Article

Achievements and Challenges in Agricultural Extension in India

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Abstract

The purpose of extension is to disseminate advice to farmers. Knowledge gaps contribute to yield gaps. Services and quality inputs are essential productivity-enhancing tools. However, their optimum use requires knowledge. Farmers also need information on prices and markets, post-harvest management, produce quality determinants, and safety standards. Some farmers marshal knowledge themselves. The "resource-poor" majority, growers of much of India's food, need external, science-based, extension to complement local knowledge. Much debate focuses on how best to achieve the desired outcomes that extension can convey. Many countries have neglected extension and indeed agriculture as a whole. But interest appears to be returning globally, and India is no exception. In 2009, a National Seminar on Agriculture Extension discussed knowledge management, convergence of extension systems, the role of information and communication technology and mass media, private sector initiatives including public–private partnerships, and farmer- and market-led extension systems. This article builds on that discussion. It looks at extension in relation to both primary production and market links, and acknowledges the contributions of all providers of extension, public and private.

Keywords

Agricultural extension, India, private extension, ATMA, mobile application

Introduction

The purpose of extension is to disseminate advice to farmers. Knowledge gaps contribute to yield gaps. Services and quality inputs are essential productivity-enhancing tools. However, their optimum use requires knowledge. Farmers also need information on prices and markets, post-harvest management, produce quality determinants, and safety standards. Some farmers marshal knowledge themselves. The "resource-poor" majority, growers of much of India's food, need external,science-based extension to complement local knowledge. Much debate focuses on how best to achieve the desired outcomes that extension can convey.

Extension in India has a mixed record. The literature rightly recognizes its role in promoting productivity, sustainable resource use, and agricultural development (Singh, 1999). But public provision has overall fallen short of expectations. Links between research, extension, and farmers are seen to be inadequate, and uncoordinated efforts abound (Planning Commission, 2008).

Delivering extension well is difficult. Widely dispersed farmers can be hard to reach, and their information needs vary considerably. Larger farmers may benefit disproportionately. Budgets of extension agencies may be inadequate. There are often too few agents, and they may face problems with motivation, competence, performance, and accountability (Anderson, 2007).

Many countries have neglected extension and indeed agriculture as a whole (World Bank, 2008). But interest appears to be returning globally, and India is no exception. In 2009, a National Seminar on Agriculture Extension discussed knowledge management, convergence of extension systems, the role of information and communication technology and mass media, private sector initiatives including public–private partnerships, and farmer- and market-led extension systems (Ministry of Agriculture, 2010).

This article builds on that discussion. It looks at extension in relation to both primary production and market links, and acknowledges the contributions of all providers of extension, public, and private.

Extension Models and Evolving Needs

The Training and Visit system (T&V) of extension, promoted by the World Bank from the 1970s, focused on the state's role in development. Top–down, T&V merged existing efforts into a single national service to promote high-yielding (Green Revolution) technologies. The system experienced success in India and some other countries for a period. Its "campaign approach" to raising food production worked best where farmers' needs and the promoted technologies matched up. Overall, however, T&V failed to live up to the promises and expectations that came with the approach. As a supply-driven system, T&V promoted approaches developed by research scientists with little input from farmers, the actual users of technology. By the 1990s, T&V's time had passed.

Since then, agricultural extension has become "pluralistic" (Birner & Anderson, 2007; Neuchâtel Group, 2000). New thinking includes decentralization, outsourcing, cost-recovery, and involvement by the private sector and non-governmental organizations (NGOs). Table 1 shows combinations of extension services and financing. Extension can come from public sector bodies such as Ministries of Agriculture or Rural Development, the private sector (e.g., consulting firms, seed and other input companies, and buyers of produce), non-profit entities such as NGOs, as well as commodity boards or farmer-based organizations. Finance can come from government, donors, farmer fees, or private firms. The latter may provide extension as part of sales or stewardship schemes to ensure proper use of their inputs.

The challenge with pluralistic approaches is to identify the mix of options best suited locally. These must be cost-effective and recognize farmers' roles in innovation (Anderson, 2007). Farmer participation in the development and dissemination of technology has emerged as an important theme. Farmer Field Schools (FFS) and the Agricultural Knowledge and Information Systems approach emphasize the merits of direct links between farmers and scientists. FFS use group-based learning, originally devised to teach Integrated Pest Management to Asian rice farmers. Versions of FFS operate in many countries, including India, but are not usually an organized nationwide system (Davis, 2006). FFS differ from "T&V" extension because they are "participatory" rather than expecting farmers to adopt generalized recommendations formulated elsewhere. Participatory methods aim to enable farmers to become self-teaching experimenters and train peers (Anderson, 2007).

Table 1. Options for Providing and Financing Agricultural Advisory Services

Provision of Service	Public Sector (Various Levels of Decentralization Possible)	Private Sector: Farmers (Individuals)	Private Sector: Companies	Third Sector: NGOs	Third Sector: Farm-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 subsides 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).

Other compatible approaches stress innovation systems and market-based, demand-driven extension. The "innovation systems" concept looks inclusively at participants and the institutional context in which new knowledge is made available and used (Rajalahti et al., 2008). In demand-driven systems, innovation follows the market. Farmers sometimes finance and manage these systems themselves. Swanson and Rajalahti (2010) call demand-driven systems "farmer-based extension organizations." As they note, these may become dominated by large-scale growers with different priorities to smallholders. Fully including the rural poor is likely to require special measures and efforts.

Market-oriented extension is relevant in economies that are experiencing growth and changes in consumer preferences that create markets for high-value products. Here it is the growing market rather than new technology that stimulates innovation uptake. China and, to a lesser extent, India have successfully made some of their extension market-driven (Swanson, 2009). Rapid growth in their non-agricultural sectors has boosted demand for high-value products, creating new opportunities for farmers. Extension workers may struggle if they lack training in marketing, farm and post-harvest management, and financial services. The "market-driven" approach has clearly succeeded when farmers organize themselves into groups or cooperatives, access knowledge and needed resources, and sell profitably into predictable supply chains.

Different extension models exist around the world; Birner et al. (2006) argue that there is no single best method. The "right" approach depends on the policy environment, infrastructure, the capacity of potential service providers, the farming systems and potential for market access, and on communities' engagement. 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 are closely linked to the widespread changes in agriculture underway. Market liberalization and gains in wealth are rapidly transforming old staple-based subsistence systems into a high-value, information-intensive commercial enterprise (Adhiguru et al., 2009). Farmers now work with various information sources to tap markets and provide consumers with good-quality commodities. As Adhiguru et al. (2009) note, the information requirement in this situation is demand driven, as different from the more supply-led approach practiced during the Green Revolution. The challenge now is (i) to improve access to suitable and timely information and (ii) to reach all farmers. Public and private systems both play a role, as Figure 1 outlines. In fact, public and private information systems should operate in partnership. Where private extension by for-profit and non-profit organizations is increasing, the public sector should focus on lagging areas and farming types, attract the private sector there, and ensure quality control. "Cyber extension" and cell phone-based applications support the process.

Indian farmers' access to the available sources of extension displays some interesting patterns.[1] Some 40 percent of all farmers access information about modern agricultural technology (Table 2). Information access increases with farm size. Progressive farmers, input dealers, and mass media are the most important sources of information and extension advice. Public extension workers, cooperatives, and output buyers/processors play a smaller role. Government demonstrations, village fairs, farmers' study tours, and KVKs (Krishi Vigyan Kendra farm science centers) are of minor importance, particularly for smallholders. The private sector (progressive farmers and input dealers) is a more

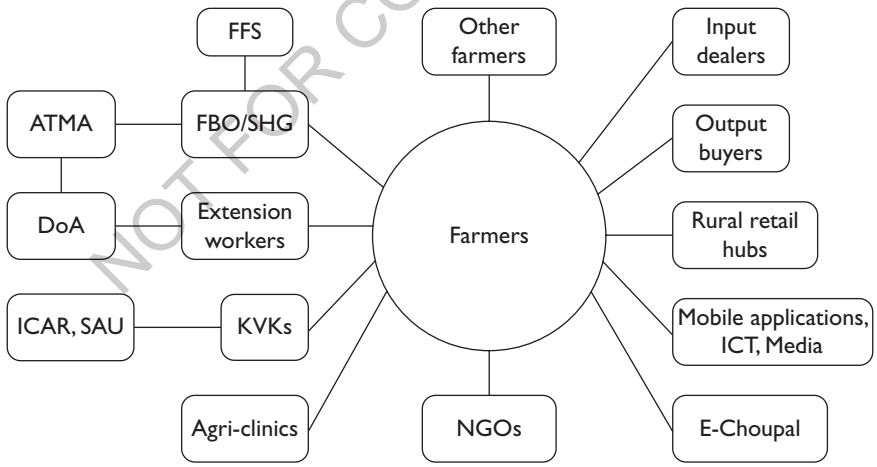

Figure 1. Information Exchange between Extension and Farmers in India

Source: 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).

