

## **Managing knowledge, creating networks and triggering innovations for sustainable agriculture**

**Anil K Gupta**

### Abstract

Conventional agricultural extension approaches have ceased to be of much effect in transforming agricultural productivity and meeting the goals of sustainable natural resource management. Multi agency approach using multimedia, multi language and multi channel is imperative. Ministry of Agriculture has realized the need for transition but the models for the purpose remain to be developed.

In this paper, I discuss the major knowledge gaps, stress the importance of peer learning and building upon farmers' own innovations and suggest new initiatives for transforming extension strategies. I have also argued that focus only on primary production in agricultural will not be viable in the long run. Value addition is necessary and extension for the purpose requires lot of action research. Village Knowledge Management Systems (VKMS) need to be developed for which a proposal has already been submitted to the Department of Science and Technology. An outline of the same is given in the paper to trigger further discussion. Farmers suicides in many states should have warranted a review of extension strategies much earlier. The proposed model aims to develop and monitor early warning signals of the socio ecological stress and recommend real time solutions.

## **Managing knowledge, creating networks and triggering innovations for sustainable agriculture<sup>1</sup>**

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One of the most remarkable developments in the field of knowledge management in recent years is realization that horizontal networks create, evaluate and disseminate more meaningful knowledge for everyday use than vertical networks. The success of social network sites illustrates the desire among the educated people to relate to and learn from each other, and share their knowledge, experiences and insights. Within the rural society, the similar examples of horizontal networks have existed from time immemorial in the form of local fairs, weekly markets and other processes. However, the horizontal knowledge networks have become weaker over time. The result is that solution to a problem may exist in a village and the next village may often be unaware, particularly if the solution is not market based. The roots of such a phenomena can be traced to partly the predominance of vertical extension systems and excessive reliance on market based mediations. The strength of markets mechanisms is the incentive based processes for reducing transaction costs. On the other hand, the short term perspective of markets often sacrifices the long term sustainability goals. The state institutions also fail often to take up long term steps when they abandon science and technology based investigations on the impact of chemical and heavy machinery based interventions in agriculture. The civil society has tried to fill some of the gaps but absence of widespread support for such initiatives has stifled its ability to do more. Therefore, there is a need to redefine the role of each of the player and evolve new models of generating, evaluating and disseminating knowledge as well as heuristics for generating location-specific knowledge.

Honey Bee Network provides some examples of creating horizontal networks to manage knowledge and trigger and disseminate innovations. I will first discuss the kinds of knowledge gaps that exist in the current extension system and then identify some models for bridging these gaps. Finally, I would suggest some policy alternatives to expand our capacity to converge the goals of sustainable agriculture, natural resource management and private and common property rights institutions.

### **Part I**

#### **Knowledge gaps for sustainable agriculture**

- a. *Decline of non-monetary technologies in the extension packages:* The extension scholars have drawn attention to this trend for more than a few decades [see the work by Dr.Y.P.Singh, Dr.Hiranand, Dr.Kamlesh kumar and others]. Recently, during the visit to the families which had unfortunate cases of farmers suicide in Maharashtra [Yavatmal, Chandrapur and Wardha regions], this gap manifested once again. Large number of cotton farmers were not only unaware of the IPM package developed by the National Centre for Integrated Pest Management but

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did not know what some farmers in Jalgaon and other districts had known for ages. Growing lady's fingers as a border crop in cotton has been known as one of the most effective traditional knowledge for trapping the pests. The knowledge from Jalgaon could reach Honey Bee Network in Ahmedabad but could not walk to Yavatmal despite huge public attention and interventions. This is just one example. One could do an audit of extension packages and find out glaring gaps in such kinds of knowledge management processes. In many cases, the knowledge exists but incentives for its diffusion don't. Paradoxically, there is not much demand even from the farmers' side for such knowledge because of years of dominance of chemical based strategies. Farmers have somehow lost their desire to help themselves, and each other, in many of the intensively cropped regions as evident from lack of sustainable technological innovations in such regions. It is in the marginal regions and sub-marginal regions that one notices far more experimentations and also appetite for such kind of knowledge. It is evident from various studies in consumer behaviour that those on the higher end of the consumption cycle tend to be less self-reliant in generating solutions for themselves. Markets have obviously reinforced such behaviour.

