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INNOVATION & INNOVATIVE PRACTICES IN RURAL INDIA

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ABSTRACT
Innovations have acquired a key-role in the growth and competition strategies of firms today. They are regarded as an essential tool to stimulate growth and enable firms to master the competition brought about by the forces of globalization. In developed countries they are thought to provide a vital buffer against challenges from low-cost producers from emerging countries.India has made commendable progress in terms of the growth of scientific and technological(S&T) culture. Today, India has a vast pool of S&T infrastructure with over 3400 technical institutions including around 600 universities, 400 national laboratories, over 1,300 in-house R&D units in the corporate and other sectors. The estimated annual out-turn of the engineering graduates is around 15 lakhs. About three fourth population of Indian population lives in rural areas and mainly depends on agriculture. Although the contribution of agriculture in Indian GDP is nearly 5%, agriculture is the source of livelihood of 70% of Indians. Hence there is a prime need of the innovations in agribusiness by which better economic productivity and social prosperity can be achieved for the Indian agriculturist.

This paper introduces the term innovation and it describes mainly two important innovations of rural India i.e. innovation(s) in agribusiness and e-panchayats. As the conclusion writer found that Indian firms and subsidiaries of MNCs based in India are now becoming important innovators in other countries by exporting technology developed in India. Hybrid rice cultivars are being exported to Bangladesh and Southeast Asia. Also, Innovations are the key drivers of the developing economy. In the near future Indian rural innovations can be the benchmark for the world and it will show the path of development for the underdeveloped, developing as well as developed societies of the world.

KEYWORDS: Innovation, Rural innovations, epanchayats, Agribusiness Innovations.

INTRODUCTION

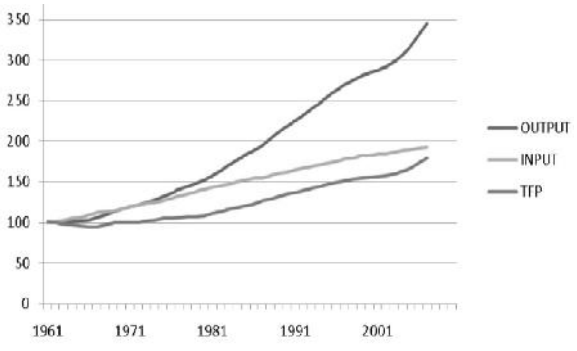
'Innovation is defined as a process by which varying degrees of measurable value enhancement is planned and achieved in any commercial activity. This process may be breakthrough or incremental, and it may occur systematically in a company or sporadically; it may be achieved by:

- Introducing new or improved goods or services
- Implementing new or improved operational processes
- Implementing new or improved organizational/managerial processes

In order to improve market share, competitiveness and quality, while reducing costs. This is accomplished through more effective products, processes, services, technologies, or ideas that are readily available to markets, governments, and society. Innovation differs from invention in that innovation refers to the use of a better and, as a result, novel idea or method, whereas invention refers more directly to the creation of the idea or method itself. Innovation differs from improvement in that innovation refers to the notion of doing something different rather than doing the same thing better. We will examine some innovative practices in India and we will look that how these practices added value(s) to the Indian economic & social development.

Research & Innovation in Indian Agribusiness

Innovations in agricultural technology and institutions and in farmers' education and experience have greatly contributed to increases in agricultural productivity in India, with agricultural production rising at an annual rate of around 2.68 percent a year from 1961 to 2007 (Figure 1). During the 1980s, growth rose to 3.49 percent but then sank to the long-run average of 2.69 percent for the latest period, 2000– 2007. For the entire period of nearly 50 years, increased inputs (land, fertilizer, labor, machinery) accounted for 53 percent of increased output, with total factor productivity (TFP) contributing the rest. Input growth accounted for all growth in the 1960s and for 70 percent of growth in the early Green Revolution period (the 1970s). In recent years, the contribution of TFP has also increased. In the period 2000–2007, TFP growth accounted for 74 percent of output growth in agriculture while increased use of inputs accounted for only 26 percent (unpublished data reported in Fuglie 2010).