Table 2. Access to Information from Different Sources across Farm Sizes In India (Percent)

	Farm Size			
Sources	Small	Medium	Large	All India
Any source	38.2	51	53.6	40.5
Other progressive farmers	16	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	10.3	15.9	7
Extension workers	4.8	9.8	12.4	5.8
Primary cooperative societies	3	6.2	8	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	2.4	2.38	2
Credit agencies	1.6	2.8	3.4	1.9
Others	1.6	2.1	2	1.7
Participation in training programs	0.7	1.9	2.3	0.9
Krishi Vigyan Kendras	0.6	1	1.7	0.7
Para-technicians/private agencies/NGOs	0.5	1	0.8	0.6
Farmers' study tours	0.2	0.3	0.6	0.2

Source: Adhiguru et al. (2009).

important source than the public sector, for all farmers. NGOs' reach is modest and displays somewhat of a bias toward larger farmers.

The data indicate that different sources' importance varies according to the information sought. For cultivation, farmers mainly want information on seed, fertilizer, crop protection, and harvesting/marketing. In animal husbandry, health and feeding top the list. Extension workers form a relatively important source of information on seed, as do progressive farmers, the media and input dealers. On fertilizer and animal feed, input dealers are consulted most frequently. Newspapers and radio are the important sources for obtaining information on crop protection. The main source of information on "harvesting/marketing" is newspapers, followed by progressive farmers. The role of extension workers is negligible (cf. analysis in Adhiguru et al., not shown). Mobile phone-based sources of information are not covered in the data consulted here.

The data suggest some degree of pluralism in Indian extension. But worryingly, only about 40 percent of farmers access information on improved technology. Progressive farmers and input dealers stand out as sources, but the quality of their information may sometimes be doubtful. The public sector is present, but farmer access to its offer seems to be low.

Public Extension in India

India's public extension began long before the Green Revolution, evolving with national priorities (Singh & Swanson, 2006). The food crises from the late 1950s prompted a focus on intensification. The Green

Revolution in the late 1960s and T&V from the mid-1970s brought food self-sufficiency in the 1980s and beyond. Feder and Slade (1986) found that T&V greatly increased contacts between farmers and extension workers. In wheat and rice, they calculated, it raised yields by about 7 percent over three years. T&V temporarily revitalized research and extension in the face of significant challenges—just what is needed again today.

Doubts, however, arose, as implied above. T&V was less successful with poorer farmers. Malnutrition and poverty actually grew, prompting a search for new solutions in the 1990s. Sulaiman (2003) describes the innovations subsequently introduced. Five-Year Plan documents explored many aspects of extension (Academic Foundation, 2004).

The early twenty-first century produced ATMA, the Agricultural Technology Management Agency. This emerged from the National Agricultural Technology Project (NATP, 1998–2005). The new thrust emphasizes local solutions, diversification, market orientation, and farm income and employment growth. The one similarity with T&V is that ATMA is intended as an organizing and unifying framework, with incentives for institutional reform and improved performance (Singh & Swanson, 2006).

ATMA

ATMA is an autonomous organization with a wide range of powers. A Governing Board determines priorities and assesses impact. ATMA jurisdiction heads (Project Directors) report to the Board. These Project Directors chair Management Committees, which include the heads of all line departments and district research organizations. Figure 2 shows ATMA's original organizational structure.

The NATP piloted ATMA in 28 districts across seven states. By 2006 ATMA had extended to some 60 districts and was intended to function nationwide within five years (Singh & Swanson, 2006).

However, bottlenecks began to emerge. Kapoor (2010) notes a lack of qualified local manpower, delivery mechanisms, technical and financial support, and a clear framework for partnerships. He also points to weak links between ATMA, ICAR, SAUs, and KVKs.

In 2010, the government issued new guidelines on ATMA. These aim 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. The guidelines also revise the list of extension activities, strengthen the Farmers' Advisory Committees, and delegate powers to State Level Sanctioning Committees that lead to allocation of ATMA funds. Figure 3 shows the new organization.

The new guidelines support convergence in four areas: extension under different programs, public agricultural research and extension, between development departments, and with the non-governmental sector. The latter area includes public–private partnerships. At least 10 percent of district allocation is meant to run outside the government sector. As well as NGOs and farmer organizations, this, for example, includes input suppliers (Government of India, 2010). The guidelines also attempt to increase responsiveness to farmers' needs.

The quality of implementation varies by state, and will remain the central issue. Challenges include the sheer scale and complexity, instilling a culture of accountability to farmers in a multi-tier organization, alignment between knowledge generation and extension, and the dependence of extension's impact on the broader policy environment.

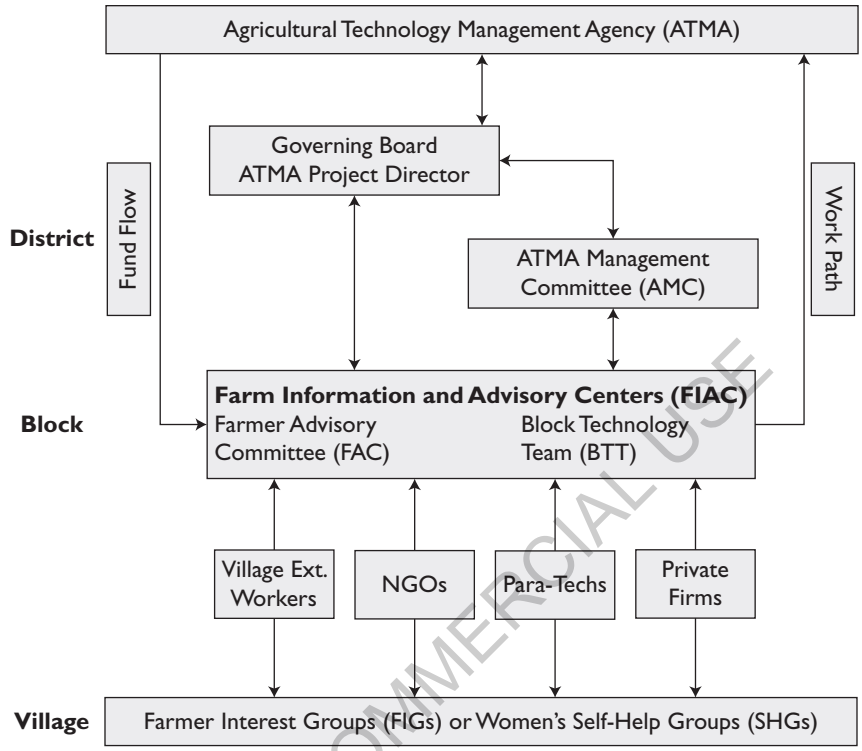

Figure 2. Original Organizational Structure of Reforms (Singh and Swanson, 2006)

KVKs and State Agricultural Universities

ICAR runs some 600 KVK farm science centers. They test and transfer technology to farmers. Most have only about 20 staff, with the limited reach highlighted in Table 2 above. The State Agricultural Universities are much larger, but still small compared with the farm population. SAU extension operates through state-level entities, but sometimes reaches out to farmers directly. KVKs and SAUs are important but under-resourced.[2] Both tend to focus on primary production rather than post-harvest and marketing aspects.

Evidence from the Field

Recent studies in Uttar Pradesh (UP) and Madhya Pradesh (MP) point out several issues. Reardon et al. (2011a, b) analyzed the types of suppliers providing inputs and services, including extension, and investigated the role of rural business hubs.

The UP survey shows that, with regional variations, an average of only 18 percent of farmers had access to extension from any source. Many respondents indicated a lack of advice at the right time.

