e., the pilot phase) to have been quite effective. (Note that the sample of 540 farmers is not representative for the state of Bihar as a whole.) Interaction with farmers and need-based training of scientists and extension workers sharpened the focus of research to meet location-specific requirements of growers, according to the study. Adoption of improved technology and practices progressed across all categories of farmers, leading to diversification of farm enterprises and added yield and incomes. The study documents 'reduced adoption lag' and growth in incomes, although (as might be expected) increases in income were higher in more advanced districts where base-income was relatively high (cited from source).

Perspective

Students of agricultural extension in India state almost unanimously that the pilot phase of ATMA was a success that got diluted later on. Many factors are responsible for this, including the 'lab-to-land' relationship for one. The once strong link between research and extension is weak today, but the example from Bihar just cited shows that it should be possible to make it

[6] An online conversation with Thomas Reardon in June 2011 helped spawn some of this discussion.

strong and functional again at the district and local level where it counts. It is at that level, too, that qualified and adequately led and empowered male and female staff is needed – people who understand agriculture and farming, accept the principles of devolution, and are trained in notions of farmer-led and market-led extension. Qualified agronomists willing to work in the field are in demand; there are not enough of them. Another aspect that is needed refers to workable solutions to the challenges of aligning the multiplicity of actors and schemes by different entities at different jurisdictional levels, not to achieve uniformity, but to arrive at a measure of coordination for best performance overall.

The UP and MP surveys referred to above illustrate the by now well-known fact that public extension has evolved from a monopolistic stance to a situation characterized by the presence of many non-governmental actors. This should be seen as a sign of success: it is because of past public research and extension efforts that agriculture has developed to a point where choices are available to many farmers. The farmers are keen on innovations, many of which come from the private sector nowadays. The private sector, in turn, is keen on business opportunities, which are not necessarily confined to the dynamic sites but may extend to poorer regions, too. Growing herbicide sales by private companies in traditional rice growing areas in a context of rising rural wages serve as an example. Mechanization is another example as labor becomes scarce, as is the demand for good direct-sowing techniques instead of transplanted rice. Micro-irrigation and mechanization are spawning whole new service industries in rural areas, bringing innovation to farmers and illustrating the growth of demand and opportunities for agribusinesses of many kinds. How the public sector reacts and adjusts to this is a major issue in the quest for productivity growth to ensure food security, environmental sustainability and greater equity and poverty reduction.

4. The Private Sector: Commercial Providers and NGOs

Agricultural extension by commercial companies is advancing rapidly in India. Segments of the private sector offering extension as part of their value proposition include the crop science industry, seed and input companies, distributors and agrodealers, service providers of various kinds, food processors and retailers, and – as seen in section 5 – mobile operators and the content providers with whom they partner. Contract farming is an increasingly important vehicle for agricultural extension. The term used in the literature for extension in this context is ‘embedded services’, where companies deliver information with the sale of inputs or the marketing of products (Feder et al., 2011).

Input providers and product aggregators present information services to farmers to differentiate their offer, foster safe and effective use of products and technologies, expand market share, and ensure the supply of commodities on a timely basis in the quantities and qualities they seek. Companies may work independently or in partnership to develop integrated offers on the input side (covering, for example, seed, fertilizer, crop protection, and irrigation products), or they may foster growth in value chains through forward linkages with buyers of produce. Such private-private partnerships may be complemented by public-private or for-profit/non-profit cooperation, in which companies link up with public providers of extension and/or NGOs. The government and NGOs can help kick-start markets for extension linked to input and/or output markets by delivering ‘patient services’ outside commercial channels, in addition to their work in settings that offer no incentive to the commercial sector at this time. Extension by commercial actors on the input and the output side of farming and NGOs are the topics of this section.

The commercial and the partnerships arena follow a variety of models for delivering and financing extension. Commercial actors may supply extension to farmers or farmer-based organizations by offering information services and inputs in contract farming or ‘outgrower’ schemes. This may include sending agronomists into farmers’ fields. Alternatively, commercial organizations may hire the services of, or partner with, third parties. The possible

partners include NGOs, as mentioned, consultants, research institutes or universities, as well as public providers of extension. As to financing, farmers and their organizations, input suppliers and product buyers may pay for tailored services from a range of possible providers. They may also benefit from public or donor-funded schemes that hire for-profit or NGO providers to offer services for free. A further model is the one where farmers obtain commodity-specific extension advice related to production contracts. Payment for extension under contracts may be through the prices paid to farmers that would reflect the cost of the extension service.

Extension by input and technology providers

As seen in section 2, input and technology providers are a frequently consulted source of extension advice through their commercial links with input dealers. Agrodealers and the farm input suppliers selling through them have an interest in pre-sale and sometimes continuing after-sale advice to growers. This is because for best results, farmers need not only inputs, but also knowledge about their proper use. More than products, input suppliers really sell effects that are expected to materialize as a consequence of the combined application of the synthetic good and knowledge. Brand reputation and market share are co-determined by the quality and relevance of the advisory services offered to farmers. The problem from the industry's point of view in this context is cost: how to extend product-related knowledge cost-efficiently to large numbers of farmers who each only buy small amounts? The challenge for regulators and the public, on the other hand, is reliability, i.e. the veracity of the information, and the integrity of products in markets such as agrochemicals, where counterfeits abound and can be useless or even dangerous.

There are an estimated 282,000 input dealers in India. They are pillars of their communities in rural or semi-rural areas, and have every interest to offer quality services to their farmer clients. But this requires training, perhaps together with lead farmers, who as a category are known to serve as multipliers of agricultural know-how and good practice. MANAGE, the National Institute of Agricultural Extension Management in Hyderabad, offers a training program for input dealers leading to the Diploma in Agricultural Extension Services for Input Dealers (DAESI). So far, however, only a minute fraction of all input dealers have been trained. The DAESI diploma covers four modules: agronomy, extension and communication methods, individual and business development, and laws relating to seeds, fertilizers, agrochemicals and consumer protection. A list of trained input dealers by district and other information are available on the MANAGE website.[7] MANAGE also offers training to other stakeholders and providers of extension.

Another way to train input dealers is by association with large organized input sales and extension schemes, of which there are a number of private ones in India today. The *Mahindra Krishi Vihar* (MKV) 'one-stop farm solution center' by the Mahindra & Mahindra Ltd. tractor and utility vehicle company is one such scheme. Early centers were started in 2000 with the establishment of the Mahindra ShubhLabh Services subsidiary. The subsidiary's stated mission is to 'tackle deficiencies in the farm sector, including low consumption of quality inputs, lack of mechanization, scarcity of farm finances and low awareness of scientific farm practices'.[8] The farm solution centers are arranged in 'hub and spokes' fashion; farmers access services through the spokes at village level. The centers operate on a franchise basis. They provide farmers with services that include quality inputs, the possibility to rent farm equipment, credit in partnership with banks, farm advice by trained field supervisors who visit fields, and off-take of crops through contracts with processors. Dovetailed with the extension advice in this model are the distributorships and retailing of fertilizer and agrochemicals in partnership with the respective manufacturers.

[7] http://www.manage.gov.in/daesi/daesi.htm.
[8] The quotes and information in this discussion of Mahindra Krishi Vihar are taken from Sulaiman et al., 2005.

A study of MKV that deserves mention as one of the few that assess the results of extension based on primary data from the field – even if the sample size was small – offers the following insights (Sulaiman et al., 2005): (i) farmers are willing to pay for an integrated set of services that gives them access to quality inputs; (ii) farmers working with a private extension service provider (in this case, MKV) can substantially increase their yields and farm income; (iii) the increases are attributable to field-specific technical advice on application of the right inputs at the right stage of crop growth; (iv) MKV as a private organization has been able to develop a sustainable and profitable business selling extension services related to both production technology and linkages to markets; (v) the apparent success of this model is in some measure due to MKV's flexible 'learning by doing' approach; and (vi) a private extension approach of this type focuses mainly on medium and larger-scale farmers.

Hariyali Kisaan Bazaar (HKB), run by DCM Shriram Consolidated Ltd. (the fertilizer, seed and sugar conglomerate), is an example of a business that seeks to provide 'end-to-end agri-solutions' to farmers. The offer is built around a package of agri-inputs, extension, credit, and produce marketing services. HKB operate a chain of more than 300 rural retail stores across eight states following the model depicted in Figure 6. Rural stores cater to 15,000 or more farmers each. HKB have evolved over the years into a 'rural super bazaar' which as well as agricultural inputs also provides fuel, credit, insurance and mobile phones, all under one roof. Factors that affect the volume of business include the quality of the monsoon, as seen in 2009, when business slowed down as rainfall dropped far below average. HKB have since their inception displayed a strong ability to lead and react to opportunities in the market, balancing efforts at consolidation and expansion. Understanding the needs of the farmer and an ability to build trust are among the hallmarks of HKB.

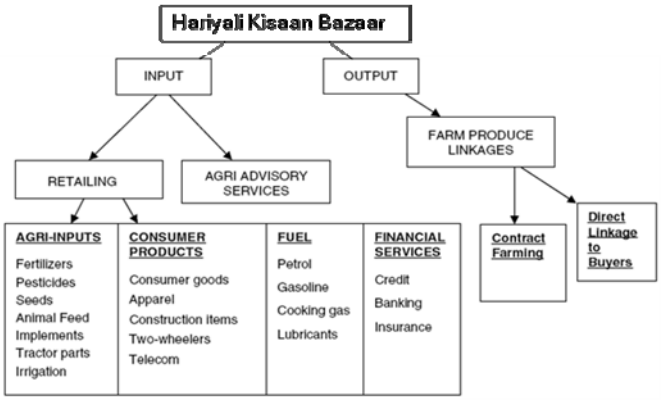


Fig. 6 Hariyali Business Model (Bell et al., 2007)

Other examples of privately driven extension by input suppliers include:

- *Tata Kisan Kendra* (now called *Tata Kisan Sansar*, TKS) by Tata Chemicals Ltd. This is a 'one-stop farmer solution shop' providing operational and advisory support to farmers, initially in the states of Uttar Pradesh, Haryana and Punjab. TKS is a franchise-based 'hub and spokes' model of outlets; extension includes soil testing, remote diagnostics and house brands for seeds, cattle feed, pesticides and sprayers. There are currently 32 hubs catering to 681 Tata Kisan Sansars and covering approximately 2.7 million farmers in some 22,000 villages across 88 districts in different parts of the country.[9]

- *Godrej Agrovet* is a chain of rural outlets, each serving some 20,000 farmers. Godrej Agrovet partners with other companies to extend its product range. Its 'one-stop solutions' model offers agricultural equipment, consumer goods, technical services, soil and water testing, veterinary, financial and post office services, and pharmaceuticals. The Godrej agri-services and retailing business was started in December 2003 in Manchar,

[9] Information taken from http://www.tatakisansansar.com/

Pune District. Since then, over 60 centers have been set up across the country. Godrej has announced its intention to have at least 1,000 stores across India that would offer a broad range of farming and consumer services and goods.[10]

- *Jain Irrigation* builds awareness regarding micro-irrigation at the Jain High-Tech Agriculture Training Institute. Farmers, students, government department officers and NGOs with an interest in agriculture receive training on topics that include watershed management, water resources and irrigation management, fertigation and modern methods of crop cultivation. Jain Irrigation also has a team of experts in agronomy and engineering who mentor client farmers.[11]

Input and technology providers seem to have converged on the one-stop solutions model (or business hubs) for rural communities illustrated by examples such as MKV, TKS, Hariyali and Godrej Agrovet. As shown below, versions of the model are also being applied by aggregators and processors offering extension services. Glendenning et al. (2010) note that 'the impact of these approaches on smallholder farmers has not been evaluated, but these services could possibly provide better-quality inputs and technical services than those offered by the local input suppliers upon which most farmers currently rely'. The private efforts 'provide products for purchase and offer information to farmers on the products they sell, along with agronomic advice'. This would clearly appear to be relevant and helpful for farmers, even if the impact in terms of farm-level and aggregate outcomes remains largely unassessed.