Source: Fuglie 2010

Figure1—Agricultural index for India, 1961–2007 (1961 = 100)

In the last two decades—that is, since 1991—milk production has almost doubled, and egg production has increased by 150 percent (see Table 1). Within the crop sector, fruit and vegetable production has increased more rapidly than that of food grains (Singh and Pal 2010). Increases in per capita income shifted consumption from basic food grains to higher-quality and higher-value foods, such as animal protein, fruits, and vegetables. Increasing income has also led to increased demand for environmental services such as clean air and water and reduced greenhouse gas emissions, leading in turn to demands for organic food and biofuels.

Table 1—Production shares and amounts by category and selected crop yields

Indicator	TE 1981	TE 1991	TE 2008
Share in the total value of production (%)			
Crop	75.5	70.6	67.1
Livestock	17.5	22.0	24.5
Forestry	5.2	4.7	3.6
Fishery	1.7	2.7	4.8
Agricultural production			
Food grains production (mt)	124.20	172.45	230.67
Milk production (mt)	31.60	51.23	100.87
Fish production (mt)	2.44	3.55	6.87
Egg production (billion, number)	10.06	20.10	50.66
Crop yields (tons/ha)			
Rice	1.25	1.72	2.20
Wheat	1.71	2.33	2.79
Coarse cereals	0.69	0.88	1.42
Pulses	0.46	0.58	0.64
Cotton	0.16	0.23	0.47
Groundnut	0.84	0.88	1.46

Sources: Extracted from Singh and Pal 2010; Ministry of Agriculture for the year 2008. (2011)
Notes: TE indicates triennium ending; mt indicates million tons.

Farmers have also increased their use of modern inputs (see Table 2). From 1991 to 2006, fertilizer use almost doubled, use of tractors and quality seed tripled, and irrigation from tube wells has expanded substantially (the share of tube wells in irrigated area increased by 5 percent, while total irrigated area increased by 26 percent, from 66 to 83 million hectares [ha]).

Table 2—Input use in Indian agriculture, 1971–2006

Input	1971	1981	1991	2001	2006
Fertilizer use (kg/ha)	16.5	34.24	69.84	91.13	113.26
Number of tractors (’000)	148.2	275.9	738.4	1,221.8	2,361.2
Share of tube wells in irrigated area (%)	16.63	26.2	38.42	40.84	43.86
Quality seed distribution (’000 tons)	NA	450	575	918	1,550
Institutional credit (rupees/ha)	53.58	232.42	631.39	3,261.40	10,544.45

Source: Singh and Pal 2010.

Key Innovations in Indian Agriculture

The most dynamic sectors for private innovation over the last decade have been the seed industry for field crops, fruits, and vegetables; the pesticide industry; and the farm machinery industry. The seed industry has produced a steady stream of new hybrids of field crops and vegetables, including revolutionary varieties like the insect-resistant cotton hybrids developed through biotechnology that now dominate the cotton seed industry.

A steady stream of new pesticides have been introduced that in general are more effective and less dangerous to people and the environment. Almost all new active ingredients were developed outside India, but at the beginning of 2011, Dow Agro Sciences and GVK Biosciences announced the development of new molecules to be used for fungicides and insecticides (Dow 2011). Innovations by local pesticide companies have largely been new, low-cost ways of producing generic pesticides and new formulations of pesticides. In addition, a number of firms have developed biopesticides.

The agricultural machinery industry has developed inexpensive, small- and medium-sized tractors for both the Indian market and small farmers in wealthy countries. This industry has also developed more efficient and less expensive micro irrigation systems.

Perhaps the least innovative sector has been the fertilizer industry, but even in that sector new products are being introduced, such as combination fertilizers and some biofertilizers. The feed industry is another industry with limited innovation, introducing a few new feed additives but primarily working on low-cost combinations of current ingredients.

Animal genetics research has had its most high-profile success in poultry. Research by the Venkateshwara Group

adapted US and European breeds and developed new local layer varieties during the 1990s. Since then, it has provided a steady stream of new hybrid poultry varieties. It is the only place outside Europe and the United States where new poultry hybrids are being developed.

The agricultural processing and plantation sectors have introduced innovations for farmers and for consumers. The plantation crop sector has introduced new clones of tea and coffee, and new management practices. The sugar industry has new management practices and some new sugarcane varieties, and has started to produce electricity and biofuels. The biofuel industry has developed innovations such as new crops (tropical sugar beets, for example) and improved biofuels machinery, but with very limited adoption in India.