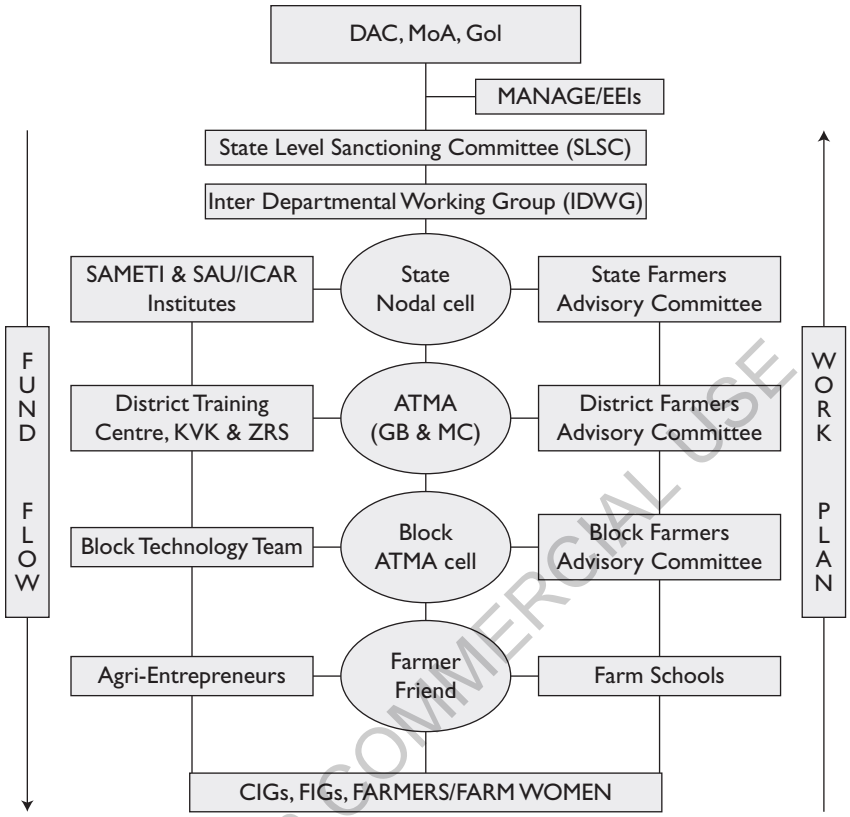

Figure 3. Structure after ATMA (Government of India, 2010)

Notes: 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.

Those who did get extension were generally satisfied. Only about a quarter of the extension came from the public sector.

The MP survey produced more favorable conclusions. The sample included the Malwa plateau, dominated by commercial agriculture such as high-value vegetable production. Eighty percent of households used extension. Smallholders did so slightly more than larger farmers, but farmers not using extension were more likely to be small. Satisfaction was high, but with timeliness identified as "major bottleneck." Direct public extension accounted for 49 percent of all use; the other half came from indirect sources such as radio and from the private sector.

Unpublished evaluations of ATMA extension criticize many aspects in some states. They include insufficient percolation of the planning process down to village level, insufficient attention to extension in districts, poor mobilization of farmer and community interest groups, failure to link district ATMA structure to the corresponding KVK, slow release of funds, and neglect of possible synergies.

Some assessments, however, are more favorable. A study in Bihar (Singh et al., 2009) found the ATMA pilot phase quite effective. The farmer sample is small, but suggests that scientists' and extension workers' interaction with farmers focused research and extension messages on local needs. All categories of farmers adopted improved technology and practices, leading to diversification and increased yield and incomes.

Perspective

There is almost unanimous agreement that the ATMA pilot was more successful than its subsequent expansion. The once strong link between research and extension is weak today, but the example from Bihar suggests that strengthening is possible at the district and local level, where it counts. This requires qualified and adequately led and empowered male and female staff—people who understand agriculture and are trained in farmer-led and market-led extension. There are too few qualified agronomists willing to work in the field. Also much needed is better alignment of the many different schemes and organizations involved in extension.

The UP and MP surveys provide a strong reminder of the role of non-governmental participants. This is a sign of success: public research and extension have given many farmers real choices. Farmers want innovations, many of which now come from the private sector. Companies seek business opportunities. Surging labor costs in rice-growing areas generate strong demand for herbicides and labor-saving devices. Micro-irrigation and mechanization are spawning whole new rural service industries. The public sector must adjust in ways that best help ensure food security, environmental sustainability, and poverty reduction.

The Private Sector: Commercial Providers and NGOs

Agricultural extension by commercial companies is advancing rapidly in India. Those involved include seed and input companies, distributors and dealers, service providers, food processors and retailers, and—as seen in the next section—mobile operators and their business partners. Contract farming is an increasingly important vehicle for "embedded services," information tied to input sales or marketed produce (Feder et al., 2011).

Input suppliers and produce aggregators provide information services to foster products' safe and effective use, expand market share, and ensure the necessary supply of commodities. Companies may work independently or in partnership with other organizations across all sectors.

A variety of models currently exist for delivering and financing extension by private providers. Commercial providers may offer information services as part of contract farming or "outgrower" schemes. They may send their own agronomists into farmers' fields or engage third parties. Possible partners include NGOs, consultants, research institutes or universities, and public providers. The sources of funding include direct farmer fees as well as public or donor payments. A further model links commodity-specific extension to production contracts: farmers' produce prices reflect the extension costs.

Extension by Input and Technology Providers

Farmers frequently receive advice from input and technology providers. Agrodealers and input suppliers have a vested interest in providing advice. They essentially sell effects such as weed control that result from applying both a product and knowledge about its best use. The quality and relevance of their advisory services are major determinants of brand reputation and market share. The industry's issue is cost: how can it most efficiently inform large numbers of farmers who each only buy small amounts? The challenge for regulators and the public, on the other hand, is reliability—both of the information and of the products. In the agrochemical market, for example, useless or even dangerous counterfeits abound.

There are an estimated 282,000 input dealers in India. They are pillars of their communities, and have every interest to offer quality services. But this requires training. MANAGE, the National Institute of Agricultural Extension Management, offers a Diploma in Agricultural Extension Services for Input Dealers (DAESI). So far, however, only a minute fraction of all input dealers have signed up. DAESI covers agronomy, extension and communication methods, individual and business development, and legislation.[3]

A number of other training sources also exist for input dealers. The *Mahindra Krishi Vihar* (MKV) "one-stop farm solution center" by the Mahindra & Mahindra Ltd. tractor and utility vehicle company is one example. Started in 2000, Mahindra ShubhLabh Services aims 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."[4] MKV centers operate on a franchise basis. They provide farmers with quality inputs, rental equipment, credit (in partnership with banks), farm advice by trained field visitors, and crop contracts with processors.

A study of MKV results based on primary field data (Sulaiman et al., 2005) suggests that: (i) farmers are willing to pay for integrated services; (ii) a private extension provider can help substantially increase yields and farm income; (iii) the increases stem from field-specific advice on input application; (iv) MKV has developed a sustainable and profitable extension business; (v) MKV's flexible "learning by doing" approach contributes to success; and (vi) this type of approach focuses on medium and larger scale farmers.

Hariyali Kisaan Bazaar (HKB), run by the DCM Shriram fertilizer, seed and sugar conglomerate, provides "end-to-end agri-solutions." The offer is built around agri-inputs, extension, credit, and produce marketing (Figure 4). HKB operates over 300 rural stores across eight states; each serves at least 15,000 farmers. HKB have evolved into a "super bazaar" which as well as inputs also provides fuel, credit, insurance, and mobile phones.