Extension by aggregators and processors

The main setting in which aggregators and processors of products impart extension advice is contract farming, the role of which is growing in Indian agriculture. Gulati et al. (2008) make the point that while 'front end' activities in the agricultural and food system (such as wholesaling, processing, logistics and retailing) are rapidly expanding and consolidating, the 'back end' activities of primary production have been continuously fragmenting. Contract farming, the authors note, holds the potential to link both ends and create viable business opportunities for farmers and agribusinesses alike.

Contract farming is sometimes faulted for being an exclusive arrangement bypassing farmers not in the contract. However, public or NGO-sponsored support systems are also 'exclusive' to the extent that they do not reach all interested farmers. Contract farming is not without risk, for example, when parties fail to honor the contract, side selling occurs, prices paid to farmers are low and quantities purchased below expectations. But contract farming does offer significant potential to improve production and farmers' lives through more predictable links with the market.

The literature on contract farming is large, and varies in its opinions. A study by IFPRI on contract farming for poultry production in Andhra Pradesh is representative of the supportive view, finding that '… contract production is more efficient than non-contract production. The efficiency surplus is largely appropriated by the processor. Despite this, contract growers still gain appreciably from contracting in terms of lower risk and higher expected returns. Improved technology and production practices, as well as the way in which the processor selects growers, make these outcomes possible. In terms of observed and unobserved characteristics, contract growers have relatively poor prospects as independent growers. With contract production, these growers achieve incomes comparable to that of independent growers' (Ramaswami et al., 2006).

[10] See http://www.afaqs.com/news/company_briefs/index.html?id=8986_Godrej+Aadhaar+launches+agri-services+cum+rural+retail+stores+in+Gujarat.
[11] See FICCI, Corporate Interventions in Indian Agriculture, New Delhi, October 2010.

Among those who have studied contract farming for organic crop production, Gahukar (2007) identifies a need for it not only because of the advantage of organized sales, but also as a vehicle to train farmers in the guidelines and protocols they need to follow. The author calls for stepped-up efforts to convince farmers about the economic benefits of the approach, but cautions that to have a future, contract farming must be profitable for all parties.

In a Punjab study, Singh identifies different models (among them corporate-led, state-led, consortium-led and franchise), finds merit in contract farming, and stresses the need for extension related to both production and marketing of crops (Singh, 2005). On the matter of agreements, the author states that it is often not the contract *per se* which makes or breaks episodes of contract farming, but how the arrangement is practiced in a given context. Monitoring mechanisms are needed, as is a voice for all parties.

Some examples of contract farming and 'value chain integration' by companies include:

- Contract farming in wheat is practiced in Madhya Pradesh by Hindustan Lever Ltd. (HLL), Rallis and ICICI (MANAGE, 2003). Under the system, Rallis supplies agri-inputs and know-how, ICICI provides credit to farmers, and HLL (the processing company) offers a buyback arrangement for wheat. Farmers benefit by having an assured market and floor price for their wheat, in addition to a timely supply of quality inputs and technical advice at no extra charge. HLL enjoys a more efficient supply chain, while both Rallis and ICICI benefit in the form of an assured clientele for their products and services.

- PepsiCo practices contract farming in tomato, Basmati rice, chilies and groundnuts in Punjab, and potato in a number of states including Punjab. In West Bengal, where PepsiCo has initiated a small project in coordination with the Syngenta Foundation for Sustainable Agriculture in Bankura, a modified version called *contact farming* is being pursued – a model that is also catching on in other states. PepsiCo ensures technology transfer through trained extension personnel, and supplies agricultural implements free of charge and quality farm inputs on credit. In return, it obtains agreed quantities of quality produce from farmers at a pre-defined price. An 'aggregator' or intermediary hired by PepsiCo organizes the participating small farmers and consolidates their output in bulk batches. Contracted farmers also have the opportunity to manage risk associated with growing potatoes with a weather index based insurance product that is sold through ICICI Lombard and managed by Weather Risk Management Services.

- Adani Agrifresh produces apples in Himachal Pradesh for the New Delhi market, sourcing its entire requirement from about 4000 farmers at the present time. The extension training focuses essentially on post-harvest practices, because apples must be in the cold chain within 24 hours of harvest. Assured prices, said to be generally 5 percent above the market, are announced on a weekly basis for different grades of apples (FICCI, 2010).

- FieldFresh Foods Private Ltd. practices contract farming with over 3,500 smallholders in Maharashtra and Punjab, where it provides guarantees to purchase produce grown within a specified quality range. The prices to be paid for given quality specifications are announced in advance. Baby corn is a key product collected for export and domestic sales. The company offers (and monitors compliance with) detailed production protocols, and sensitizes farmers to adequate input use and minimum residue limits. Lead farmers are designated as mentors and to manage demonstration plots, recruit farmers, and provide advisory services and post-harvest and logistics support (FICCI, 2010). A 2010 case study by the Yale School of

Management describes FieldFresh's difficulties as it tested different sourcing models, finally choosing contract farming as the best approach.[12]

The above shows that private initiatives span a variety of regions and crops and are being implemented by both large and medium-size organizations (FICCI, 2010). A large number of such private initiatives are at work. Annex II offers a sample inventory of extension led by input suppliers and private companies that engage in contract farming in India. The message that emerges is, again, that this is an active area that deserves to be studied both for the methods of extension and their impact on productivity and incomes by farm type and size. The report by FICCI notes that companies face significant challenges on account of the smallness of farm holdings and the vagaries of nature that plague production. But the benefits of the projects for farmers are frequently deemed to be notable, too. They include productivity gains, price advantages and learning effects such as how to comply with (international) standards and norms.

Extension through mixed partnerships

While contract farming 'carries the essence of the farm-firm linkage' (Gulati, 2010), the incentives for it to arise and be practiced in ways that are attractive for all parties do not come about naturally, but need to be built. This is particularly true for contract farming with smaller, resource-poor growers. Mixed partnerships including one or more non-profit actors may be necessary to bring contract farming to this group. The non-profits might organize farmers in groups and initially provide extension services for free, nurturing the process and helping to build trust with the farmers (that their product will be sold) and the buyer (that there will be agreed qualities and quantities of product to be bought).

An example of a mixed partnership in agricultural extension is the arrangement (dating back to 2001) between the Dhanuka Group (an agrochemicals company) and the government of Madhya Pradesh, with MANAGE, the National Institute of Agricultural Extension Management as an advisor. Under this partnership, the aim was to work together in one district (Hoshangabad) on a wide range of topics. These included soil testing, training of farmers in soil fertility issues and fertilization, seed treatment and the sourcing of quality seed, diagnosis of pests and diseases, safe and effective use of crop protection products, organizing farmers into groups, conducting group meetings and demonstrations of various kinds, and researching markets to identify potential wholesalers, processors and retailers where direct sales would be possible, bypassing middlemen. Extension in the district was to a large extent privatized under the partnership. Agricultural production responded well, to the point where the National Productivity Council honored the district with its best productivity award in 2004 (Singh, 2007).

Mixed partnerships of this kind (public-private and/or for-profit/non-profit) abound, but rarely appear in the literature. Basix, the 'livelihood promotion institution' established in 1996, links extension services paid for by farmers with microfinance products offered by its own for-profit financial arm. Poultry Coop is a for-profit venture that pays for live birds procured from small farmers after deducting the cost of feed and services, including advisory services. It continues to be supported by its founder, the NGO PRADAN on which we will have more to say below. The Agriclinics and Agribusiness Centers (ACABC) provide agricultural advisory services to farmers through agricultural graduates known as 'agripreneurs'. While returning mixed reviews on different aspects of the scheme, studies indicate that the agripreneurs can be a solution with greater ability to meet farmers' needs than the public extension system (Glendenning et al., 2010).

[12] Yale School of Management, FieldFresh Foods, Yale Case 10-036, December 2010.

Perspective on extension by commercial providers and mixed partnerships

An important question that arises in the context of extension advice from agrodealers and input suppliers relates to the quality of the information they provide. Input companies are often said to be promoting their brand whereas agrodealers are thought to push sales with an eye on their margins whether this is in the interest of farmers or not. It would be good if this were tested neutrally with the right study design, sampling and survey-based tools. There is a more favorable hypothesis that would then also be assessed, i.e. that private solutions are responsive to farmers' needs by their nature. Input dealers have an incentive to offer good services and advice, because that is what their reputation and business depend on. Seed and technology providers have sales forces that pay repeat visits to farmers to cultivate business. They understand that honest advice linked to the products they sell creates a competitive edge. Buyers of products provide advisory services to farmers as part of their procurement drive. And since it is crucial that extension and R&D are closely linked in both directions, commercial extension is likely to be an effective means to deliver private sector R&D results that meet farmers' needs.

Extension by commercial actors may not reach resource-poor marginal farmers, to be sure, but neither does public extension in large measure, as we saw above. Partnerships with non-profit entities can create conditions where smaller and poorer farmers are reached. The Poultry Coop - PRADAN example is a case in point. This is a frontier with much untapped potential. It can be pursued in the context of government efforts under ATMA, where the need for public-private partnerships is recognized, or independently of it. But lining up incentives and clarifying accountabilities and roles in partnerships are hard work. NGOs and more generally, non-profits, the subject to which we turn next, can play a catalytic role.