- b. *Lesser attention on diffusing science and robust heuristics:* Way back in 1988, I wrote a paper on Transferring Science for Development and Diffusion of Dryland Technology. My argument was that in ecologically heterogeneous regions, the classical lab to land model would not work. There was a need for distributed and decentralized development of technologies for which farmers will have to become partners and scientists would have to help in transmitting scientific principles and thumb rules. We did not go very far with this thinking unfortunately. Let me illustrate few examples of how both state agencies and private companies have not exploited the opportunities of partnership for producing and disseminating viable location-specific knowledge. More than two decades ago, there was an advertisement issued by a large pesticide manufacturing company in Newsweek entitled. "A case where prevention is not better than cure". It is such a powerful message implying that farmers, those who want to use chemicals, should not use a schedule based strategy of sprays but opt for need based strategy. This advertisement was never issued in India by the same company. Likewise, the state agency also could not propagate similar messages. The result is excessive use of chemicals and consequently development of pest resistance, increase in the cost, reduction in the profits and huge debt burden on the farmers. The resultant distress is obvious. Many times, the recommendations of sowing time for different crop varieties are made in terms of days or weeks. In the wake of climate change and higher degree of uncertainty, such advice has little value. What is important is the temperature and moisture correlates of the sowing time. We need to provide information about these parameters and map them on to the robust indicators which farmers can use to make their judgments.
- c. *Monitoring the indicators of sustainability:* Despite well evident realization that current agricultural technologies are not sustainable, we have not started a systematic study or action research to develop such indicators. There are many studies which show that farmers do have their own indicators of sustainable production whether for crops, animals or trees. Scholars have used even companion plants (so called weeds) as indicators of soil mineral properties. While much is talked about precision agriculture, the probes with GPS and GIS

capabilities have not been developed to make a grid based soil micro nutrient map. The question of dispensers does not arise. Thus neither the ecological indicators are being documented or developed nor electronic probes are being designed. CSIO (Central Scientific Instruments Organization) had taken some lead in this regard but not much has happened in terms of mass applications. Long-term experiments monitoring the effects of various technological changes are also not being studied. The dissemination of such knowledge based indicators thus is not taking place. Ask a farmer how does he value land before purchase and he would describe so many indicators about its quality. So is the case with the animals and trees. In Madurai, where neem plantations have been taken up on a large scale by the farmers, the patterns of cracks on the bark seem to indicate the productive potential of trees. Accordingly, the less productive trees can be harvested early or weeded out.

- d. *Online and offline databases in local languages for sustainable agriculture:* A search on internet about the sources of information in local languages with graphic details whether of beneficial insects, monitoring tools for soil and water quality measurement, developing farmer bred varieties by making selections, etc., will reveal the current national commitment to communicate with the farmers in their language. Thus, on one hand we lack relevant information for non-chemical, non-monetary inputs and on the other, whatever we have, we are not able to communicate in local languages.
- e. *Integrating micro level weather data with crop pest, disease and productivity parameters:* With the advent of self-contained automatic weather stations developed by IIT, Madras, with possibilities of mobile based communication at preset interval, there is a need for developing crop-weather and input models for dealing with risks and uncertainties. A very massive effort is required for knowledge intensive approaches to managing production systems. It is well known that a combination of temperature, moisture and soil conditions may influence the onset or growth of several diseases or pests. Once we know about the equations, farmers can develop intelligent heuristics and anticipate the problem so that they can deal with it appropriately. Traditionally, farmers have done that in potato and some other crops to deal with frost and blight incidence. Intelligent farmers require intelligent knowledge management approaches. It is time that we reinvent the entire discipline of extension.
- f. *The linkage among soil, crop, animal and human health:* As a part of a report for developing Village Knowledge Management Systems (VKMS) for Department of Science and Technology, submitted recently, I have shared my anguish at lack of studies to demonstrate such linkages. There are studies which show clearly the effect of nutrient efficiency in soil on animal and human health through transfer of this deficiency in food. One of the first such tablets which came in the market for human consumption was zinc supplements in 80s when the deficiency of this element led to large scale health effects. Role of Boron in mitigating pain in the joints and the ability of local varieties of maize to mobilize it better than hybrids has not been adequately pursued in India. Similar is the situation with regard to the role of other elements including lithium. Selenium deficiency is known to cause adverse effects on young bovines and even in the humans. Preventive health is much more democratic, affordable and accessible. Improving health