Other examples of extension by input suppliers include:

- *Tata Kisan Sansar* (TKS) by Tata Chemicals Ltd. These "one-stop farmer solution shops" provide operational and advisory support, mainly in Uttar Pradesh, Haryana, and Punjab. Services include soil testing, remote diagnostics and house brands for seeds, cattle feed, pesticides and sprayers. Some 681 TKS serve 2.7 million farmers in about 22,000 villages.[5]
- *Godrej Agrovet* is a chain of rural outlets, each serving some 20,000 farmers. GA offers agricultural equipment, consumer goods, technical services, soil and water testing, veterinary, financial and post office services, and pharmaceuticals. Started in 2003 near Pune, it now has over 60 centers across the country. The company aims to open at least 1,000 stores.[6]

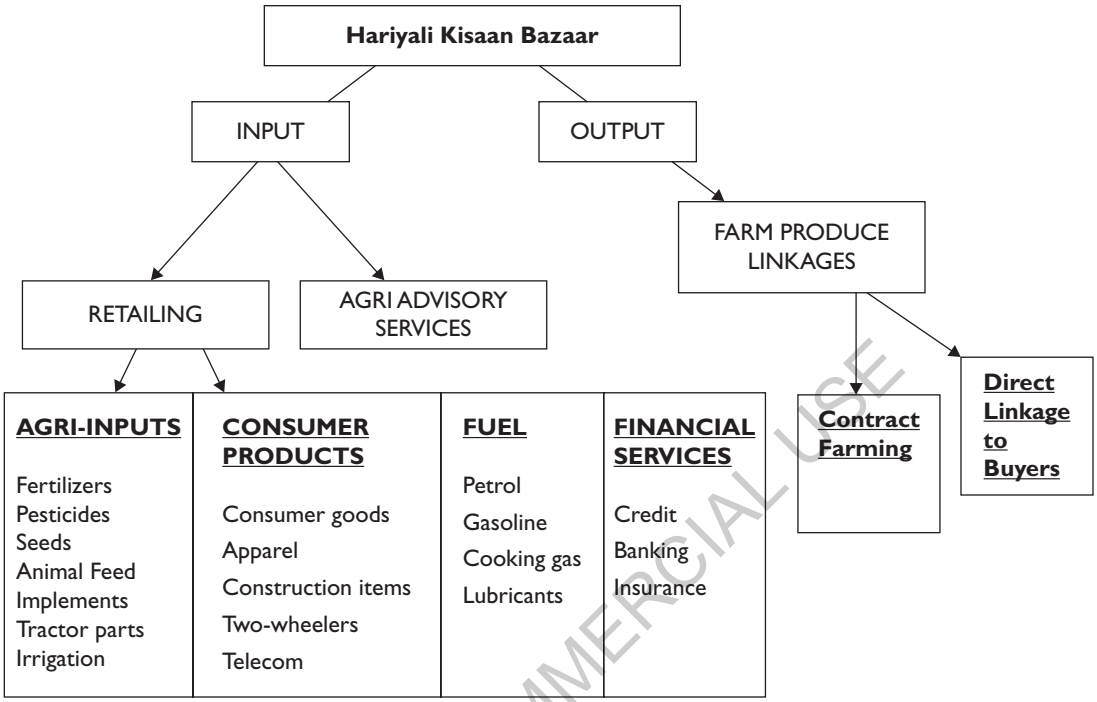

Figure 4. Hariyali Business Model (Bell et al., 2007)

- *Jain Irrigation* provides education on micro-irrigation at its High-Tech Agriculture Training Institute. Farmers, students, government officers, and NGO staff learn about water resources, watershed and irrigation management, fertigation, and modern cultivation. Jain Irrigation agronomy and engineering experts also mentor client farmers.[7]

Glendenning et al. (2010) note that these approaches' impact on smallholders is yet to be evaluated, but they may "provide better-quality inputs and technical services than […] local suppliers upon which most farmers currently rely."

Extension by Aggregators and Processors

Extension by aggregators and processors of produce mainly operates via contract farming, the role of which is growing in Indian agriculture. Gulati et al. (2008) make the point that while "front–end" activities such as wholesaling, processing, logistics, and retailing are rapidly expanding and consolidating, "back–end" activities of primary production have been fragmenting. Contract farming, the authors believe, can link both ends and create business opportunities for all concerned.

The literature on contract farming is not universally positive. However, an IFPRI study of Andhra Pradesh poultry farming states that "contract production is more efficient than non-contract." Although

the processor benefits most from the efficiency surplus, farmers "gain appreciably" through lower risk and (expected) higher returns. Improved technology and production practices help make these outcomes possible (Ramaswami et al., 2006). For Gahukar (2007), the advantages of contract organic farming include organized sales and the training on production protocols they need to follow. A Punjab study also finds merit in contract farming, and stresses the need for extension related to both production and marketing of crops (Singh, 2005).

Examples of contract farming and "value chain integration" include:

- Contract wheat farming practiced in Madhya Pradesh by Hindustan Lever Ltd. (HLL), Rallis and ICICI (MANAGE, 2003). Rallis supplies agri-inputs and know-how, ICICI provides credit, and the processors HLL offer a buyback arrangement. Farmers have an assured market and floor price, quality inputs, and free technical advice. HLL's supply chain is more efficient, and Rallis and ICICI have an assured clientele.
- PepsiCo contract farming in tomato, Basmati rice, chilies, and groundnuts in Punjab, and potato in several states. In a small West Bengal project with the Syngenta Foundation for Sustainable Agriculture (SFSA) in Bankura, PepsiCo pursues a modified version called "*contact* farming," now also catching on elsewhere. PepsiCo ensures technology transfer through trained personnel, and supplies agricultural implements free of charge and quality farm inputs on credit. In return, it obtains agreed quantities of quality produce at a pre-defined price. An aggregator consolidates smallholders' output. Farmers can also mitigate potato-growing risk with a weather index-based insurance sold through ICICI Lombard.
- Adani Agrifresh apple production for New Delhi in Himachal Pradesh. The extension focuses on post-harvest practices, because apples must be in the cold chain within 24 hours. AA announces assured prices weekly, above the market (FICCI, 2010).
- FieldFresh Foods Private Ltd. contract farming in Maharashtra and Punjab. Baby corn is a key product for export and domestic sales. The company sets production protocols, monitors compliance, and sensitizes farmers to suitable input use and minimum residue limits. Lead growers manage demonstration plots, recruit farmers, and provide advisory services and post-harvest and logistics support (FICCI, 2010). A 2010 Yale School of Management study describes how FieldFresh tested different sourcing models, finally choosing contract farming.[8]

Extension through Mixed Partnerships

Contract farming "carries the essence of the farm-firm linkage" (Gulati, 2010), but the incentives for it need careful building. This is particularly true with smaller, resource-poor growers. Mixed partnerships including non-profit organizations can help here. The non-profits may organize farmers and initially provide extension for free, nurturing the process and helping to build trust between farmers and buyers.

The Dhanuka Group (an agrochemicals business) has worked since 2001 with the Madhya Pradesh government and MANAGE, the National Institute of Agricultural Extension Management. The topics include soil testing and fertility, seed treatment, sourcing quality seed, diagnosis of pests and diseases, safe and effective use of crop protection, farmer organization, demonstrations, and market research. This partnership largely privatized extension; agricultural productivity responded well, and in 2004 won a national award (Singh, 2007).

Basix, the "livelihood promotion institution" established in 1996, extends services with microfinance products from its for-profit financial arm. Poultry Coop is a for-profit venture by the NGO PRADAN that pays farmers for live birds, deducting the cost of feed and services. The Agriclinics and Agribusiness Centers (ACABC) provide agricultural advisory services through "agripreneurs." Studies indicate that the agripreneurs may meet farmers' needs better than public extension (Glendenning et al., 2010).

Perspective on Extension by Commercial Providers and Mixed Partnerships

How good is the information that agrodealers and input suppliers provide? Critics accuse suppliers of promoting their own brands, and agrodealers of pushing sales regardless of farmers' real interests and needs. The criticism still awaits neutral and robust study.

The study would also test the opposite hypothesis: that private solutions naturally respond to farmers' needs. Input dealers' reputation and business depend on providing good services and advice. Seed and technology sales forces know that honest advice on products creates competitive edge. Buyers of produce advise farmers as part of their procurement drive. Commercial extension is also likely to be best at delivering private sector R&D results that truly meet farmers' needs. Partnership with non-profits can help reach smaller and poorer farmers. PRADAN's Poultry Coop is an example.

Managing partnership incentives, roles, and accountabilities is hard work. Non-profits can play a catalytic role.

Extension by NGOs

NGOs provide very important support to Indian smallholders. Like government organizations, however, they cannot cover all those seeking advice. NGOs range considerably in size. Their 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 as focal points for demand-driven agricultural extension. Outside sponsors or donors often help. The box below explains how the SFSA partners with small, local NGOs to deliver extension services for productivity growth and improved links to markets. The NGOs were active in the respective areas before the Foundation stepped in. Community organization and social programs had already progressed well when they teamed up to address agriculture.

Extension with Multiple Partners: The Syngenta Foundation in India

In 2004, the SFSA and Syngenta India Limited (SIL) initiated work to address problems facing smallholders. Neither had prior extension experience. A pilot project began in central India, in partnership with the leprosy rehabilitation center Maharogi Sewa Samiti (MSS). Improved agronomic practices significantly raised productivity. The trials also quickly indicated the cash-generating

(Box Continued)

(Box Continued)

potential of vegetables. With truckloads of vegetables going to Chandrapur market, the SFSA-SIL team felt confident about reaching out to more farmers. A fully fledged extension program emerged, which now operates across four states.