Extension by NGOs

NGOs are very important sources of support for small farmers in India. As with government organizations, however, their numbers are insufficient as service providers in community-based extension to cover all those seeking advice. NGOs range considerably in size, from small, local entities to large organizations with multi-state reach. Their level of professionalism and knowledge of agriculture vary, but their social commitment is typically high. Many dedicate themselves to forming self-help groups or farmer-based organizations that may become focal points for demand-driven agricultural extension. The self-help groups and farmer-based organizations, and the NGOs that help bring them to life, are often supported by outside sponsors and donors. The box below explains how one such external entity, the Syngenta Foundation for Sustainable Agriculture, partners with small, local NGOs to deliver extension services for productivity growth and improved links to markets. In the projects in question, the NGOs' presence preceded that of the Foundation. Progress in community organization and social programs was already notable by the time they teamed up with the Foundation to address agriculture.

NGOs such as Basix, PRADAN and BAIF are at the larger end of the scale in India, and are perhaps better referred to as social entrepreneurs. They operate in numerous states (Figure 7), have been active for many years, and work according to established approaches and methods. Basix (the microfinance institution referred to above) works with more than 3.5 million customers, of whom over 90 percent are rural poor households and about 10 percent are urban slum dwellers. Basix operates in 17 states, 223 districts and over 39,000 villages. It has a staff of more than 10,000; 80 percent of the employees work in small towns and villages.[13]

Basix intermediates extension services for farmers across eight crops (cotton, groundnut, soybean, pulses, paddy, chili, mushroom and vegetables) as well as dairy operations and

[13] Taken from http://www.basixindia.com/.

rearing of goats and sheep. The purpose is to improve farming and find market outlets and value-adding activities together with the farmers, who pay for the services. The agricultural, livestock, and enterprise development services are made available by 1,000 livelihood service providers, who work like extension agents for 200-400 customers each (Glendenning et al., 2010). According to Basix, its services reach around 800,000 farmers and involve productivity enhancement, risk mitigation, local value addition and alternative market linkages for synthetic inputs, bio-inputs and outputs.

Extension with Multiple Partners: The Syngenta Foundation in India

In 2004, the Syngenta Foundation for Sustainable Agriculture (SFSA) together with Syngenta India Limited (SIL) initiated work in India to address problems facing smallholder farmers. Since neither had prior experience in extension *per se*, they started small to improve their understanding of the subject. A pilot project began in Chandrapur in central India, in partnership with Maharogi Sewa Samiti (MSS), the Leprosy Service Society founded by the social visionary Baba Amte. Farming experiments in the MSS community demonstrated very quickly the possibility of significant increases in crop productivity from improved agronomic practices. The trials also indicated the cash-generating potential of vegetables in just one year. The Somnath campus of MSS was only growing rice when the project started. Rice production was intensified, but soon truckloads of vegetables also went to Chandrapur market. It was then that the SFSA-SIL team felt confident about reaching out to farmers on a larger scale. A fully-fledged agricultural extension program emerged, which now operates in some 14 locations across four states.

Thus, for example, in early 2006 three projects started in disadvantaged areas of Bankura, Kalahandi and Jawhar. Each project runs in partnership with a local NGO that had been working with rural people, but not in agriculture. The first task was to reorient their approach to include farming. In each project a small extension team was put in place, led by a qualified agriculturalist and assisted by field workers consisting of local youth. Then the process of capacity-building of the targeted farmers as well as the extension teams began. Advanced crop technologies were passed on through farmers' workshops, trials in farmers' fields, and demonstrations. When it was realized that knowledge alone would not suffice, steps were taken to make available the recommended inputs and tools (paid for by farmers). Seed multiplication by farmers was introduced to improve availability and bring down prices. Encouraging results began to emerge. By following improved methods, including SRI, the 'System of Rice Intensification', farmers achieved significant yield gains. Vegetable cultivation turned out to be a remunerative option for many of them. A striking feat was achieved by a Bankura tribal couple who earned a net income of INR 10,000 (approx. US$ 200) by growing tomato on just 337m^2 in 2008. Good seed and the right choice of variety, coupled with agronomic support, made the difference.

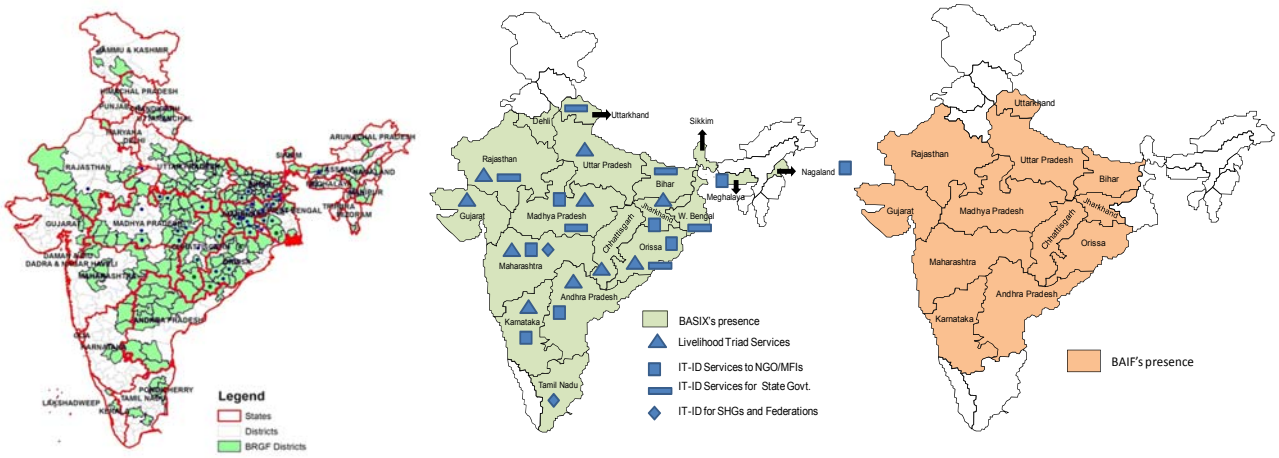
As SFSA decided to scale up activities and reach thousands of smallholders, it took feedback from farmers and a commissioned external evaluation into account. Intervention steps were broadened, for example, to include watershed management and rainwater harvesting, working with self-help groups in clusters of villages, holding farmers' fairs, and building learning communities. Intense discussion with partner NGOs about crop technology, agronomy, work methods, and principles of learning with and from farmers became a hallmark of the approach.

The program has come a long way since it began with a few hundred farmers in 2004. The outreach now covers about 45,000 farmers, not including those who have graduated from the program. About a third of the smallholders reached have become successful vegetable growers. The projects are also helping farmers tap into government schemes. Linking groups of them to markets is an explicit objective that needs to receive more attention in future. Activities to help make projects self-sustainable are being strengthened. For example, farmers' groups are pursuing additional income-generating enterprises such as the production of hybrid seed for sale.

The NGO PRADAN (Professional Assistance for Development Action) is a leader in the promotion of self-help groups in India. In crop and livestock development, the organization focuses on productivity enhancement, diversification and links to markets as core strategies. PRADAN was established in 1983 in the belief that the way to conquer poverty is by enhancing poor people's livelihood capabilities and giving them access to sustainable

income-earning opportunities.[14] Specific areas of engagement include increasing the productivity of the main cereal crops to improve food security, and diversification into cash crops such as pulses, oil seeds and vegetables. Horticulture is becoming increasingly important in the livelihood programs of PRADAN. All projects share the goal of enhancing the management of natural resources, and hence greater environmental sustainability, particularly in hilly regions.

PRADAN works like Basix with many local partners. It has, for example, an association with the government of Madhya Pradesh in rural development, women and child development, forestry, sericulture and agriculture, with a focus on land and water development and agricultural productivity. For the latter purpose, PRADAN works through the Rashtriya Krishi Vikas Yojana scheme and at times in association with ATMA. The association with Madhya Pradesh is of note in light of the state's public-private partnership with for-profit Dhanuka, referred to above. Partnerships can take many forms, but the general purpose is always the same – to pool assets and capabilities for given purposes, in this case the delivery of agricultural extension and the creation or provision of links to markets in ways that bring value to farmers.



PRADAN Basix BAIF

Fig. 7 Operational areas of PRADAN, Basix and BAIF (Source: websites)
Note: IT = information technology, ID = institutional development

According to its 2007-08 Annual Report (the most recent one available on the internet), PRADAN's 41 field teams worked with 142,000 families during the year (up from 113,000 the year before) in more than 3,400 villages. Like Basix, PRADAN receives funding from a number of sources. They include the Indian government, Indian philanthropic and corporate bodies, as well as international donors and philanthropic organizations.

The BAIF Development Research Foundation (also Bharatia Agro-Industries Foundation) is another large NGO working in agriculture and livestock development, in addition to other sectors, and operating in 12 states. BAIF's areas of work also include water resources development, sericulture, agroforestry, post-harvest product management and marketing, cattle feed and forage production, microcredit, and applied research (for example in cattle reproduction). As in the case of PRADAN, the fostering of rural self-help groups is important.[15] BAIF was established in 1967, has more than 3,000 employees, including a strong contingent of scientists, and today operates from some 750 BAIF centers across India.

[14] Taken from http://www.pradan.net/.
[15] See http://www.baif.org.in/aspx_pages/index.asp.

BAIF works through associate organizations and is said to reach out to 2.5 million farmers in more than 45,000 villages, many in tribal, mountainous and dry-land areas. BAIF is recognized by the government of India through numerous sector ministries which have recommended that states learn from the BAIF experience and develop programs in association with this NGO.[16]

One of BAIF's activities is the 'wadi' program to establish orchards, supported by soil and water conservation work on degraded land in tribal communities. This program currently covers over 5,000 villages, benefitting more than 150,000 families in six states. BAIF facilitated the formation of farmers' cooperatives and federations of self-help groups. 37 of these organizations now form the national Vasundhara Agri-horti Producers Company Ltd. (VAPCOL). VAPCOL supports its members in the development of products, processing and the supply chain. 2008-09 sales were worth some US$ 17 million. The wadi program is being replicated with technical assistance from BAIF under a special Tribal Development Fund established by the National Bank for Agriculture and Rural Development, NABARD.[17]

Interventions of this kind are clearly relevant as vehicles to bring 'extension' to resource-poor, marginal farmers. Our observations in the field suggest that Basix, PRADAN, and BAIF, and others like them, large and small, are spear-heading needs- and demand-driven extension, going for what works based on systematic assessments of opportunities and constraints, organizing women's groups and farmers, and fostering innovation in participatory ways, with an eye on the market for activities reared in the primary sector and value addition. It is an approach that would seem to ensure that farmers' information needs are met, to paraphrase the title of the paper by Glendenning et al. (2010) that we cited on occasion above. Of course, the literature formally assessing the performance of community-based extension is thin. Problems of 'elite capture' and deficits in the performance of service providers may exist. But the observed approach and dedication of many NGOs is notable and the number of farmers reached is large, as the figures referred to suggest. The number of farmers in need is of course much larger still, illustrating the problem of limited availability of competent service providers noted in section 2 and discussed by Feder et al. (2010). Consequently, much more is needed along the lines of the activities of contributors such as Basix, PRADAN and BAIF. It is hoped that the public sector, the donor community and domestic and international philanthropists with the means to support providers such as these take note and consider offering their support.