India also has become a global R&D center for food and beverages for many multinational corporations (MNCs), considering the size of the market in south Asia. Innovations from Indian R&D labs are mainly in the form of value-added products and supply chain management techniques.

Quantitative Data on Trends in Innovation

Time series data on innovation—pesticides, seeds, and biotech—show rapid increases in recent years. One measure of innovation in the seed industry is the number of cultivars the Department of Agriculture *notified* or recognized as new cultivars during various periods. This is an incomplete measure of innovation because notification is not required except for cultivars from public breeding. Government allows private companies to introduce cultivars without notification, which companies have preferred, and so only few private cultivars have been notified. Even with this partial measure, the rate of innovation holds steady from the 1980s to the 1990s but then grows rapidly after 1999 (Table 3).

Table 3—Trends in notified varieties of major field crops

Crop	Number of notified varieties and hybrids by decade		
	1980–1989	**1990–1999**	**2000–2010**
Rice	198	188	303
Wheat	84	66	112
Maize	43	64	113
Pearl millet	38	45	51
Sorghum	55	49	55
Cotton	72	78	95
Total	490	490	729

Another important area of innovation that can be quantified is the number of biotech genes (also known as *events*) and transgenic cotton hybrids. Transgenic cotton hybrids and new genes must be registered with the biosafety authority, and the rapid growth in numbers of hybrids and genes registered is shown in Table 4. The first transgenic hybrids of cotton containing the Bt1 gene were approved in 2002. The number of transgenic hybrids containing the Bt gene increased exponentially after 2005. The private sector has developed nearly all of these hybrids. In 2002 the first Bt gene was approved for commercialization and marketed through the joint venture Mahyco-Monsanto Biotech (MMB). In 2006, new Bt genes began appearing. In May 2006, Monsanto and Mahyco produced hybrids with stacked Bt genes, Bollgard-II (BG II). In the same year, two domestic seed companies, JK Agri Genetics and Nath Seeds, had new Bt genes approved for commercialization. The JK Bt was based on an Indian public-sector Bt gene, and the Nath Bt was licensed from a Chinese firm. In 2008 and 2009, two new Bt events were approved. The first was developed by Metahelix and the second by the University of Agricultural Sciences Dharwad (UAS Dharwad).

Table 4—Bt cotton hybrids and events approved annually and number of firms selling Bt cotton in India, 2002–2010

Particulars	2002	2003	2004	2005	2006	2007	2008	2009[a]	2010[b]
# of Bt hybrids approved	3	3	4	20	62	131	274	248	104
Events approved[c]	1	0	0	0	3	0	1	1	0
# of companies with Bt cultivars	1	1	1	3	15	24	31	33	37

Source: Compiled from IGMORIS 2010; Choudhary, B. and K.Gaur. 2010 Adityendra 2007; GEAC 2009.

Notes: [a] Cultivars approved by the Genetic Engineering Approval Committee exclusively for 2009.

[b] Approved cultivars through May 2010.

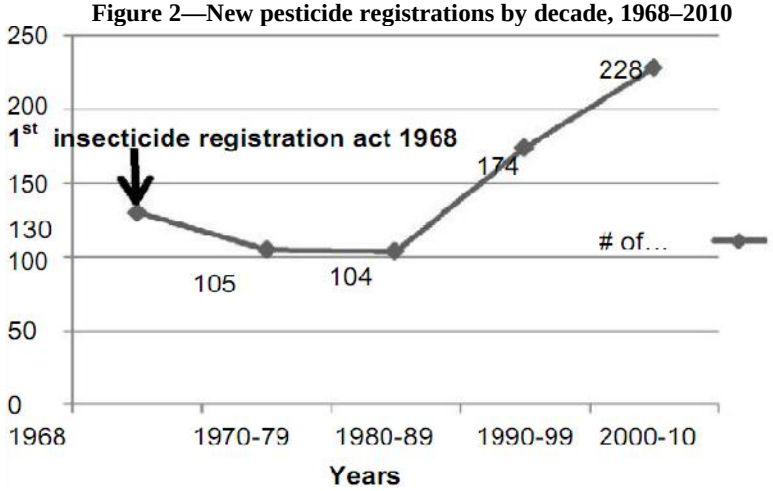
[c] Approved events are Monsanto BG 1 and BG 2, JK (IIT Kharagpur collaboration), Nath event (Chinese Bt event),

Metahelix, UAS Dharwad (Central Institute for Cotton Research collaboration). Events in the pipeline include Round-up Ready Flex (RRF)trait by Monsanto, Dow Agro Sciences, JK event, and Bayer Crop Science.