In 2006, projects started in disadvantaged areas of Bankura, Kalahandi, and Jawhar. Each 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. Each project has a small extension team led by a qualified agriculturalist and assisted by young local field workers. The teams promoted advanced crop technologies through workshops, trials in farmers' fields, and demonstrations. Knowledge alone would not suffice, so the project teams made available the recommended inputs and tools for farm purchase. Seed multiplication by farmers improved availability and brought down prices. With improved methods, including SRI, the "System of Rice Intensification," yields rose significantly. Vegetables became a remunerative option for many farmers.

Before SFSA further scaled up its activities, it consulted farmers and commissioned an external evaluation. Intervention was broadened 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 and farmers about crop technology, agronomy, work methods, and principles of learning with and from farmers became a hallmark of the approach.

From a few hundred farmers in 2004, the outreach currently covers about 45,000 farmers. About a third of the smallholders reached have become successful vegetable growers. The projects are also helping farmers tap into government schemes. SFSA is working to make projects self-sustaining and improve links to markets. Farmers' groups are pursuing additional income-generating enterprises such as the production of hybrid seed for sale.

Basix, PRADAN, and BAIF are among India's larger NGOs, and are perhaps better referred to as social entrepreneurs. They operate in numerous states (Figure 5), have been active for many years, and use well-established methods. Basix works with more than 3.5 million microfinance customers, of whom some 90 percent are poor rural households and 10 percent urban slum dwellers. Eighty percent of its 10,000 employees work in small towns and villages.[9] One thousand "livelihood service providers" apply extension to cotton farming, groundnut, soybean, pulses, paddy, chili, mushroom, vegetables, and livestock. Around 800,000 farmers pay for services (Basix website; Glendenning et al., 2010).

PRADAN is a leading promotor of self-help groups. It aims to conquer poverty by enhancing poor people's capabilities and access to sustainable income opportunities.[10] Specific foci include cereal productivity for food security, and diversification into cash crops such as pulses, oil seeds, and vegetables. PRADAN works with many partners, including the Madhya Pradesh government, the Rashtriya Krishi Vikas Yojana scheme, and ATMA. Funding comes from the Indian government, philanthropic and corporate bodies, as well as international donors and philanthropic organizations.

The BAIF Development Research Foundation is another large NGO working in agriculture and livestock development. As with PRADAN, the fostering of rural self-help groups is important.[11] BAIF has more than 3,000 employees, who operate from some 750 centers. It reaches out to 2.5 million farmers, many in challenging areas. The government of India recommends that states learn from and work with BAIF.[12] The NGO's

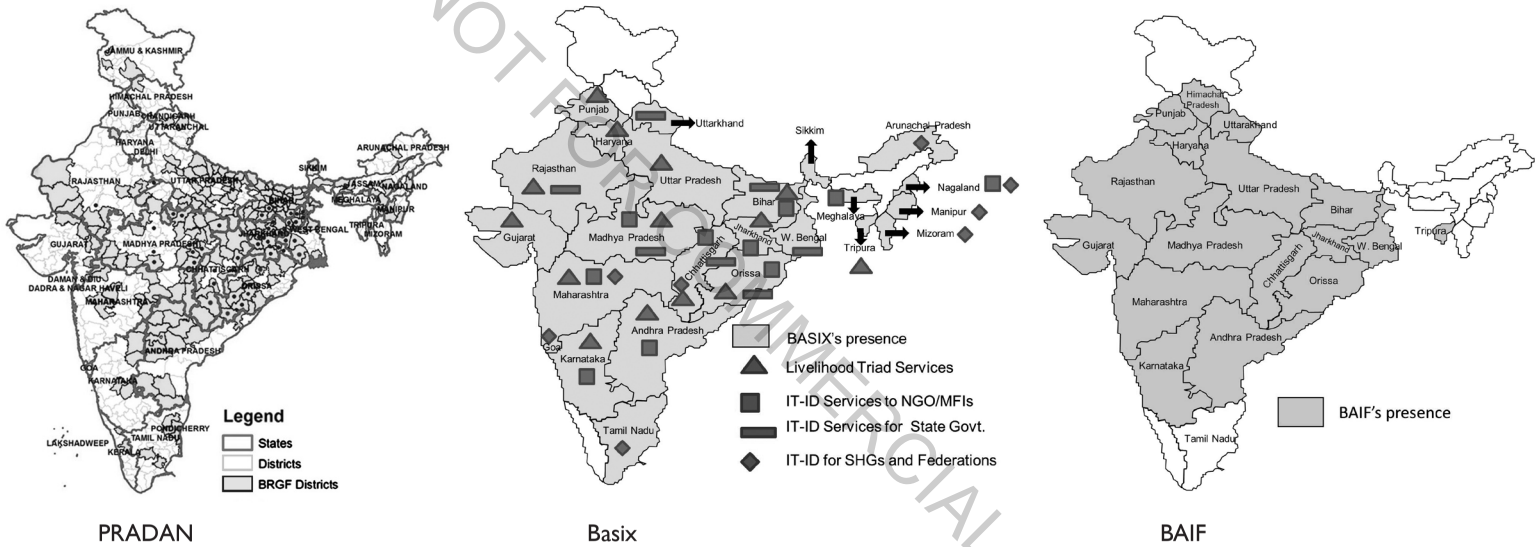

Figure 5. Operational Areas of PRADAN, Basix and BAIF

Source: Adapted from Websites.
Notes: IT = information technology, ID = institutional development.

"wadi" program to establish orchards is supported by soil and water conservation. BAIF has facilitated the formation of farmers' cooperatives and self-help groups. The wadi program is being replicated under a special Tribal Development Fund established by the National Bank for Agriculture and Rural Development.[13]

Basix, PRADAN, BAIF and others like them spearhead needs and demand-driven extension. They have a keen eye for what works, and on the market. They organize women's and farmers' groups, and foster innovation in participatory ways. They reach large numbers of farmers, but many more are still in need. It is hoped that the public sector, donors, and philanthropists will all support such efforts.

Mobile Applications in Agriculture

Mobile applications have the potential to revolutionize farmers' transactions and ways of working. Although a resource for agricultural extension, they are not yet widely discussed even in recent literature. This section helps to fill that gap. We chart the evolving world of mobile communications in agriculture and assess the experience in India so far, recognizing that any overview of this highly dynamic field is quickly out of date.

Mobile applications in agriculture (sometimes referred to as "mAgriculture") relate to the delivery of agriculture-related information and services via mobile devices. The broader field of "eAgriculture" involves access to personal computers and the internet.[14] For "mAgriculture," farmers only need access to cell phones. Teleconnectivity is growing rapidly[15] and, assuming continued fast expansion in rural areas, could empower huge numbers of farmers. The benefits of "mAgriculture" extend potentially to all aspects of extension, service delivery, and market links.

Initially, however, "mAgriculture" remains constrained. Demand-side limitations include connectivity deficits, illiteracy (in text-based communication), low education, and poverty. Supply-side constraints are related to product timeliness and relevance, marketing and pricing, and the suppliers' business models.

Lowering the cost of information is vital: information deficits are key constraints in agriculture. Research in Sri Lanka found that information, from planting decision to product sale in wholesale markets, can account for up to 11 percent of overall production costs (de Silva and Ratnadiwakara, 2008). The discussion of mobile technologies in agriculture is therefore largely optimistic, despite the challenge of accessibility (Bhavnani et al., 2008). Some authors argue that technology can reinforce existing dependencies and control (Leye, 2009). Others see it simply as an enabler of positive outcomes, given the right policies and mentoring (Fourati, 2009). We share this latter view.

Mobile applications can serve many needs. These include extension in the narrow sense of advice, as well as input, services and output transactions, and data collection. Figure 6 identifies opportunities along the value chain. We focus here on "extension proper" and market transactions.

The complexity of mobile applications depends on their particular goal (Figures 7 and 8). Low-complexity applications enable provision by voice or text of information such as weather forecasts or price data. Medium-complexity applications provide decision support with location-specific information. The information still basically flows one way, but to specific clients.