through improving nutrition is a cost effective way. For improving nutrition, enhancing soil health may be much more effective and efficient. There is no point in keeping artificial boundaries between agricultural and health extension in such cases. Nutraceuticals have occupied huge segments in the market worth billions of dollars. Many of the crops and varieties under threat of extinction actually are much richer source of minerals and fibres [such as minor millets]. Almost everybody today suffers from cholesterol problem and thus needs fibre and mineral rich diet. The soils of rainfed regions because of less leaching are rich in minerals. Without improving productivity, we can increase the income of the dryland farmers by adding value and characterizing their outputs appropriately. Approaches to manage such knowledge require development of new generation tools, techniques and communication channels.

- g. *Transition to agro-industrial and processing based extension:* It is ironic that the advantages of industrial growth have not percolated adequately in the rural areas. In the time of recession, we have not yet explored the opportunity for new kinds of distributed growth possible through value addition in agricultural production. The extension system has remained focused on primary production. It is time to change this trend. To illustrate, I have studied the patents in India and USPTO on various agricultural commodities. In the crops like psyllium [*isabgul*] where we have almost monopoly in the world, there are only two Indian patents in USPTO. Hundreds of other patents are by US and European companies and researchers. The implication is that Indian farmer will only export raw materials and the value will be added abroad. There is no way we can increase the income of farmers substantially only by focusing on primary production. The management of knowledge which will trigger entrepreneurship, value addition and drive to reach global markets will require sharing such findings with the farmers regularly. There is no attempt to share the latest patents on different agricultural commodities with the farmers so as to let them know the new potentials that are being discovered. Now that many industrial workers are going back to rural areas due to economic crisis, the extension service can convert it into an opportunity by focusing on industrial extension. There is a need for close cooperation with the Ministry of MSME to trigger joint initiatives.

## **Part II**

### **Bridging the gap**

Honey Bee Network has a huge database of grassroots innovations which on its own it will never be able to reach the nooks and corner of the country. The Network has done very well in scouting and documenting grassroots innovations, traditional knowledge, ideas, etc., and of course not all of them being unique or distinctive, numbering more than 100,000 from over 545 districts. Our record in dissemination, value addition or commercialization is not so distinctive. One of the reasons has been that the budget of NIF (National Innovation Foundation) went down in real terms during the last eight years while the knowledge base expanded phenomenally. There are KVKs (Krishi Vigyan Kendras) in almost every district but do farmer innovators get a chance to demonstrate their technologies at public cost at these KVKs. Likewise, are scientists mandated to do systematic validation of farmers' claims? NIF has MOUs with CSIR and ICMR. Surely, the agricultural extension and research systems will one day be convinced to join hands with this Network to recognize, respect and

reward creativity at grassroots. There are varieties developed by the farmers which have diffused over thousands of acres in several states but these farmers have not yet become role models for others. The idea is not to diffuse just the solutions but also the way to find solutions. Once we do that, there is nothing which will stop millions of farmers trying out local solutions for solving problems. India will truly then become a knowledge society. New models:

Developing a Village Knowledge Management System based on mobile and other ICT applications. It should have following dimensions [details described elsewhere, Gupta 2009, DST, GOI]. The following framework was developed specifically for those regions from where farmers' suicides have been reported. But with some modification, similar framework can be adapted for different regions and group of farmers.

### **NATURAL RESOURCE MANAGEMENT:**

1. Land information systems: Village level land use maps, showing soil characteristics, fertility, location and status of water sources and their quality, indicators of soil productivity status (Same, better or worse compared to the benchmark, GPS based grid system to encourage precision farming to economise on external inputs and move towards low external physical inputs based sustainable agriculture. The GIS will incorporate farmer based plot level information with the ability to monitor the state and the utilisation of future investments and their effect on risks mitigation.
2. Agro meteorological information base: Village level network of recording type automatic weather stations with appropriate analytical tools to convert observations into indicators and inputs for decision support system.
3. On-farm research and technology development: Development of contingency crop and livestock options, blending farmers' innovations from different regions to generate low costs affordable and adaptable solutions.
4. Pests, disease and nutrient management at farm level: Incorporating non-chemical pests management strategies to reduce, if not eliminate application of chemicals.