Bt stands for *Bacillus thuringiensis*, a bacterium that is the source of the gene that makes this cotton poisonous to certain insects but not to other insects or mammals.

Pesticides registrations have increased rapidly since the 1980s. Twice as many pesticides were registered in the first decade of the 21st century as were registered in the 1980s (Figure 2). These registrations, all by private companies, are primarily new formulations of active ingredients, but some new active ingredients and formulations for new crops, especially horticulture crops, have been developed.

Figure 2—New pesticide registrations by decade, 1968–2010



Source: Compiled from Central Insecticide Board and Registration Committee, 2010.

Private sector research & innovation

The innovations discussed above have come from government research programs, Indian firms' research, and foreign research. Public-sector research programs continue to make important contributions to the development of new varieties of self-pollinated crops like rice, wheat, many pulses, and oilseeds; improved dairy breeds and veterinary vaccines; and innovations in crop, pest, and resource management.

Other innovations in the seed industry were primarily developed by the private sector. Varieties of other crops such as cotton, maize, pearl millet, and sorghum, which are all hybrids in India, primarily come from the private sector (Table 5). Since liberalization of the vegetable seed trade in 1988, vegetable varieties primarily come from the private sector, which either imports or develops its own varieties (Table 6).

Table 5—Numbers of field crop varieties by public- and private-sector institutions in India, 2005– 2010

Crop	Public sector	Private sector
Tomato	3	160
Eggplant	8	218
Chili	2	73
Capsicum	1	31
Cauliflower	1	35
Cabbage	-	20
Okra	2	32
Watermelon	2	25
Cucumber	2	10
Gourd	6	80
Source	Kataria 2005	

Sources: MoA ,2010; truthfully labeled varieties collected from individual firms' websites and survey (34 firms).
Note [a] Includes only actual hybrids released by the private sector (not open-pollinated varieties).

[b] Includes open-pollinated varieties (mostly), 48 of which are hybrids.

Table 6—New vegetable hybrids in India, 1998–2005

Crops	Truthfully labeled private hybrids 2005–2010	Notified public varieties 2005–2010
Rice	79a	240b
Wheat	40	95
Maize	136	87
Pearl millet	97	48
Sorghum	75	46
Cotton	255	70
Total	603	346

Sources: MoA ,2010; truthfully labeled varieties collected from individual firms' websites and survey (34 firms).

Other innovations (in both product and design) were primarily developed abroad and then imported. These include the active ingredients of pesticides, varieties of European vegetables, designs of tractors and harvesters, biotech genes, poultry genetics, and veterinary medicines.

Patent data enable us to compare innovation among different industries and between Indian and foreign firms. Table 7 provides data by major industry on number of patents granted and applications for patents not yet granted. Data are not available from before 2000 in most agriculture-related industries because product patents were not allowed in chemicals (including pesticides, fertilizers, and veterinary medicines), agriculture, and biotechnology until 2005, although they could be filed before that. New plant varieties cannot be protected by product patents, but since 2009 they can be protected using the Plant

Variety Protection (PVP) and Farmers' Rights Act. The largest numbers of patents granted and of published applications are in the pesticide industry, followed by plant biotechnology. Agricultural machinery has the third-largest amount of patenting. MNCs dominate patenting in

most industries. However, patenting by Indian industries is also growing (compare granted with published patents), especially in pesticides, fertilizers, and agricultural machinery. Patents by MNCs primarily reflect research conducted outside of India and brought in through local subsidiaries and partners

Table 7—Private-sector patenting in India, 2000–2010

Sector	Firm type	Granted (2000–2010)	Published (2004–2010)
Plant biotechnology	Indian	1	8
	MNC	78	245
Pesticides	Indian	58	89
	MNC	373[a]	1,199[a]
Fertilizers	Indian	5	46
	MNC	16	25
Agricultural machinery	Indian	31	39
	MNC	52	109
Total	Indian	95	182
	MNC	519	1,573