5. Mobile Applications in Agriculture

Mobile applications have the potential to revolutionize the linkages and transactions between farmers and service providers of many kinds. They can be a resource for agricultural extension, but are not yet widely discussed even in the more recent literature on extension that is cited in this paper. This section attempts to fill this gap by exploring the current and potential role of mobile applications in both extension and the task of bringing farm produce to the market. We chart the evolving 'ecosystem' of mobile communications in agriculture and assess the experience in India so far. We focus on the scope and risks, recognizing that any overview of this highly dynamic field is quickly out of date.

Mobile applications in agriculture (sometimes referred to as 'mAgriculture') are about the delivery of agriculture-related information and services via mobile communications technology, in particular mobile phones, smartphones, PDAs or tablet devices such as the iPad. 'mAgriculture' is thus different from, or a special subset of, 'eAgriculture'. This broader field involves the delivery of agriculture-related services using information and communication technologies that require access to personal computers and the internet. It

[16] Based on http://sapplpp.org/links/baif.
[17] Source: http://dev.ikf.in/baif/our_programmes_land_based_livelihood.asp.

may also involve wireless devices as well as techniques such as remote sensing and geospatial information systems that capture and present data linked to locations.[18]

For 'mAgriculture' to materialize, farmers must have access to cell phones. Mobile applications bypass those without cell phones, except where community level solutions are available. Mobile phone access constitutes a lower hurdle than the prerequisites for 'eAgriculture', namely owning or having access to an internet-connected personal computer, predictable supplies of electricity, and knowing what to do with the computer. Teleconnectivity is growing rapidly[19] and, assuming continued fast expansion in rural areas, could empower large numbers of farmers by providing access to information on farming and supply chains.

Nevertheless, in the short run, 'mAgriculture' remains constrained on both the demand and the supply side. Demand-side factors include deficits in connectivity, illiteracy (a problem in text-based communication such as SMS, not voice-based interaction), low average levels of education, and poverty. Supply-side limitations are related to product timeliness and relevance, marketing and pricing, and the suppliers' business models, as discussed below. Products must be helpful to the farmer and available in the right language. The scope and need for innovation in the realm of content remain huge.

The benefits of 'mAgriculture' extend potentially to all aspects of extension, service delivery and linking farmers to specific markets. The benefits include access to information at lower cost, reduced asymmetry of information, increased transactional efficiency, improved agribusiness process management, and higher producer productivity and incomes.

The importance of lowering the cost of information is difficult to overstate: knowledge and information deficits are key constraints in agriculture. Research in Sri Lanka found that the cost of information from planting decision to product sale in wholesale markets can be as high as 11 percent of the overall cost of production (de Silva and Ratnadiwakara, 2008). Much of the discussion of mobile technologies in agriculture is optimistic for this reason, even though it acknowledges accessibility as a challenge in harnessing the full potential (Bhavnani et al., 2008). Some of the literature takes issue with the assumption that technology is an autonomous force for good, arguing that it can reinforce existing dependencies and forms of control (Leye, 2009). A third strand occupies the pragmatic middle ground, viewing technology not as an end in itself, but as an enabler of positive developmental outcomes in the context of the right policies and mentoring (Fourati, 2009). We share this latter view. Meaningful products, the right delivery arrangements and client mentoring make all the difference.

Mobile applications can serve a wide variety of needs. These include extension in the narrow sense of advice on farm production, transactions in markets for inputs and farm outputs, the sale and administration of financial and other services, and the collection of data for research. Figure 8 identifies business processes that offer opportunities for mobile applications along the value chain. We focus below on 'extension proper' and market transactions for inputs, services and outputs.

The complexity of mobile applications depends on their particular goal (Figures 9 and 10). Low-complexity applications enable the one-way provision (by voice or text message) of information such as weather forecasts or price data that are generated automatically or stored in data bases. Medium-complexity applications, in turn, involve services for decision

[18] The Agropedia system of digital content organization is an example of 'eAgriculture' (www.agropedia.iitk.ac.in). Agropedia was launched in Jan. 2009 as a one-stop shop for information on Indian agriculture. A 'knowledge organizing platform … to leverage the existing agricultural extension system', Agropedia offers, *inter alia*, knowledge modules of chickpea, sorghum, pigeon pea and groundnuts developed by ICRISAT. Other partners include SAUs, ICAR, some NGOs, some KVKs, NRSA, TATA Chemicals, FAO, technology partners, and others.

[19] By Jan. 2011, India's total wireless subscriber base was 771.18 million, of which 33.6 percent was rural (TRAI, 2011).

support that work with location-specific information. Providers can, for example, use these to develop soil fertility-related recommendations or crop-specific disease warnings based on local climate data. Information in these applications still basically flows one-way, but is focused on specific clients.

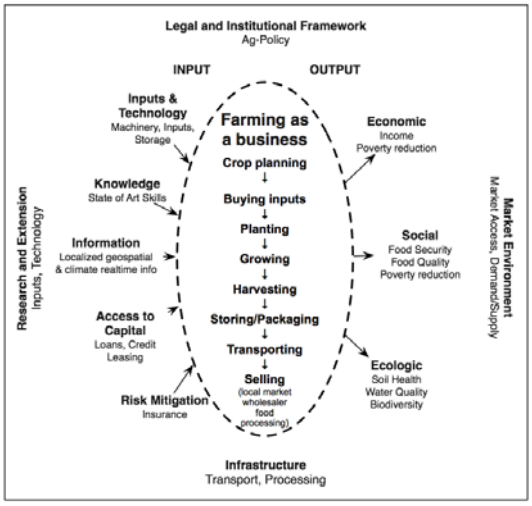


Fig. 8 Farming activities from a business perspective
Source: Brugger, Syngenta Foundation

Systems of high complexity involve information flows in more than one direction. They are transactional, permitting the administration of user-generated information, customized feedback and advice, remote diagnostics, and the management of individual accounts for farmers by service providers, input dealers, product aggregators and traders. Mobile banking, the transfer of money by cell phone, and crop insurance that runs on a mobile platform as in Kenya [20] are examples of complex mobile solutions already available, albeit in some instances still on an experimental basis. Below are some examples of different application complexity levels covering extension, market links and services. Table 5 lists the cases discussed and provides web addresses and qualifiers that characterize the ventures and their business model, many of which are at the pilot stage.[21]

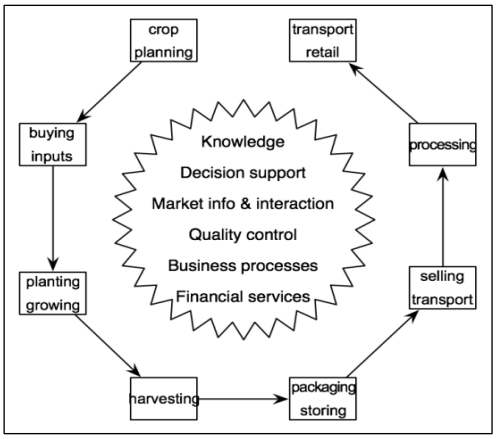


Fig. 9 Business processes offering opportunities for mobile applications
Source: Brugger, Syngenta Foundation

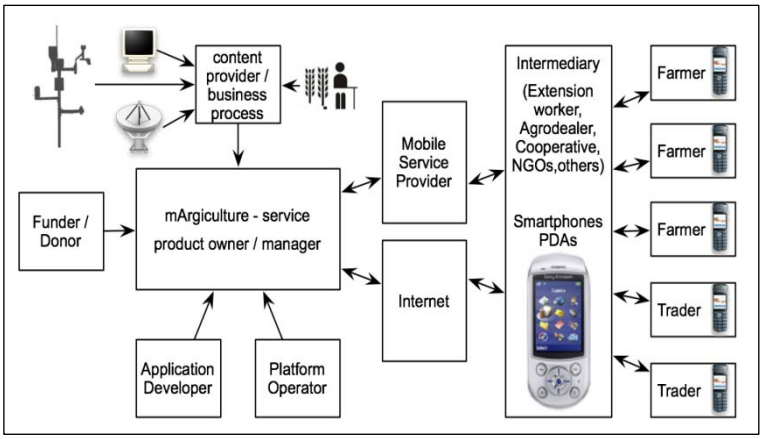


Fig. 10 Complex applications
Source: Brugger, Syngenta Foundation

[20] See www.kilimosalama.org.
[21] The description of the cases in the discussion below is based on information gleaned from these web addresses.

Mobile applications in extension

Extension calls for applications that disseminate knowledge to address skills gaps in agriculture and promote learning. Such applications are on a continuum from 'mLearning' to 'mFarming', where 'm' refers to mobile communications. Under 'mLearning', knowledge of farming and agricultural techniques is disseminated to subscribers with the possibility for interaction and group learning among farmers. Digital Green, for example, can be said to facilitate 'mLearning' with its videos 'of farmers, by farmers, and for farmers' and its hundreds of mediated screenings in villages and rural settings (see below). 'mFarming', on the other hand, is about services and individual decision support with the help of local, contextually relevant information. mKrishi and e-Sagu (see below) are applications more in the space of 'mFarming'.

Table 5 Sample of India's mobile applications in agriculture (2011)

Extension	**Business model**	**Medium**	**Complexity**	**Info flow**		**Business model**	**Medium**	**Complexity**	**Info flow**
• aAqua (www.aaqua.org)	Non-profit	Internet /text	Low	Interactive	• Kisan Call Center (KCC) (www.manage.gov.in/kisan/default.htm)	Govern-ment	Voice	Low	Interactive (call ctr)
• Avaaj Otalo (www.hci.stanford.edu/research/voice4all)	Non-profit	Voice	Medium	Interactive	• mKrishi (www.tcs.com)	Commer-cial		High	Interactive
					• eSagu (www.esagu.in)	Non-profit		High	Interactive
• Digital Green (www.digitalgreen.org)	Non-profit	Video	Medium	One-way	• Nano Ganesh (www.nanoganesh.com)	Commer-cial		Low	One-way
• Nokia Life Tools (NLT) (www.nokia.com)	Commer-cial	Text	Low	One-way	Market facilitation • Reuters Market Light (RML) (www.thomsonreuters.com)	Commer-cial	Text	Low	One-way
• IFFCO Kisan Sanchar Ltd (IKSL) (www.iksl.In)	Commer-cial		Medium	One-way + helpline	• e-Choupal (www.echoupal.com)	Commer-cial		Low	One-way

Source: Authors. Entries in this table are a sample of mobile applications only.
Websites were functional at the time of writing.