Systems of high complexity involve transactions, information flows in more than one direction. Examples already include mobile banking, cell phone money transfer, and crop insurance that runs on a mobile platform, as in Kenya.[16] Below are some examples of different application complexity levels

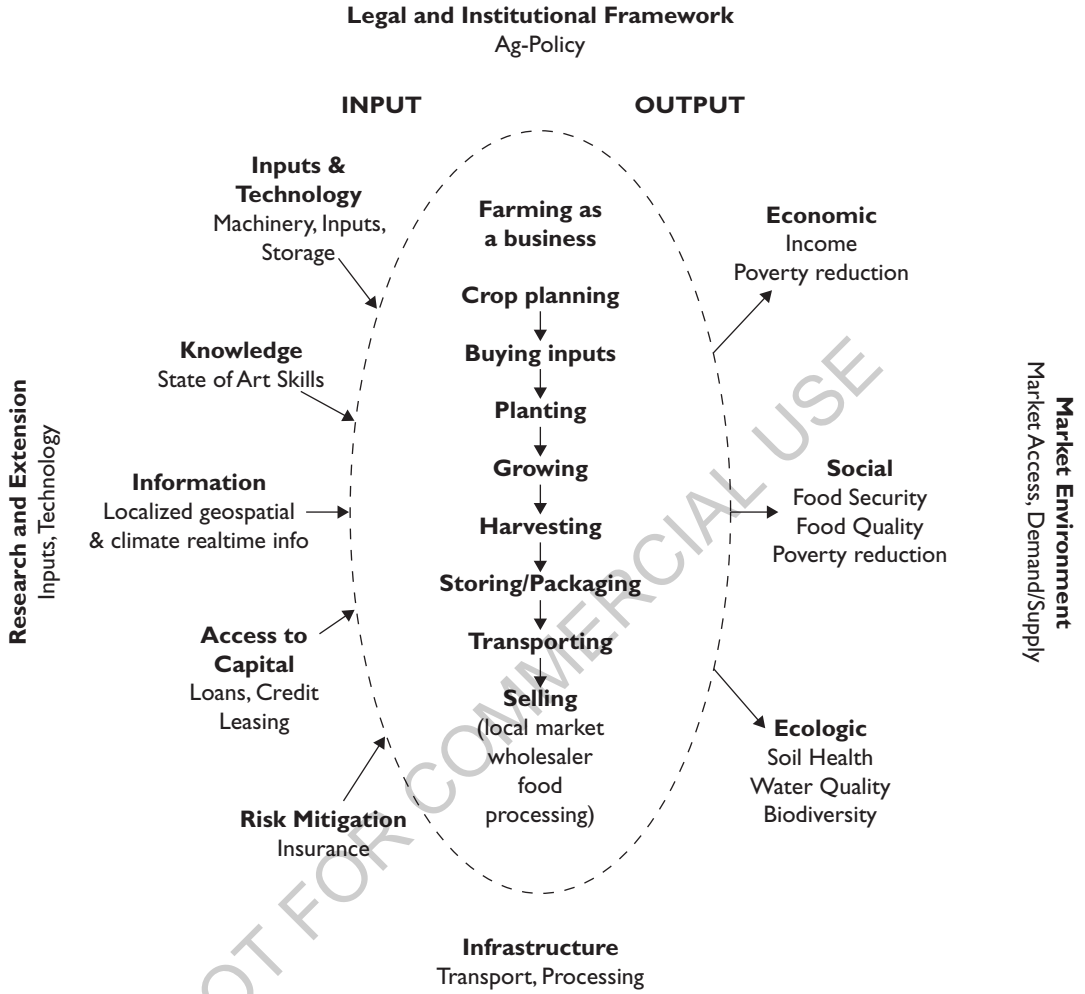

Figure 6. Farming Activities from a Business Perspective

Source: Syngenta Foundation.

covering extension, market links, and services. Table 3 provides web addresses and characterizes the ventures, many of which are at the pilot stage.[17]

Mobile Applications in Extension

Extension requires applications that disseminate knowledge to address skills gaps. "mLearning" disseminates farming knowledge, with the possibility of interaction and group learning. Digital Green

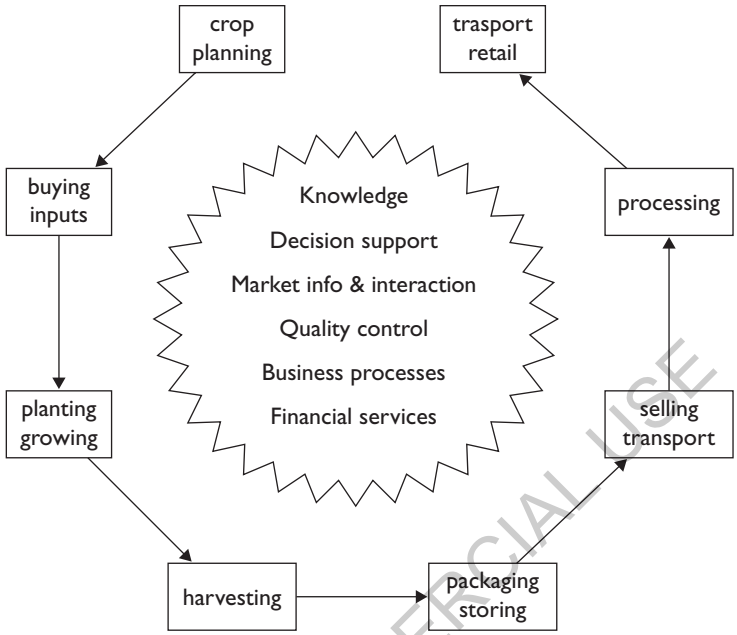

Figure 7. Business Processes Offering Opportunities for Mobile Applications

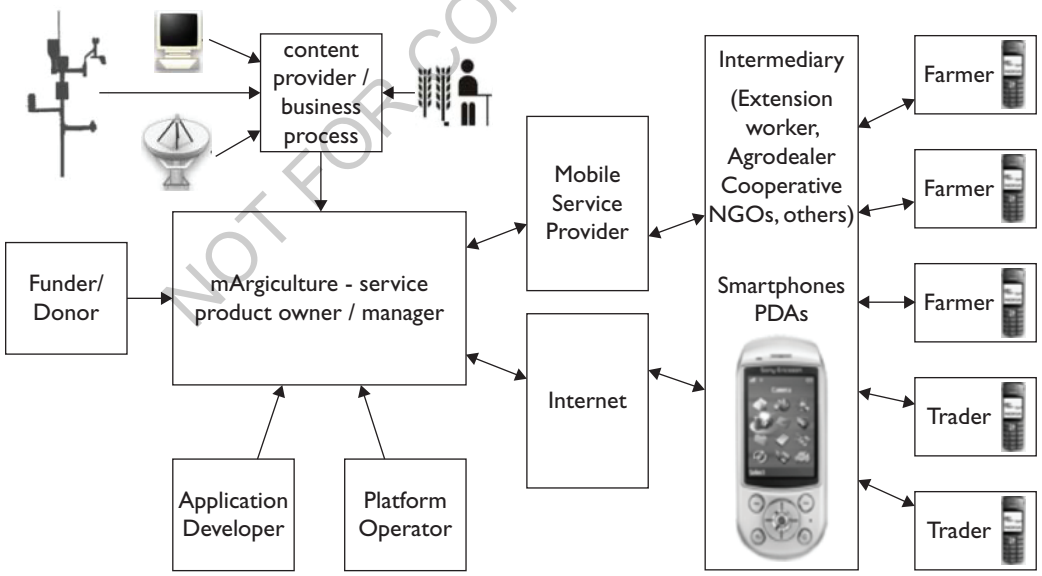

Figure 8. Complex Applications

Source: Syngenta Foundation.

Table 3. Sample of India's Mobile Applications in Agriculture (2011)

Extension	Business Model	Medium	Complexity	Info Flow		Business Model	Medium	Complexity	Info Flow
	Non-profit	Internet/ text	Low	Interactive	• Kisan Call Center (KCC) (www.manage.gov.in/kisan/default.htm)	Government	Voice	Low	interactive (call center)
• aAqua (www.aaqua.org)									
• Avaaj Otalo (www.hci.stanford.edu/research/voice4all)	Non-profit	Voice	Medium	Interactive	• mKrishi (www.tcs.com)	Commercial		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)	Commercial		Low	One-way
• Nokia Life Tools (NLT) (www.nokia.com)	Commercial	Text	Low	One-way	Market facilitation				
					• Reuters Market Light (RML) (www.thomsonreuters.com)	Commercial	Text	Low	One-way
• IFFCO Kisan Sanchar Ltd (IKSL) (www.iksl.in)	Commercial		Medium	One-way + helpline	• e-Choupal (www.echoupal. com)	Commercial		Low	One-way

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

facilitates mLearning with its videos and hundreds of mediated screenings in villages. "mFarming," on the other hand, may be said to refer to services and individual decision support with the help of local, contextually relevant information. Examples include mKrishi and e-Sagu.