Source: Compiled from Intellectual Property India,2011

Table 8 shows that Indian companies hold most PVP certificates for new varieties, 52 of the 80 that have been issued in the two years since the PVP office was established. MNCs have 17, and government institutions have 11. Table 2.6 does not include 403 PVP certificates on previously existing varieties, of which the public sector holds more than 75 percent. In the Indian system, farmer groups may also get PVP certificates, but so far farmer groups hold only 3 existing varieties and no new varieties

Table 8—Plant variety protection certificates issued for new varieties in India, July 2009– May 2011

Crop	Total	Indian firms	MNCs	Public
Cotton	24	23	1	0
Green gram	2	2	0	0
Maize	12	5	0	7
Pearl millet	7	4	3	0
Sorghum	11	3	5	3
Rice	23	15	8	0
Wheat	1	0	0	1
Total	**80**	**52**	**17**	**11**

Source: Calculated by authors from data obtained from Plant Variety Protection Authority of India 2009, 2010, 2011.

In the past, Indian firms licensed or copied agricultural innovations based on foreign technology, or foreign MNCs transferred technologies to their subsidiaries in the agricultural chemicals, tractors, and vegetable seeds industries. However, Indian firms have new methods of gaining access to international technology. Some companies are purchasing world rights to a technology. For example, the Indian pesticide company United Phosphorus Ltd (UPL) purchased DuPont's global Mancozeb fungicide business. Another new way of accessing technology is the purchasing of foreign companies to gain access to technology and markets. For example, in February 2006 UPL bought Advanta, a Netherlands-based multinational seed company, and moved its headquarters from Europe to India. Advanta has also recently bought several sorghum seed companies in the United States. Mahindra & Mahindra has expanded in a similar fashion, buying American and Chinese tractor companies. Shree Renuka, now India's largest sugar producer, has purchased several major Brazilian sugar and ethanol companies, gaining access to their sugarcane and processing technologies.

Indian firms and subsidiaries of MNCs based in India are now becoming important innovators in other countries by exporting technology developed in India. Hybrid rice cultivars are being exported to Bangladesh and Southeast Asia. Indian small tractors are being exported to the United States, Africa, and elsewhere. Generic pesticides are exported around the world. Indian biopesticides based on neem are being exported to Europe, the United States, and Asia.

INDIAN E-PANCHAYATS

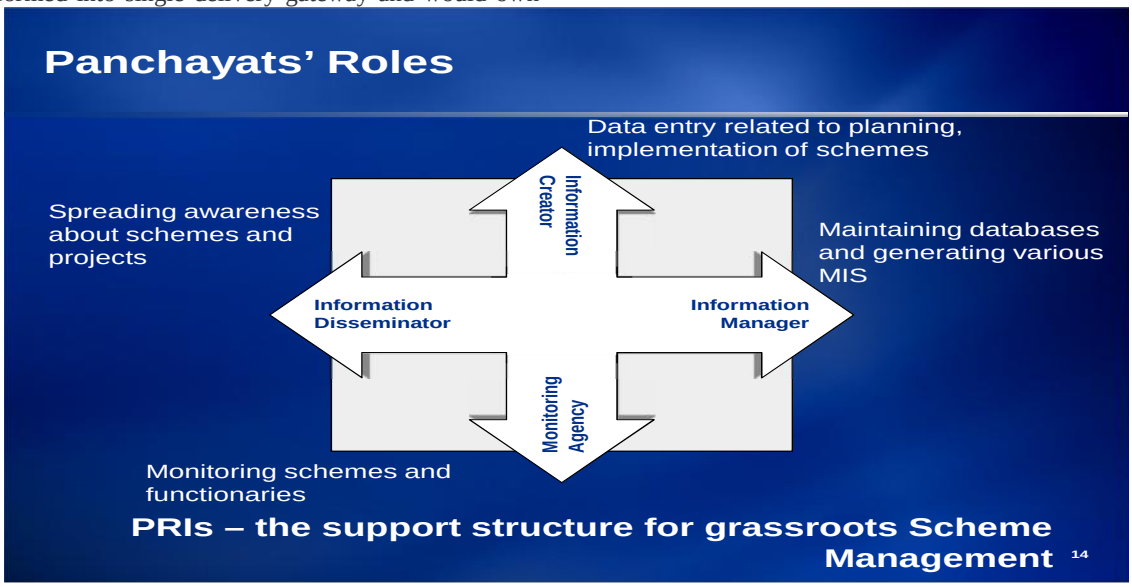
The vast majority of India's population lives in the villages and the Panchayats (village level governance units also known as Panchayats Raj Institutions(PRIs)) represent the face of the governance for these villagers. To improve the quality of governance of these PRIs including 0.235 million Gram Panchayats, 6094 Block Panchayats and 633 Zilla Panchayats, the Ministry of Panchayati Raj (MoPR),Government of India (GOI) has initiated the e-governance scheme known as ePanchayats. Following are the objectives of e-panchayats: (Role of panchayat is depicted in figure 3.)