- ***aAqua*** ('Almost All Questions Answered') is an internet based discussion portal initiated in 2003 by the Developmental Informatics Lab of the Indian Institute of Technology in kiosks and cybercafés in Pune. aAqua is more an example of 'eAgriculture' than 'mAgriculture', except that it offers access to its platform via SMS as an additional service. It is an open forum where users have created more than 90 percent of the content themselves, uploading text, photographs, and videos to the site. A farmer can ask a question on aAqua from a kiosk or cybercafé; other farmers or experts view the question and reply (in English, Hindi or Marathi). Different discussion groups cover aspects of crop cultivation, animal husbandry and dairy, market prices and other topics. There is rapid retrieval of documents and images using keyword-based searches assisted by query expansion and indexing techniques. aAqua, a non-profit venture, operates on the basis of freely accessible software and only a small initial investment. It can be replicated quite easily, but has not gone to scale: the number of registered users was about 17,000 by early 2011. Poor Internet connectivity in villages and illiteracy appear to be among the conditions working against scale-up.

- ***Avaaj Otalo*** is a voice-based system for farmers to access and discuss relevant and timely agricultural information by phone. The system was designed in 2008 as a partnership between the IBM India Research Laboratory and the Development Support Center (DSC), an NGO in Gujarat supported by different donors. Avaaj Otalo is an important and promising experiment in voice information services for small farmers. A

must-read description by Patel et al., 2010, arrives at optimistic conclusions on the suitability of voice as a medium for online communities in the rural developing world.

By dialing a phone number and navigating through simple audio prompts, farmers can record and respond to questions, and they can access content assembled by experts. In addition to the question-and-answer forum, Avaaj Otalo offers both an announcements board of regularly updated topics and access to past programs of DSC's popular weekly radio show where listeners can call in to discuss their experiences related to the advice heard on the air. Farmers, Avaaj Otalo learned, are extremely interested in listening to other farmers' questions and the corresponding discussion in interactive fora. Avaaj Otalo was initiated as a pilot with 63 farmers in Gujarat in 2009 and received 3,500 responses in the first month. The application was launched across the state in 2010 with a publicly accessible number. The number is toll-free at the time of submitting this paper (airtime cost being borne by DSC). This raises issues of financial sustainability that are discussed by Patel and co-authors, along with possible solutions.

- ***Digital Green*** is a non-profit organization with funding from the Bill and Melinda Gates Foundation and the Deshpande Foundation. It disseminates agricultural information to small and marginal farmers through digital video (see Ghandi et al., 2009). The approach offers significant potential to improve the effectiveness and reach of extension programs by delivering targeted content that is scalable to large numbers of farmers. The application is 'mobile' in the sense that the product is portable, but it is not a cell phone driven solution. Some 1,200 videos on agricultural techniques have been produced since operations started in 2008. Farmer groups and extension providers can access the library and use films sequentially to build farming capacity over time and as a learning resource in community interactive settings. An innovative IT solution supports up to 100,000 concurrent users anywhere in the world, enabling offline operation in low and limited bandwidth locations. (Internet connectivity is needed to synchronize user data with the global repository.) Statistics on the number of screenings and farmers involved, and case-by-case stories of impact, are updated frequently on Digital Green's website. More comprehensive evaluative assessments are not available as of today. The number of farmers involved has increased rapidly, reaching 42,000 in early 2011. But maximizing impact will depend to a large extent on the nature and effectiveness of Digital Green's partnerships with extension providers, be they NGOs, governmental agencies or the private sector. In the non-profit domain, Digital Green is partnering with large, well-established organizations such as BAIF and PRADAN. It will be interesting to see how video as a medium is incorporated into, and is allowed to shape, the methods of extension of these and other organizations.

- ***Nokia Life Tools (NLT)*** was launched in India in 2008 and in Indonesia and China in 2009 as a commercial application aiming to supply a range of agriculturally relevant resources on low-cost Nokia phones. Information is pushed to subscribers via daily text messages in up to 10 languages in two categories of service: 'basic' available across India for Rs 30/month, and 'premium' available in 10 states for Rs 60/month. The agriculture segment of NLT covers commodity prices in a large number of mandis for crops chosen by the subscriber, data on seed and other input prices in locally relevant markets, weather forecasts by postal code, and agricultural and animal husbandry tips and techniques. Data on the number of subscribers could not be verified for this paper. The application, which works as long as there is GSM coverage, is very promising, but depends on successful solutions to the problem of collecting accurate data with sufficient 'granularity' to be helpful to users. NLT is partnering with private and public institutions in the quest for user-relevant information. Partners have included Reuters Market Light and e-Choupal (see below), some NGOs, input suppliers, microfinance institutions, and some state marketing boards. Impact assessments are not available at this time.

- ***IFFCO Kisan Sanchar Limited (IKSL)*** emerged as a partnership between mobile operator Bharti Airtel and IFFCO (the Indian Farmers Fertilizer Cooperative Ltd) in 2007. The remit of IKSL is to improve farmers' decision-making capability by providing information on market prices, farming and animal husbandry techniques, fertilizer, weather forecasts, and rural health initiatives. Five free voice messages in local languages and customized for different jurisdictions are sent to subscribers every day, except Sunday. A 24-hour farmer helpline completes the service. IKSL markets this as part of a special mobile package on Airtel's network with an IFFCO Kisan branded SIM card for which farmers pay a one-time activation fee. The voice mail service is free, but helpline queries are charged at the rate of 1 Rs/minute. IKSL targets the millions of farmers that populate IFFCO's 40,000 member societies. On a cumulative basis, close to 3 million SIM cards have reportedly been activated; some 0.7 million farmers were active customers in late 2010. There is potential to go to scale in this partnership, which in its early days received a launch grant from the GSMA Foundation. A market research firm interviewed some 8,000 respondents in 2009 to assess their satisfaction level. The service received good ratings on parameters such as clarity and relevance of messages in comparison with other sources of information. Individual descriptions of impact on crop yield and farmer income are available on IKSL's website, but formal assessments of impact remain to be published. As in the case of NLT and other applications, it is probably still too early for this. The IKSL model is promising, yet also raises questions on many demand and supply-side aspects that determine the size of this market for farmers of different kinds and economic means.[22]

- ***Kisan Call Centers (KCC)*** were launched in 2004 by the Department of Agriculture & Cooperation of the Ministry of Agriculture to deliver extension services to the farming community across the country. The purpose is to respond instantly to issues raised by farmers in 22 local languages in all states. Calls are toll-free and handled in two categories. Level 1 answers most calls. On Level 2, subject matter experts answer the more difficult items within a prescribed number of hours. Figure 11 shows the generic workflow of call centers such as KCC.

  KCC report that farmers' demands for information relate to the suitability of weather conditions to farm operations, fertilizer application and pest management, the sourcing of quality inputs and credit, and crop insurance and market support systems. KCC have good call-related statistics, possess nodal agencies that monitor their activities and conduct agent training, have state level monitoring committees and a knowledge management system for their agents, and conducted an evaluation study in 2006-07. This study found good levels of client satisfaction, but provides no quantitative information on impact.[23] KCC have cumulatively answered more than six million calls so far. According to senior officers in early 2011, KCC plan various forms of expansion, both geographical and social. Future additional customers will include farmers in the North-East, and farm women and illiterates. KCC can be financially viable as long as the Ministry of Agriculture provides support.

- ***mKrishi*** is a personalized, integrated rural services platform launched by Tata Consultancy Services (TCS) in late 2007. The goal is to raise on-farm yield, reduce input cost, provide better market linkages, and foster rural entrepreneurship. The platform is complex. It combines multiple technologies to bring information regarding local weather, fertilizer requirements based on soil conditions, pest control, and current food grain prices in local markets in a rich content format to the farmer's low-end mobile handset. It allows farmers to send queries, images and voice-activated SMS, and it provides customized

[22] Following IKSL's success, two similar ventures between a phone operator and a fertilizer company were recently launched: Reliance Communications and Krishak Bharati; and Bharat Sanchar Nigam Ltd and National Fertilizers Ltd.

[23] See http://www.docstoc.com/docs/36523062/Impact-Evaluation-Study-of-Kisan-Call-Centres.

responses in the relevant language.[24] Customization is in part made possible by automated weather stations and sensors that are deployed in villages and linked to a central server. A Frequently Asked Questions database handles many of the queries. More sophisticated questions are forwarded to experts who work with a system that resembles email and enables them to see photos and other local information. Farmers receive responses within 24 hours (Pande et al., 2009). mKrishi is adaptable to illiterate farmers who can make queries from a cell phone using voice-specific functions. Figure 12 provides an action chart.

mKrishi is a fee-for-service application used by some 5,000 farmers in early 2011. Willingness and ability to pay have emerged as issues, prompting TCS to reduce subscription fees. TCS works with partners and stakeholders, including local entrepreneurs, input companies and NGOs, to commercialize the service. The application's impact on farm productivity and income will be a function of the relevance and affordability of the advice and products and marketing support intermediated through these partnerships.

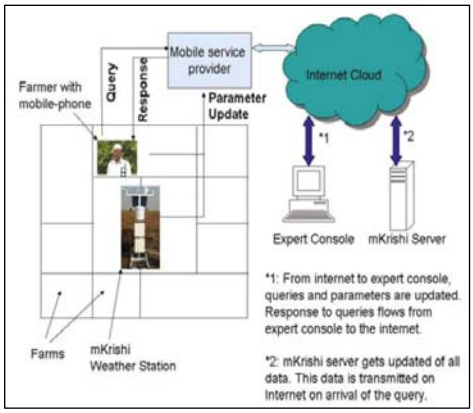


Fig. 11 Call center workflow
Source: Brugger, Syngenta Foundation

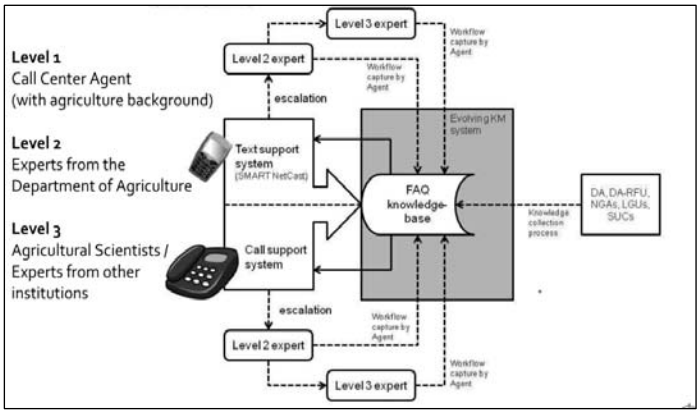


Fig. 12 mKrishi action plan
Source: www.tcs.com.