- ***aAqua*** ("Almost All Questions Answered") is an internet-based discussion portal initiated in 2003. aAqua is more "eAgriculture" than "mAgriculture," but also offers SMS access. It is a non-profit open forum where users have created more than 90 percent of the content. A farmer can ask a question from a kiosk or cybercafé; farmers or other experts reply in English, Hindi, or Marathi. Separate discussion groups cover different topics. Keyword-based searches enable rapid retrieval of documents and images. aAqua uses freely accessible software and requires only limited investment. It can be replicated quite easily, but has not gone to scale: there were about 17,000 users by early 2011. Poor village internet connectivity and illiteracy appear to be a hindrance.

- ***Avaaj Otalo*** is a voice-based system to access and discuss agricultural information piloted in 2009. It is an important and promising experiment. Patel et al. (2010) are optimistic about voice as an information medium for rural communities. By dialing a phone number and navigating through simple audio prompts, farmers can record and respond to questions, and access content assembled by experts. In addition to the highly popular question-and-answer forum, Avaaj Otalo also offers a range of other services. The number is toll-free at the time of writing; the NGO DSC pays airtime costs. This raises issues of financial sustainability discussed by Patel along with possible solutions.
- ***Digital Green*** is a non-profit organization that disseminates agricultural information to small and marginal farmers through digital video (see Ghandi et al., 2009). The approach could significantly improve extension programs by delivering targeted content scalable to large numbers of farmers. The application is "mobile" in the sense that the product is portable. Digital Green has produced some 1,500 videos on agricultural techniques since 2008. Offline operation in low and limited bandwidth locations is easy. The number of users has increased rapidly, reaching 42,000 in early 2011. But maximizing impact will depend heavily on Digital Green's partnerships with extension providers such as BAIF and PRADAN. It will be interesting to see how video influences these NGOs' extension work.
- ***Nokia Life Tools (NLT),*** launched in India in 2008 and in Indonesia and China in 2009, supplies agricultural resources on low-cost Nokia phones. Subscribers receive daily text messages in a choice of 10 languages and two service levels. Information includes local prices for individually chosen crops, seed and other inputs, weather forecasts, and farming tips. This promising application works wherever there is GSM coverage, but depends on collecting accurate data helpful to users. NLT is partnering with private and public institutions so as to address this issue.
- ***IFFCO Kisan Sanchar Limited (IKSL)*** intends to improve farmers' decision-making with information on market prices, techniques, fertilizer, weather forecasts, and health. Subscribers receive five locally customized voice messages six days per week. A 24-hour helpline completes the service. Farmers pay a one-time activation fee for an IFFCO Kisan SIM card. Voice messages are free, but helpline queries cost 1 Rs/minute. IKSL targets the farmers in IFFCO's 40,000 member societies; some 0.7 million were active customers in late 2010. The service has scored well for clarity and relevance. The model is promising, but the achievable number of farmers of different economic means remains to be determined.[18]

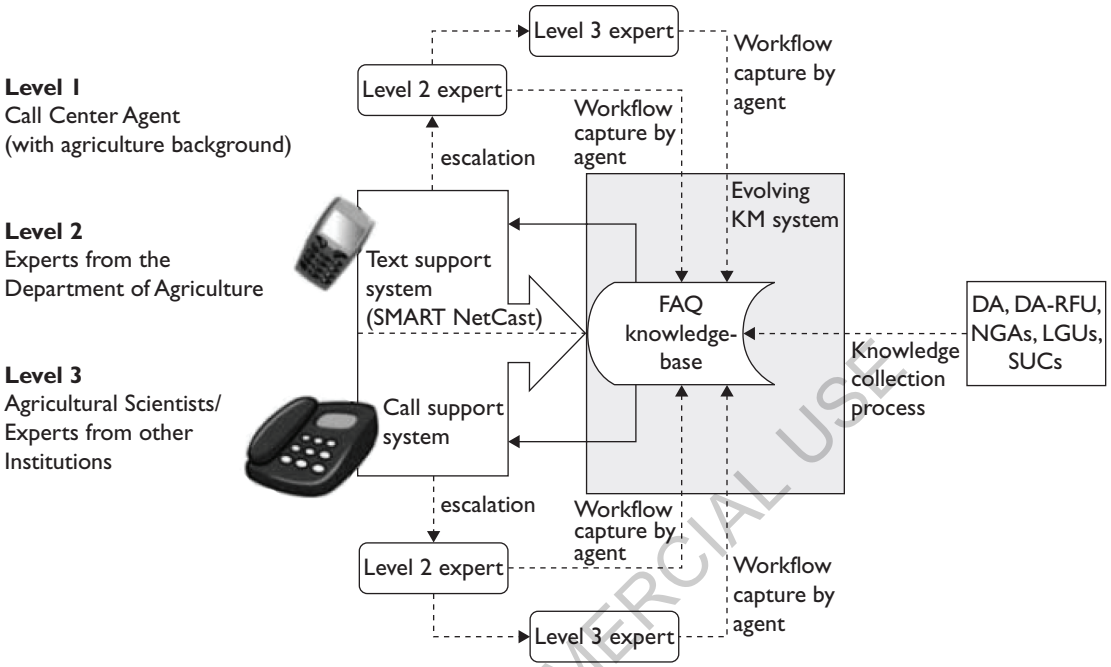

Figure 9. Call Center Workflow

Source: www.tcs.com.

- ***Kisan Call Centers (KCC)*** (Figure 9) deliver extension services nationwide, responding instantly to farmers' issues in 22 local languages. Calls are toll-free and handled in two categories. Level 1 covers most calls. On Level 2, subject matter experts answer the more difficult items within a prescribed period. Most queries 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. A study in 2006–2007 found good client satisfaction, but provides no information on impact.[19] Future additional customers will include farmers in the North-East, and farm women and illiterates. Ministry of Agriculture support keeps KCC financially stable. Figure 9 shows call centers' generic workflow.
- ***mKrishi*** (cf. Figure 10) is a personalized platform to raise yields, reduce input cost, provide better market linkages, and foster rural entrepreneurship. It combines multiple technologies to bring content from a wealth of sources to farmers' low-end handsets. Farmers can send queries, images, and voice-activated SMS; they receive responses in the relevant language.[20] Customization is in part made possible by automated weather stations and village sensors linked to a central server. A "Frequently Asked Questions" database handles many queries. Experts tackle more sophisticated questions 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). Illiterate farmers can use voice-specific functions. Issues with payment have prompted a reduction in fees.

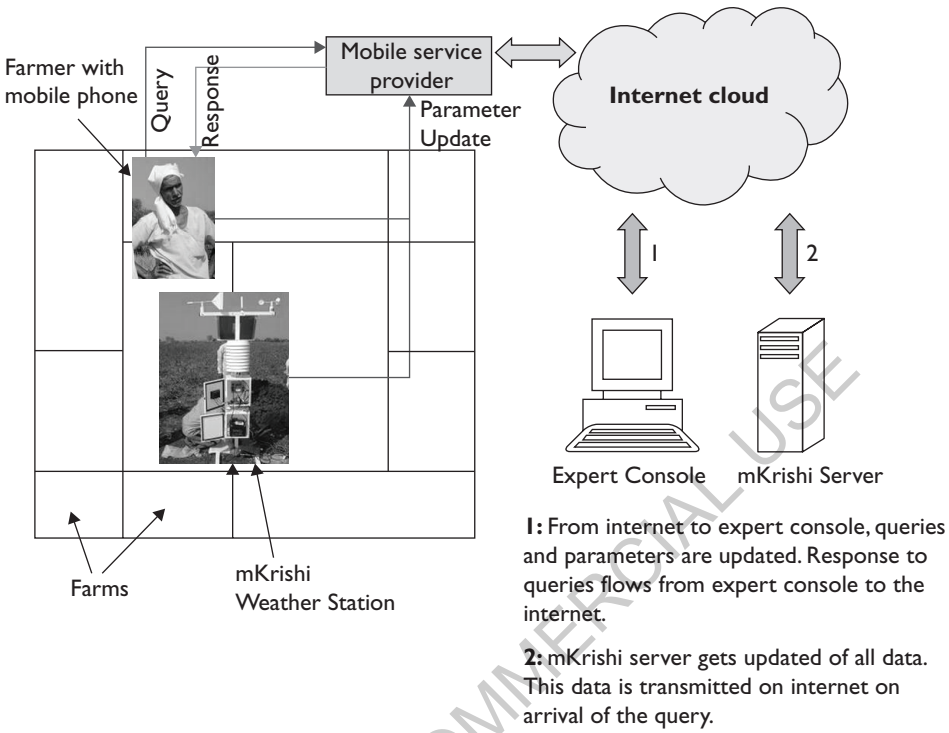

Figure 10. mKrishi Action Plan

Source: Syngenta Foundation.