### **SOCIO-ECONOMIC INDICATORS:**

5. Monitoring system for socio-economic indicators: Anticipating household level to stress due to market and non-market based fluctuations and their varying effects on different classes of farming in different villages. The monitoring of household level access to formal credit and flexibility in its rescheduling and rehabilitation in the event of market or environment based risks.
6. The increasing burden of monetary inputs must be monitored so that relative advantages of non-monetary technologies can be better appreciated by the farmers.
7. Creating platform for informal lenders to share their terms and by legitimising competition among them, improving conditions of delivery.

8. Preventing foreclosure of properties of small farmers through debt and providing insurance cover.
9. Tracking markets and their effects on farmers under stress: Social reporting system will need to be developed so that information about anybody noticed under excessive stress and facing closure of most survival options is reported to the District Emergency Response System. The distress otherwise becomes despair after other options are exhausted. Price, and market accessibility information may improve the options of the farmers.

#### **EDUCATION, HEALTH AND NUTRITION:**

10. Monitoring educational and health status of various family members, particularly under economic stress, outside formal institutional lending or under default to the moneylenders.
11. Developing linkage between soil, crop and human health, anticipating implications of changing food habits because of grains distributed through PDS or otherwise.
12. Monitoring chronic nutritionally deficit regions and households: Special measures to be initiated for providing relief in such regions in a manner that women and children do not suffer excessively contributing to the family distress.
13. Providing emergency health response in case of attempted suicide or other socio-psychological indicators of depression: In the post crop failure and other such disasters, special counselling would be needed to avoid distress becoming despair. It is understood that mere counselling may not help. But, it might create room for manoeuvre for absorbing institutional slackness or inertia in responding to household level critical situations.
14. Monitoring special health indicators in 31 or 40 districts from where maximum suicides have been reported.

#### **KNOWLEDGE MANGEMENT SYSTEM:**

15. Creating maps of peoples' knowledge linked to spatial and sectoral insights: There are several ways in which time bound mapping of resources, opportunities, skills and ideas can be done. If out of hundred days of employment provided under Employment Guarantee Scheme, only ten or twenty days were spent for mapping biological, physical and other resources, a complete inventorisation can be achieved in all the villages affected with the distress. Similar attempt can be made to document the traditional knowledge as well as contemporary innovations in the same areas.
16. Creating MIS (Management Information System) linking Village Information System, Village Knowledge Register, health education and other developmental indicators, etc., with the physical and biological resource based information system.

17. Development of decision support system (DSS) for incorporating innovations and other knowledge from informal or formal sectors in day-to-day decision making by the households.

Several other models can be tried involving private, public, cooperative and civil society sectors. One has to appreciate that creating constructive tensions will keep the systems in balance and reinforce mutual accountability. Much is said about the dealer based extension system, however, the short-term view of the market can sometime do irreparable damage to the long term sustainability goal. At the same time, with appropriate indicators, training, and monitoring system, private and civil society sectors can blend and provide highly focused services. The involvement of user groups in generating and disseminating relevant knowledge has been tried in irrigation projects and some of the commodity cooperatives. However, we have not built the knowledge management capacity at the community level by sharing the scientific knowledge with the people. It will make lot of sense if we could focus in the coming years on transferring and developing science based knowledge systems in the country. That would imply enhancement of the capacity of the extension workers in statistical analysis of the data to be collected through observation trials as well as through on-farm scientific trials.