- ***Nano Ganesh*** is about irrigation control through mobile phones. Mobile operator Tata Teleservices and the agro-automation company Ossian are enabling farmers to activate and monitor irrigation pumps remotely. The system uses a low-end Nokia phone and a mobile modem connected to the pump's electrical starter. While not strictly speaking an 'extension' application, this is an interesting technology that could serve as a platform for additional services. The technology was developed to deal with conditions of erratic power supply. Farmers routinely have to walk or drive several kilometers to water their crops, only to find that *in situ* there is no electricity to power their pumps. Nano Ganesh allows farmers to dial a code from any phone to a mobile modem attached to the pump. This informs them whether electricity is available and allows them to switch the pump on or off remotely. The system should help save time, water, electricity and fuel.

- ***e-Sagu*** was started in 2004 as an initiative of the International Institute of Information Technology (IIIT), Hyderabad, and Media Lab Asia. The purpose is to deliver timely, personalized advice to farmers for a nominal subscription fee. A team of agricultural experts at IIIT and an 'agricultural information system' constitute the 'brain' of e-Sagu. Local centers equipped with a weather station serve as intermediate assembly points and each cover about ten villages. Lead farmers work as coordinators, collecting farm registration and farm management and agronomic data. They visit participating farms weekly to observe and photograph crop status. This information goes to the main center, which prepares farm-specific advice. Transmission to and from the main center is by e-

[24] Quoted from http://www.csr360gpn.org/magazine/feature/mkrishi-connecting-indias-rural-farmers/.

mail from connected local centers or on a compact disc dispatched by courier. Lead farmers deliver the advice to the farmers in their charge who are in this way mentored on a 'query-free' basis at regular intervals from pre-sowing operations to post-harvest management and precautions. The system is efficient in that agricultural scientists can now give advice without visiting crops, which enables them to advise more farmers.

e-Sagu has served several thousand farmers so far. Assessments noted a positive correlation between the adoption of e-Sagu advice and both crop yield and savings due to the more judicious application of fertilizer and crop protection products (Ratnam et al., 2006). e-Sagu reports that its operation can be financially sustainable, but that will depend on the future business model, including e-Sagu's ability to combine forces with a strategic partner. e-Sagu – more an 'eAgriculture' than a 'mAgriculture' application – has missed out on advances in mobile technology in recent years that could enable it to gain efficiency and relevance as a solution in 'mAgriculture'.

Mobile applications for better market access and services

- ***Reuters Market Light (RML)*** is a leading commercial information service for farmers delivered via SMS. The information includes market prices, weather updates, news on agricultural policies, and advice to match each stage in the farming cycle. Farmers can personalize the information with reference to types of crops, region and their local language. RML sells its service through mobile operators, agri-retailers, credit societies and rural banks, input companies, and others with a business or non-profit stake in agriculture. By the end of 2010, RML offered information of around 1,400 different markets, 440 different crops and varieties, and weather forecasts for 2,800 locations. RML has hundreds of thousands of farmer subscribers in 13 states. A 2009 study by the Indian Council for Research on International Economic Relations (ICRIER) indicated that all RML customers interviewed had benefitted to the tune of 5 percent to 25 percent of their annual income.[25] Mittal et al. (2010) found that the price information given by RML is accurate and of good consistency. According to them, this explains the high degree of confidence in RML expressed by farmers in their survey.

- ***e-Choupal***, an 'eAgriculture' application, is reported here because of its importance as a successful platform to create a virtual market and address infrastructural and other bottlenecks. These problems affect the transparency and functioning of many markets in India. e-Choupal was launched in 2000 by the agri-division of ITC Ltd, the Indian Tobacco Company. A network of rural commerce hubs equipped with a computer connected to the internet each serves some 600 farmers in surrounding villages. A local person acting as a *sanchalak* (coordinator) runs the village e-Choupal. Farmers go there to obtain daily updates on crop prices in local mandis, procure seed, fertilizer, and other products including consumer goods, and sell their crops for prices offered by ITC. Through its bulk operation, ITC typically pays more than farmers would receive from traditional traders. Thanks to its system, ITC operates at a cost advantage, controls the quality of what it buys, and obtains direct access to farmers and information about conditions on the ground. ITC reports that it recovers its equipment costs from an e-Choupal in the first year of operation and that the venture as a whole is profitable. In an attempt to leverage its brand, e-Choupal partners with, and opens up rural markets for, third parties in sectors ranging from seed, implements and other inputs to consumer goods, finance, insurance and other services. Charging for access to its platform helps ITC recover spending on infrastructure and operations. Today, e-Choupal's 6,500 village kiosks serve some four million farmers who grow a range of crops in 40,000 villages across ten states. Expansion to 100,000 villages in 15 states is planned.

[25] Quoted from http://en.wikipedia.org/wiki/Reuters_Market_Light#ICRIER_study_in_2009.

Perspective

Mobile phones and 'mAgriculture'/'eAgriculture' can raise productivity and farm incomes when the information is of good quality and timely, and farmers believe they can trust the advisory relationship. This is the conclusion of the empirical study by Mittal et al. (2010) referred to above – the first investigation of the impact of mobile phones on Indian agriculture. The study also states, however, that the full potential of mobile telephony will only be realized with improvements in content, supporting infrastructure, access to financial services and markets, and farmer education. Resource-poor small farmers face greater barriers than larger farmers in deriving benefits from mobile applications because of their more limited ability to use and leverage the information that can be accessed.

Some additional insights documented in the study are as follows (again, see Mittal et al., 2010):

- *Mobiles as an instrument of information dissemination*: Despite continuing connectivity gaps, farmers view mobiles as the instrument of choice to gain access to agriculture-related information. Interviewees felt that, because of its more personalized nature, mobile telephony had the potential to be a more reliable source of information than other available sources.

- *Type of information sought by farmers*: Interview data show that farmers access information on their mobiles in the following order of topics: seed, mandi (output) price, fertilizer application, crop protection, harvesting and marketing, and implements and tools.

- *Impact of mobiles on agriculture and small farmers*: Almost all interviewed farmers reported increases in convenience and cost savings from using their mobiles. But reported usage and benefits varied by states. Farmers in Maharashtra reported far higher use of their phones and mobile-enabled information services than those in Uttar Pradesh and Rajasthan. The authors ascribe differences to variations in infrastructure, financial services, and the mobile-enabled information services available in the three states.

- *Impact of mobiles on traders/brokers*: Mobile phones are a critical resource for traders and brokers. They enable them to shift tonnage across markets in response to price differentials, in the process optimizing their daily earnings but also smoothing out supply. Mobiles also facilitate the numerous services as advisors and intermediaries that traders provide for farmers.

- *Mobiles and market transparency from the farmer's perspective*: Market information accessed by mobile phone influences farmers' selling decisions. Market information improves farmers' ability to negotiate better pricing terms from local traders.

Mobile applications and examples of 'eAgriculture' such as the ones listed and discussed above are important to agriculture and farming in India. But some of the services on offer are more successful and make more impact than others. Why is this so and what is needed to overcome the demand and supply constraints on the dissemination of relevant, mobile-enabled information services for farmers, including small farmers? This is the concluding topic to which we now turn.

The applications listed and discussed above vary considerably in their ownership and business model (government, non-profit, commercial), technical complexity, direction of information flow (one-way versus interactive), the medium employed (voice, text, video), and the type of information pushed (general as opposed to customized). There are also differences in the availability of farmer mentoring to help interpret and clarify the action implications of mobile information. We would assume that mentoring raises the value of the information, particularly for resource-poor smallholders. It may also play a role in building trust.

Mentoring, which is part of some of the mobile offers, can take many forms and vary in intensity. IKSL's helpline compensates to a degree for the limitations inherent in its one-way communications model. However, Mittal and co-authors also found that awareness of customer support options tends to be low, and that farmers therefore do not often contact the information provider with further queries. Avaaj Otalo offers mentoring via interactive voice communications and its radio call-in feature. (Radio remains relevant in the 'mAgriculture' world!) Digital Green's videos provide raw material and vehicles for live group mentoring. E-Choupal's hubs and *sanchalaks* are focal points for mentoring. The more complex mKrishi and e-Sagu applications offer mentoring by definition because of the two-way communications characteristic they share. Much more could be achieved in these cases, though; mKrishi is at work with its business partners to build up the mentoring part of its approach. The need for mentoring is naturally greater where the mobile information is weaker or more ambiguous. Mittal and co-authors identified differences in the subscribers' perception of RML and IKSL in this respect. The RML service was perceived as providing information that was well tailored to subscribers' needs and easy to access, whereas users generally saw IKSL as a bit more 'hit and miss' and sometimes lacking in relevance to farmers' needs. In some sense this is not surprising: agronomic information is more difficult to convey through mobile means than market price data, driving home the need for mentoring and the required technical and organizational arrangements to make it possible in the first place.

Mentoring and the feeling that they are being taken care of are important for clients. However, other factors are important, too. They include richness and clarity of content, accessibility, and value for money in the case of commercial applications. 'Accessibility' comprises aspects over which the suppliers of applications have no control (literacy, initial skills, and educational level of prospective users) and others they can shape (language offerings, accessibility across a range of handsets, timeliness of service, training and support functionality). The cases listed and discussed above cover a range of conditions and approaches in this realm.

From the supplier's point of view, the viability of mobile offerings depends on a range of factors, too, including (i) the business model and how the partners in the venture work together, (ii) cost considerations and how to finance content development and the maintenance of the technical platform, and (iii) revenue generation and the required size and scale. Systems that run like premium services on a subscription basis (e.g., RML) need high volumes to generate enough revenue for the operator. On the other hand, services that are more content focused and offer higher levels of individualization may be difficult to scale up. The providers of these services may have to tap other funding sources in addition to the user fees they can charge. Business and stakeholder partnerships may be the solution here and, for non-profit ventures, philanthropic donors. The exit strategy for donors and eventual cost recovery should be considered from the outset; it is not clear how this is handled in the non-profit ventures identified above.