- ***e-Sagu*** aims to deliver timely, personalized advice to farmers for a nominal subscription fee. A team of agricultural experts and an "agricultural information system" constitute the "brain." Local centers equipped with a weather station each cover about 10 villages. Lead farmers collect farm registration, management, and agronomic data. They visit participating farms weekly to photograph crop status. This information goes to the main center, which prepares farm-specific advice. Transmission is by email or couriered CDs. Experts can give advice without visiting crops, which enables them to advise more farmers. Assessments have noted a positive correlation between adoption of e-Sagu advice, crop yield and savings through more judicious application of inputs (Ratnam et al., 2006). Financial sustainability will depend on e-Sagu's ability to combine forces with a strategic partner.

Mobile Applications for Better Market Access and Services

- ***Reuters Market Light (RML)*** is a leading commercial SMS service providing market prices, weather updates, news on agricultural policies, and advice to match each stage in the farming cycle. Farmers can personalize the wide-ranging information by crops, region, and language.

RML sells its service through a variety of agriculture-related businesses. It has hundreds of thousands of subscribers. A 2009 study found that farmer customers of RML increased their income from sales informed by RML data by 5 to 25 percent.[21] Mittal et al. (2010) found the RML price information accurate.

- ***e-Choupal*,** an "eAgriculture" application, is referred to here because of its importance as a successful platform to create a virtual market and address infrastructural and other bottlenecks. Rural hubs equipped with an online computer each serve some 600 farmers. A local *sanchalak* (coordinator) runs the village e-Choupal. Farmers use it to obtain crop prices, procure seed, fertilizer, and other products including consumer goods, and sell their crops at prices offered by ITC, e-Choupal's parent company. ITC typically pays more than traditional traders, but operate at a cost advantage, control quality, and obtain direct access to farmers and information about conditions on the ground. ITC plans to expand the e-Choupal offer from today's 40,000 to 100,000 villages.

Perspective

Mobile phones and "mAgriculture"/"eAgriculture" can raise productivity and farm incomes when the information is good and timely, and farmers believe they can trust the advisors. This is the conclusion of the empirical study by Mittal et al. (2010), the first investigation of the impact of mobile phones on Indian agriculture. The study adds 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 smallholders currently benefit less from the information than larger farmers.

Additional study insights are that:

- Farmers view mobiles as the best route to reliable information.
- Farmers access topics in the following order: seed, produce prices, fertilizer, crop protection, harvesting and marketing, equipment.
- Almost all farmers report convenience and cost savings, but usage and benefits appear to vary considerably between Indian states.
- Mobiles are a critical resource for traders and brokers. They enable them to shift tonnage flexibly, and facilitate the numerous services that traders provide for farmers.
- Market information accessed by phone influences farmers' selling decisions, and helps them negotiate better prices.

The next few years will be a fast-moving and defining period for mobile applications. This is true for agricultural extension and processes of development and economic growth more broadly. The "mAgriculture" offers have evolved from market information to weather forecasts and related news, and from there to crop and livestock production know-how. Providers such as mKrishi are now tackling the customization of information, where data go for remote analysis and personalized solutions. Novel and exciting business prospects are emerging, boding well for the future of agricultural extension.

Conclusion

We have discussed encouraging developments and continued shortfalls in extension. A major bright spot is the vast potential of mobile applications to inform and communicate with farmers, now being tackled by innovative actors. Interactive platforms now emerging are expected to redefine service provision and market linkages. Another bright spot is the community-based knowledge and information services fostered by professional NGOs, empowering poorer farmers 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.

Two large interrelated issues remain unsolved: coverage of small farmers, and the public sector's role and effectiveness. Small farmers' output is vital for food security and agricultural growth. Their productive potential could multiply sustainably with the right technology, services, mentoring, and market access.[22] But they are not receiving these on the required scale. Public extension reaches a tiny percentage of farmers operating less than two hectares. All providers together reach some 40 percent of all farmers, typically with an advantage for larger growers. The task is to expand coverage to all farmers with potential for growth in crop and livestock production. For NGOs, this requires doing more of the same, with adequate manpower and funds. For the private sector, expanding the offer will often depend on infrastructure and other public goods. For the public sector, the need lies in experimentation, documentation, replication and scaling up of what appears to work—with a view to nurturing the extension offer of for-profit and non-profit private actors into settings and types of farming that are currently underserved. All participants need to build on each other's contributions through judicious partnerships.

Currently, government clearly faces the largest challenges in extension. The private sector is enjoying dynamic growth opportunities in agricultural supply chains, and its presence will become more and more pervasive. The required re-think by government prompted by this situation has barely started. Government approaches are conceptually founded in the Green Revolution and food security considerations of days gone by, centered on basic grains. Agriculture has moved on. Subsistence farming is history, at least aspirationally. The staples still need to be supplied, but high-value products and processed foods are increasingly important. Rising rural wages and food prices are raising farmers' demand for technology and services, and the private sector readily responds.

The government needs to adjust by filling the many remaining gaps, in partnership with private for-profit and non-profit actors. This should pave the way for eventual commercial agriservice delivery to underserved parts of the country. Government should take a careful look at every crop and state. Funding may emerge as a constraint, but other obstacles are likely to loom larger—political commitment to agriculture, institutional and implementation issues, management and organization. Challenges of implementation are widely cited as a bottleneck in Indian agriculture and rural development, begging the question of how government can inject skills, motivation, a sense of mission and renewal where they are needed. ATMA appeared to assemble the right conditions during its pilot phase. Under the 2010 Guidelines, it must now combine framing the task from above with the needed resources, guidance and empowerment below. Block-level ATMA organizations play a key role. They include farmers' representatives and local structures that should originate proposals for district approval. Making this process work is a top priority.

Acknowledgments

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Notes

1. 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.
2. 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).
3. http://www.manage.gov.in/daesi/daesi.htm
4. The quotes and information in this discussion of Mahindra Krishi Vihar are taken from Sulaiman et al. (2005).
5. Information taken from http://www.tatakisansansar.com/
6. See http://www.afaqs.com/news/company_briefs/index.html?id=8986_Godrej+Aadhaar+launches+agri-services+cum+rural+retail+stores+in+Gujarat.
7. See FICCI, Corporate Interventions in Indian Agriculture, New Delhi, October 2010.
8. Yale School of Management, FieldFresh Foods, Yale Case 10-036, December 2010.
9. Retrieved from http://www.basixindia.com/
10. Retrieved from http://www.pradan.net/
11. See http://www.baif.org.in/aspx_pages/index.asp
12. Based on http://sapplpp.org/links/baif
13. Source: http://dev.ikf.in/baif/our_programmes_land_based_livelihood.asp
14. The Agropedia system of digital content organization is an example of 'eAgriculture' (www.agropedia.iitk.ac.in). Agropedia was launched in January 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.
15. By January 2011, India's total wireless subscriber base was 771.18 million, of which 33.6 percent was rural (TRAI, 2011).
16. See www.kilimosalama.org
17. Descriptions are based on information on these web sites.
18. 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.
19. See http://www.docstoc.com/docs/36523062/Impact-Evaluation-Study-of-Kisan-Call-Centres
20. Quoted from http://www.csr360gpn.org/magazine/feature/mkrishi-connecting-indias-rural-farmers/
21. Quoted from http://en.wikipedia.org/wiki/Reuters_Market_Light#ICRIER_study_in_2009
22. 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.

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