Lessons need to be learnt from the experience of Bt cotton in Gujarat: Despite the fact that neither the effect on soil microbial diversity nor on other environmental parameters was monitored by the scientists and extension workers, the growth was unprecedented. In about six years, farmers developed more than 300 so called illegal varieties, demystified the technology and increased the production from 30 lac bales to more than 100 bales in six to seven years without any specific intervention by the state agencies except in infrastructure [[www.blonnet.com/2006/11/14/stories/2006111400591100.htm](http://www.blonnet.com/2006/11/14/stories/2006111400591100.htm)]. The farmer breeders gave performance guarantee to the buyers and offered to collect the payment after the harvest. This was a privilege not offered even by the large companies. There is no legal ban in the country on transferring genes or special traits from one variety to another although environmental clearances are required and must be provided expeditiously without compromising science in the case of farmer bred varieties. Navbharat Seeds gave away the parent lines they developed from the Bt seed collected from farmers field [that is their version] and made these lines open source. So long as India does not provide any legal restriction on transfer of gene even from the protected varieties, farmers must be encouraged to develop their varieties. However, in cases where varieties have been protected [none of the Bt varieties are yet protected under PPVFRA], the license for self-use and sale is allowed under the law without using the brand name.

The consumption of pesticides came down drastically and many distributors closed their shops. However, as it often happens, nature does not accept uniformity, even of the Bt gene. Therefore, the need for sufficient precaution, environmental and health monitoring and disseminating scientific data on consumer and environmental protection aspects is undoubtedly there. Many secondary pests have become primary pests due to excessive sprays in some parts. Similarly effect on livestock, wildlife and human health needs to be studied. Millions of workers who spray pesticide without the use of safety gears were protected in the above case because of much lesser sprays. The need to involve farmers explicitly in the technology development chain has been reinforced once again by Gujarat experience. It is not that farmers stopped at merely solving a technological problem. They developed innovative agronomical practices even in totally new technologies such as Bt cotton. They grew nine month crop instead of conventional six months and with additional irrigation and



some inputs, got almost double the yield per hectare from such fields. Even the most skeptic extension scientists may like to reconsider the potential of farmer-to-farmer diffusion of technologies. Unfortunately, compared to trials of organic, chemical based, Bt with chemical, Bt with IPM, Bt with only herbal pesticides and agronomic means were not taken up despite repeated pleas [Gupta and Chandak, 2006]. The experience in other states was not so good and I assume mainly because farmers relied on corporate seeds, did not do enough experimentation and did not have a strong tradition of decentralized hybrid seed production [which Gujarat farmers were pioneer in] and did not have enough area under irrigation. Many times, the best state can do is to keep away. In this case, perhaps the state kept too much away and did not carefully analyse the environmental and other aspects.

The popularization of herbal pesticide in Gujarat is also much more widespread than in many other states. An interesting model was presented by Uplenchwar in Maharashtra way back in early 90s. He was a student of Dr.Rahudkar, a very eminent farmer supportive scientist. He wrote down the formula of herbal pesticide on the school wall for anybody and everybody to read and use. He also sent postcards to 1000 villages addressed to 'an anonymous farmer' giving the formula and mentioned, 'if you want to use the formula on your own, go ahead and do it. However if you want to avoid the drudgery and buy it, then buy it from me' [Pastakia, 1995]. The use of open source technologies with market-based mediation was illustrated in a wonderful way.

With the expansion of mobile phones even in the rural areas in the country, Honey Bee Network has been trying to develop application in multiple languages for farmers to get the same easily. From the time and place of the query, the database should be able to link the stage of the crop at which the problem might have occurred. Accordingly, the response should be tailored. Similarly, about 100,000 common service centers are being set up in as many villages. There is very little multimedia, multi language content on sustainable agriculture except at [www.sristi.org](http://www.sristi.org) site, which can be accessed by farmers for their use. There is a need for a mission-based approach to revitalize extension agenda.

### **Part III**

#### **Policy alternatives for institutional innovations in extension**

The suggestion for using a multi agency extension system, combining farmer-led and market-led extension system is completely valid and in fact is overdue. The need for integrating conventional as well as ICT applications is also very obvious. Some of the challenges, which need to be addressed for promoting institutional and technological innovations, are:

- a. *A national database on major pests, diseases, weeds and other soil and climate based stresses with photographs, multimedia clips with local names and control measures:* The fact that having spent thousands of crores on so-called agricultural innovations and extension, we still do not have such databases easily accessible to farmers should make us look at our priorities self-critically. The information exists, it has to be converted into knowledge and blended with the traditional wisdom so as to generate a decision support system [DSS].