The next few years will be a fast moving and defining period for mobile applications in agricultural extension and, more generally, the integration of mobile-based information services into processes of development and economic growth. The cases discussed above show a trend towards content-rich location-based information and technological integration. The functionalities on offer from 'mAgriculture' ventures have evolved from market information to weather forecasts and related news and from there to targeting agricultural extension, spreading know-how about crop cultivation techniques and livestock production. Providers such as mKrishi are now tackling the challenge of customizing information. Among other aspects, this takes the form of 'tele-agriculture' where data go for analysis and remote diagnosis, with experts replying to farmers, offering them personalized solutions as in e-Sagu or more automated information and advice as pioneered by mKrishi. In these set-ups, some types of intermediaries – extension agents, really – continue to play important roles. In e-Sagu's case, the agent collects localized information and translates the experts' advice to the

farmer. With mKrishi, the agent would be an entrepreneur who invests in an agriculture-related or service business besides supporting the farmer. Novel and exciting business prospects are emerging, boding well for the future of agricultural extension.

Conclusion and Recommendations

At the outset of this paper, we confirmed the vital role of knowledge and information as co-determinants (with other factors) of productivity in agriculture. One-fourth of the yield gap for maize in South Asia is due to knowledge deficits according to an estimate we cited. Extension is key in this situation and a much debated topic in India today as the country seeks to modernize its farms and achieve the higher and sustained levels of TFP growth that are the hallmark of success in agriculture over time.

In the preceding pages, we discussed encouraging developments and continued shortfalls in extension. The scope for mobile applications to make information available to farmers and communicate with them is vast and chased by innovative actors, a major bright spot in extension. Interactive next generation platforms now emerging are expected to re-define the environment of service provision to farmers and facilitating links to markets. Community-based knowledge and information services for farmers fostered by professional NGOs are another bright spot, where farmers at the lower end of the endowment spectrum are empowered through their organizations and community structures to innovate, diversify and assume greater control over their lives. Extension by commercial providers is growing rapidly, to the point where they are already the main source of agronomic information in the segment of farmers that accesses such information. Input dealers and 'progressive farmers' are the first 'ports of call' for many, far ahead of governmental extension workers and public institutions such as the KVKs on an all-India basis. Questions are sometimes raised about the quality of the information given to farmers by the private sector. Expressions of doubt with respect to quality can be countered with reference to the long-term business interest of private operators, which would seem to demand high quality services and information. This issue should be studied openly and impartially with the aid of appropriate surveys so that the debate can move on from conjecture to objectivity and facts.

Two large and interrelated issues remain unsolved: Coverage of small farmers, and the public sector's role and effectiveness in extension. Small farmers represent an untapped opportunity for food security and agricultural growth. Their productive potential could be multiplied, and sustainably so, with the right kinds of technology, services, mentoring, and access to markets.[26] But this is not happening on the required scale. Data cited in this paper suggest that public providers of extension reach at most 6 percent of farmers operating up to 2 hectares of land. All providers taken together reach some 40 percent of farmers of all sizes, typically with at least somewhat of a bias in favor of larger and relatively better endowed growers. The task is to expand coverage to all farmers that operate under conditions where there is potential for growth in cropping and livestock production. For the NGOs, rising to the challenge requires doing more of what they already do, as described in this paper, with adequate resources in the form of trained and motivated manpower and operating funds. For the private sector, expanding the offer will in good measure depend on infrastructure and the availability and quality of other public goods. For the public sector, the need lies in experimentation, documentation, replication and scaling up of what appears to work, including the instances of success recorded during the pilot phase of ATMA. For all participants, expanding coverage means leveraging each other's skills and contributions through judicious partnerships.

[26] The situation is more complicated for the segment of marginal farmers who are so asset-poor that their prospects for economic advancement may lie more in the labor market than in the intensification of production.

As we write, the entity that's challenged in extension is clearly the government, at all levels. The private sector is taking off in the context of dynamic opportunities in agricultural supply chains shaped by economic growth and the expansion of demand. Its presence will become more and more pervasive, requiring a re-think on the part of the government, which has however barely started. The government's ways in extension have evolved in the context of institutions that emerged from the experience of the Green Revolution and food security considerations that centered on the supply of basic grains for consumption at farm level and public procurement. This mindset is no longer relevant. Agriculture has moved on, subsistence farming is at least aspirationally a memory of the past and high-value products and processed foods are increasingly displacing the staple commodities of old (although the staples still need to be supplied). Rising rural wages (and rising food prices for that matter) are raising farmers' demand for technology and services, and the private sector readily responds. How should the government adjust?

The answer, we suggest, lies in filling the many remaining gaps, in partnership with private for-profit and non-profit actors and with a view to paving the way for eventual agriservice delivery on a commercial basis to currently underserved areas that can be linked to the market.

To get organized for this task, a new look at the reasons for laggardness by crop categories and states might help (see Section 1 above). Funding may emerge as a constraint from this analysis, but other aspects, including in the first place political commitment to agriculture at state and local levels, institutional issues, management, organization and implementation, are likely to show up as more immediately binding and more intractable constraints. Indeed, the problem of implementation is widely recognized and cited as a bottleneck in Indian agriculture and rural development, leading to the subtle question of how skills and motivation – not to mention a sense of mission and renewal – can be injected into the relevant administrative levels where this is needed, such as to produce the desired outcomes in farmers' fields at scale. ATMA appears to have assembled the right conditions for this during its pilot phase, as argued in this paper. Under new Guidelines issued in 2010 it must now combine framing the task from above with the needed resources, guidance and empowerment below. Block-level ATMA organizations have a key role to play. They include farmers' representatives and community and local structures that originate proposals that would in the end go to the district level for approval. But there are questions as to how well this process works. Rendering it functional, representative, transparent and effective is a top priority today.

So the recommendations that can be formulated start with the institutional dimension: ATMA must be made more functional in the settings and states where it is not performing well. To this end, a number of considerations seem in order:

- Agricultural productivity growth varies by state (as well as within states) and major crops. The public sector should focus disproportionately on the lagging states and the lagging areas in states where the private sector has little incentive to be present at this time. A high-resolution map of yields and other productivity-related indicators and explanatory variables would assist in the prioritization of the public sector's focus on underserved areas.

- Given that (as shown in this paper) extension clearly does not work equally well across states, there is a need and justification for a frank comparative assessment of why this is so, starting with political and institutional considerations and including the factors affecting the capacity to implement projects and assignments on the ground. The insights gleaned from this assessment might then be made public in some appropriate way with a view, potentially, to allowing a 'pecking order' of achievers and peer pressure to arise. The insights might also prove helpful in designing

interventions of an experimental kind where the feasibility of specific extension solutions would be tested across states.

- Public-private partnerships should be the thought pattern and 'method of choice' underpinning the government's stance in agricultural extension. Partnerships (enabling the combination of public goods and goals with the innovation and marketing expertise of the private sector) are recommended as transitional arrangements as we shift from current conditions to the delivery of agriservices on a commercial basis supported by enlightened regulation.

- To reach into lower strata of farm capability, the public sector should expand its cooperation and partnership with non-profit NGOs that (as experience and observation in the field demonstrate) can act as effective 'retailers' of extension and support services at the block and village level. Already, there are instances where professional NGOs provide content to the government's extension agenda, sometimes against payment from the government or as conduits for subsidies. This is a positive development that could be expanded systematically, together with the provision of government funds for needs such as soil testing labs, farm machinery, or cold storage facilities that arise in the context of NGOs' work with farmers.

- Other recommendations that arise from this paper include the need to strengthen and adequately fund the SAUs, KVKs and other points of delivery of extension, including the agriclinics and agripreneurs. Furthermore, extension and prioritized agricultural research that addresses what farmers actually need should be functionally linked. Needs-oriented thinking and action on the ground should be rewarded and made part of the culture of agricultural R&D programs and institutions at all jurisdictional levels, but particularly at the district and local level where farming actually occurs.

- The centrality of agronomic support to farmers should be recognized and properly delivered on, with adequate time for mentoring in the field, working through community structures and local personnel trained for the purpose.

- The centrality of markets should be recognized and with this the need to incorporate sourcing of inputs and prospects for product sales into the extension agenda in cooperation with the private sector such as rural business hubs where they exist.

- And finally, priority should be attached to the training of input dealers, given their documented importance as sources of extension advice for farmers. The work of MANAGE in this respect offers a model that could be applied at scale.

The above envelope of measures could go a long way towards raising the effectiveness of public extension as the agricultural sector transforms itself and the challenges of extension and agriservice delivery become more complex. The public sector has roles to play on its own, but (as argued above) needs to operate in partnership with the private sector for purposes of scaling up. This opens up a new frontier where trust needs to be built, thinking aligned, common goals and relative complementarities defined and mutual accountability and obligations agreed. Every partnership is different, and blueprints do not exist. Hence partnerships are unlikely to be easy to craft, but it is difficult to see how the challenges of extension discussed in this paper can be solved without them.

Annex I: China's Extension System

When China started its rural economic reforms and the 'Household Responsibility System' in 1978, it needed to reorganize and strengthen its system of agricultural extension. By the mid-1980s, China had established a comprehensive nationwide extension network, with a five-level hierarchy from national, provincial, city, county to township. The national agro-technical extension and service center (ATEC) is responsible for long-term strategy, with implementation taking place at the other hierarchy levels. The extension system is organized according to agricultural sub-sectors. Most counties have set up extension stations for crop, livestock, aquaculture, agricultural machinery and economic management. Depending on local conditions, more specific crop stations such as cotton or tea may be established as well. By the mid-1990s, the total number of trained extension staff exceeded one million, with more than 90% working at county and township levels.

At the end of the 1980s, the system became overstaffed and inefficient, due in part to the proliferation of specialized stations or extension hubs (Huang et al., 2000). This created a financial burden for local governments. To resolve this, the central government began to implement a series of reforms. So-called 'commercial' reforms to introduce a new funding model began in the early 1990s. Extension workers were classified into three categories: fully-funded agents (government payroll), partially-funded agents (government pays part of base salary) and self-funded agents (base salary comes from commercial activities and grants). Counties had flexibility in implementing these reforms. In most cases, crop stations are categorized as fully-funded agents while input supply stations for example for seeds and pesticides are classified as self-funded agents. Livestock and aquaculture related stations are often classified as partially funded agents. As a result, the funding for extension activities from local, provincial and the central government has been reduced.

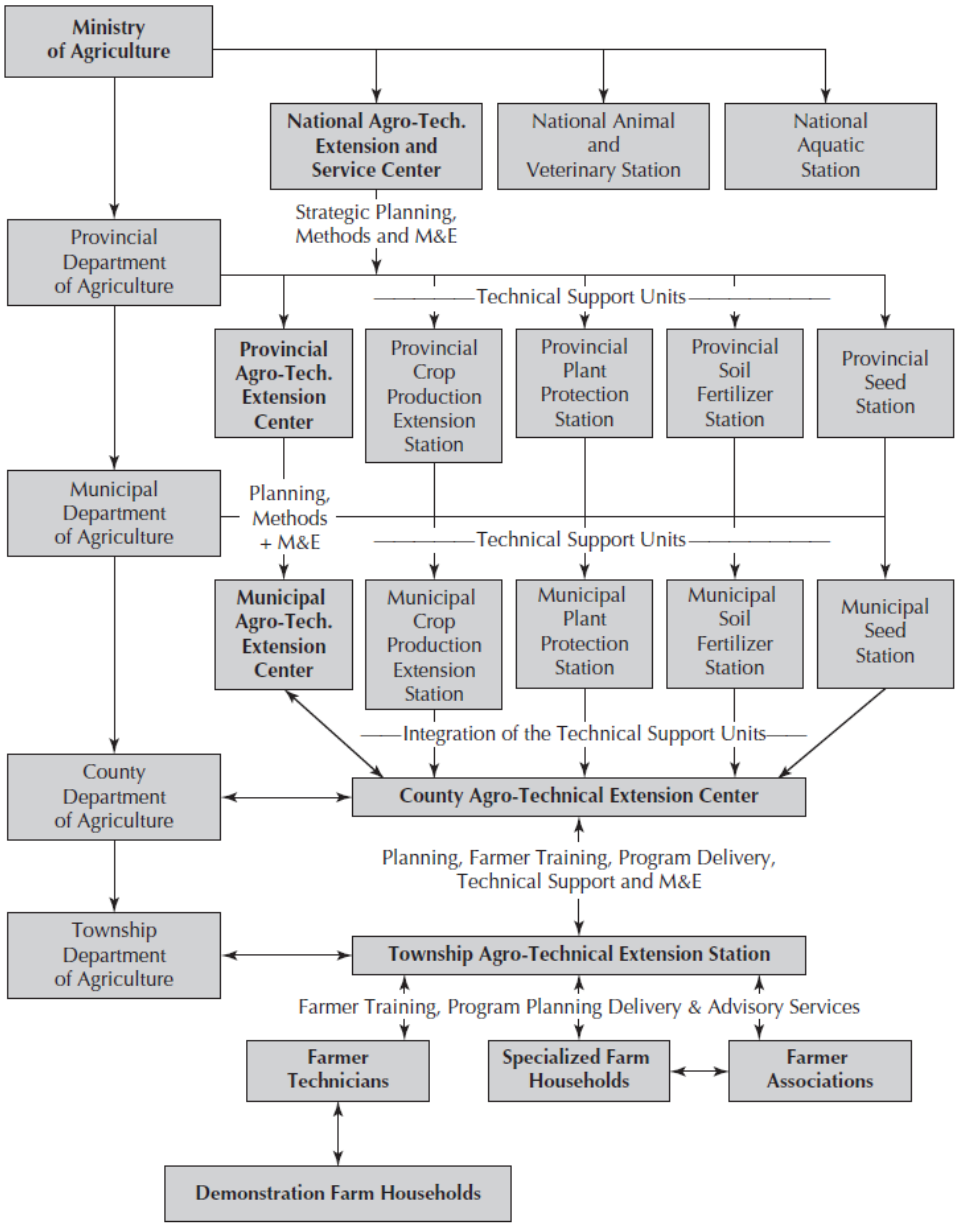
In order to improve efficiency and coordination among extension stations, another reform was initiated with a view to merging various specialized hubs into one-stop shops. In the process, for example, many counties merged their crop management technology, plant protection, and soil and fertilizer technology stations into single crop extension service centers (Hu et al., 2009). Annex Figure 1 shows the structure of the extension system after this reform. The integration of crop-related stations was relatively straightforward since these are directly under the administration of agricultural bureaus. But the next step, with mergers across different bureaus (e.g. livestock, aquaculture), proved more difficult because of administrative barriers. The process towards complete mergers is still underway.

In an attempt to reinvigorate the extension system, the central government enacted another reform in the late 1990s (Hu et al., 2009). This shifted administrative rights (the so-called 'three rights' of personnel, finance, and materials) from county agricultural bureaus to township governments, with a matching shift in budgetary burden. Unfortunately, this reform broke former productive links between the county and township agricultural extension stations. Township agents are frequently called upon to respond to administrative duties that have nothing to do with agricultural extension, including family planning, budget management, elections and legal matters. The current extension system also faces problems in other respects, for example, the lack of competency and updated knowledge of agro-tech extension staff who struggle to keep up with farmers' rapidly evolving needs.

Public agricultural extension in China has been reformed repeatedly to improve efficiency and better serve the country's huge number of small farms. The system has been quite successful in promoting the adoption of new agricultural technologies including improved crop varieties. Since the economic reforms began in 1978, there has been a steady increase in the production of cereals and high value horticultural and livestock products. For example, cereal yield has risen from about 3 to 5.5 ton/ha on average, resulting in an increase in cereals production from 290 to 480 million tons. The volume of fruits and vegetables increased 8.6 times between 1979 and 2008, that of animal protein (meat products) 5.6 times. Extension has played a significant role in these achievements by disseminating modern technologies. China continues to be concerned about national food security, but farmers no longer have to sell specific quantities of cereals to the government at reduced prices. Farmers generally grow the crops that reflect their aspirations, given their land, labor and other resources and their access to markets.

The key factors that facilitated the rapid transformation of the agricultural sector in China include rapid economic growth, changing consumer food demand, investment in rural infrastructure, vocational agricultural training for young people in rural areas, and the transformation of the agricultural extension

system to better serve the needs of farmers as they diversify and intensify their farming activities (Swanson & Rajalahti, 2010). These factors are visible in other Asian countries as economic growth unfolds. However, the participation of small farmers in the agricultural transformation depends on specific policy and operational issues – for example, whether the public agricultural extension system is prepared to organize farmers into producer groups to enable them to pursue high-value horticulture, livestock, fisheries, and other enterprises that will help increase their household income.



Annex Fig. 1: Structure of the agro-technical extension system in China (Swanson et al., 2003)

In China, small farmers are increasingly organized into producer groups for different high-value crops and products. There are mainly two types of producer organizations: associations and cooperatives (co-ops). New Cooperative Laws few years ago allow farmers to organize themselves and to link up with agribusinesses. There are many types of co-ops, such as vegetable marketing or fish producer co-ops, etc. Most pursue mixed activities that include farmer training, and processing and marketing of produce. By 2005 there were over 150,000 specialized farmers' co-ops in China. About half of them focus on crop cultivation, one-third on animal husbandry and aquaculture, and the rest on machinery and other sectors. Many villages have one or more co-ops. Geographically, the co-ops are relatively more developed in the middle and eastern parts of the country where commercialization is more intense. The producer organizations usually understand their members' real needs better and when necessary invite technicians from extension stations or research institutes to provide technical and

managerial training. The co-ops and associations have played an important role in promoting agricultural development and increasing farmers' income.

Apart from public and cooperatively led extension, agribusiness enterprises (seed companies, pesticide and plastic film manufacturers, for example) also participate in agricultural extension in China. Multinationals such as Monsanto and Syngenta have R&D and extension departments in the country. Their extension workers visit farmers in the fields and guide them on how to apply their products. Small private businesses that may not have the resources to proceed independently collaborate with existing extension networks (including the CropLife China Association) to reach farmers.

Since 2006, "New Countryside Construction", a new national strategy for agriculture and rural development, has been put forward to address the widening rural-urban income inequality and stimulate domestic consumer demand. It seeks to improve agricultural production, living standards and public administration in rural areas.

Annex II: Private Sector-led Extension: Some Examples

Private sector-led extension (by input suppliers)

Projects/Initiatives	Project initiator	Type	Services	Area
Hariyali Kisaan Bazaar	DSCL	Ag input retail store	A complete range of ag inputs, irrigation equipment, easy crop financing, technical guidance, credit facility.	India
Godreh Agrovet	Godrej	Rural retail hub	Complete ag solution, household services, value added services (post, banking, pharmacy)	India
Shakti	Hindustan Unilever Ltd.	Rural retail hub	Ag products reaching remote rural areas	India
Reliance Retail	Reliance	Rural business hub	Ag procurement & retail center	India
Mahindra Krishi Vihar	Mahindra Subhlabh Services Ltd.	One-stop shop	Ag input sales, equipment hiring, farm consultancy	India
Tata Kisan Kendra	Tata Chemicals Ltd.	Ag input center	Ag input services, equipment leasing, agronomy services, training, soil analysis by use of remote sensing	India
Indiagriline*	EID Parry Ltd.	Internet kiosks	A platform for extension delivery	Tamil Nadu (TN)

*Additional ICT-related private extension is described in section 5 of this paper.

Contract farming by private companies in India

Companies	Commodities	States
Appachi Cotton Company	Cotton	Tamil Nadu, Karnataka
AVT Natural Products Ltd	Marigold Caprica Chilly	Karnataka
Cargill India Pvt Ltd	Wheat, Maize, Soybean	Madhya Pradesh (MP)
Escorts Ltd	Basmati	Punjab
The Global Green Company Pvt Ltd (Naan)	Gherkin, Babycorn, Paprika	Karnataka, AP
Hindustan Lever Ltd	Wheat	Madhya Pradesh
Ion Exchange EnviroFarms Ltd	Organic Products of Banana, Pineapple, Papaya, Wheat, Basmati, Cotton	TN, MP, Gujarat, Haryana, Maharashtra
ITC - IBD	Soybean	Madhya Pradesh
Ken Agritech Pvt Ltd	Gherkin	Karnataka
Marico Ltd	Safflower	Maharashtra, MP, Gujurat, Karnataka, Chattisgarh, Rajasthan
Mahindra Shubhlabh Services Ltd	Many crops	Maharashtra, Punjab
Mother Dairy Fruits and Vegetables Ltd	Various fruits and vegatebles	Delhi
Natural Remedies Pvt Ltd	Coleus	Karnataka
Nestle India Ltd	Milk	Punjab
Nijjer Agro Foods Pvt Ltd	Tomato and Chilli	Punjab
Pepsi Foods Pvt Ltd	Chilli, Groundnut, Seaweed, Tomato and Basmati Rice	Punjab, TN

Rallis India	Basmati, Wheat, Fruits, Vegetables	Punjab, Utter Pradesh, MP, Maharashtra, Karnataka, TN
Satnam Overseas Ltd	Basmati	Punjab
Super Spinning Mills Ltd	Cotton	Tamil Nadu
The Ugar Sugar Works Ltd	Barley	Karnataka
Unicorn Agrotech Ltd	Gherkin	Karnataka
United Breweries	Barley	Punjab
Sanjeevani Orchards Pvt. Ltd	Pomegranate	Madhya Pradesh

Source: Sunanda (2005); http://www.agmarknet.nic.in/ConFarm.htm

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