- b. *Development of artificial intelligence based expert systems to enable farmers to derive field plot specific management strategies:* With the decentralized automatic weather stations proposed under VKMS for at least 40 districts, a pilot project for development of DSS and expert systems can be launched. A decision tree analysis approach can also be used to enable farmers to trade off various options progressively over time and space. Some preliminary work has been done in the country but much more remains to be done. It will require collaboration among different disciplines and departments with lot of empirical data to be pooled from the long-term soil fertility trials and on-farm experiments.
- c. *National fund for validating and value adding farmers' innovations for solving technological and resource use problems:* NIF and Honey Bee Network have succeeded in creating long term collaboration with CSIR (Council of Scientific and Industrial Research) and ICMR (Indian Council of Medical Research) besides many other institutions. Similar collaboration remains to be developed with agriculture research systems formally though at informal level, a very active cooperation is taking place. A national fund is required under which farmers will have a right to demand research from the public institutions and will not have to beg for such favours, as is often the case presently. Once such experiments have been validated, the extension system should incorporate the recommendations for appropriate domains. This fund should target all crops, livestock species, trees and value added products developed by the farmers or groups thereof on their own without any outside help. NIF can mediate in the matter since it already has a huge database drawing upon knowledge from over 545 districts.
- d. *Public content on public and private media:* The effectiveness of radio still remains as one of the most democratic means for diffusing knowledge. And yet, we have not made much use of this media in popularizing creative and experimental ethic at the grassroots level. While private channels and international networks like BBC, Discovery and Al Jazeera have taken repeated note of the subject, national channels are yet to do so in a systematic manner. Likewise, thousands of village level kiosks have been set up by various public and private partners and yet the content which will bring people to the kiosks is not being created. A national task force needs to be created which should invite individual and institutions to collaborate in closing this gap. It is ironical that an IT super power has such a poor record of using IT for reaching masses in local language with user managed and modified content.
- e. *User driven innovations in value addition:* If it is accepted that extension in future will not deal with only primary production, then inter-ministerial task force has to be created for building a platform for sharing available solutions and inviting proposals for solving unsolved problems. A challenge programme should be launched to develop cost effective mobile exhibitions, an innovation train and other such mechanisms to create countrywide awareness in this regard. We cannot remove poverty, improve productivity and generate employment if farmers and labourers continue to be employed in low value adding activities. Large number of examples are displayed at [www.nifindia.org](http://www.nifindia.org) and [www.gian.org](http://www.gian.org) which have been developed by the farmers and mechanics themselves. Why should not public extension agencies help in creating markets for such innopreneurs [innovation based entrepreneurs], many of whom are also ecopreneurs?

- f. *Extension strategies for farm labourers:* It is a paradox that most political parties woo labourers as voters but seldom consider them as target of technological extension system. While a farmer has enormous knowledge of his own field and of the neighbouring field may be, a labourer has to work many fields in many different regions and seasons depending upon the migration profile. It is obvious that her knowledge is far more diverse and yet extension system has ignored farm labourers. In academic journals, literature on the knowledge of farm labourers is also very scanty. That is why at a recent conference to revisit Farmers First concept developed in 1987 [in which I was also involved as organizer] at IDS, Sussex, I argued as to whether time has not come to move from Farmers First to Labourers First. Perhaps, Ministry of Agriculture should join hands with Honey Bee Network in organizing the first international conference on Labourers First so that their knowledge, skills and insights can become a viable, legitimate and essential pivot of future technological change strategies. India needs to show the way in this regard.
- g. *Linking germplasm, food processing industry and decentralized opportunities for agro and food processing:* It is well known that when income increase in any society, the proportion of processed food increases in the consumption basket. Be it roasted grains, flakes, germinated pulses or confectionary items or nutraceuticals. Extension system can join hands with NBPGR and private food industry to document the women's knowledge about various varieties, their uses and then make this database available to the food processing industry for adding value. Simultaneously, CFTRI (Central Food and Technology Research Institute) can be brought into picture so that models of decentralized entrepreneurship can be developed.

The whole approach to extension has to become more entrepreneurial and any delay in this transition will make the system more irrelevant. The innovations have to take place in *content, communication and collaboration* aspects of extension systems. I hope that the proposed national dialogue will prove to be a watershed in the history of extension science and action in the country. There is no other choice if the long forgotten village level extension worker has to be empowered to become a friend of the farmer and labourers once again.