1. Bring participatory approach in district planning process
2. Inclusion of standard financial accounting and reporting guidelines in functions and schemes of Panchayats.
3. To enhance the ability of panchayats to better collect, manage and utilize local revenue
4. Providing connectivity with state and national level agencies for support and smooth fund flow
5. Formation of database relating to integrated information about education, health, land, irrigation, agriculture, UID assets etc.
6. To bring transparency through social audit
7. To strengthen the service delivery system
8. To enable capacity building of officials of panchayat
9. To provide linkages to external world in term of markets and other financial opportunities

Background development of e-Panchayats

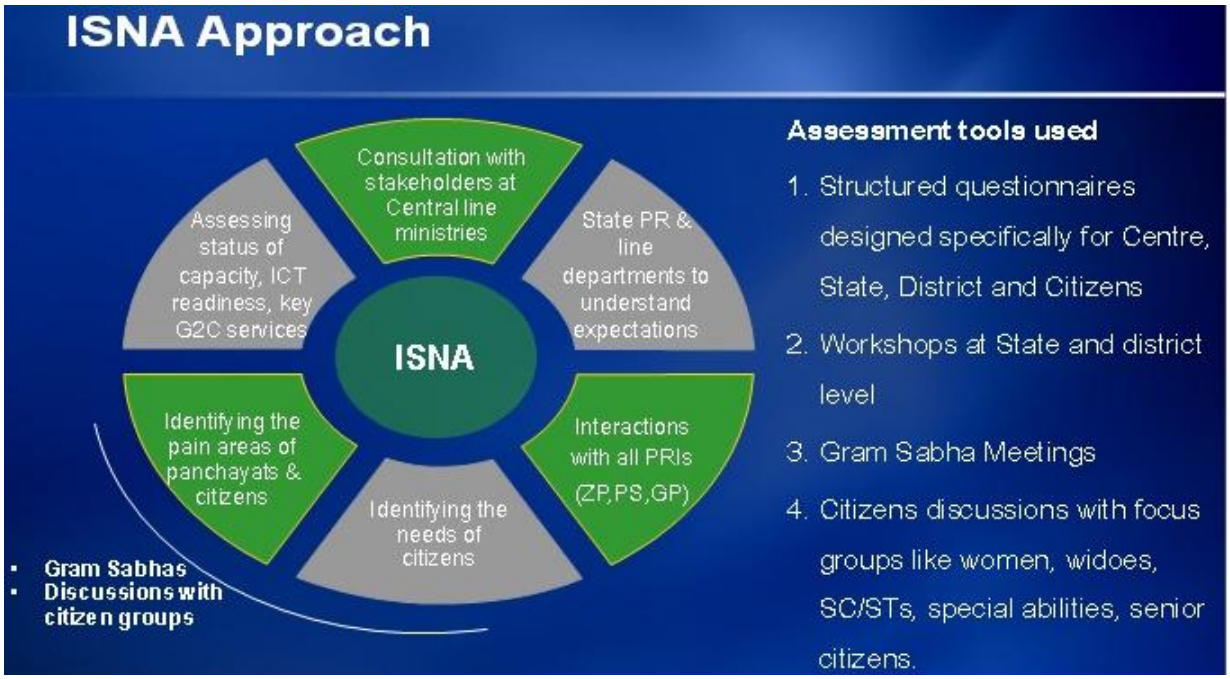
Jul '10	MoPR initiated the e-Panchayat Study Project to assess: • Role of Panchayats across various sectors • Needs of various Union Ministries / State Deptts that can be best fulfilled by the Panchayats • IT interventions made at the State level • ICT readiness of Panchayats • Service delivery needs of the citizens
Jan-Dec '09	Comprehensive nation-wide study across 114 Panchayats, 38 Districts and 27 States
2006-2009	IT interventions for Panchayats across the country • ePanchayat in AP, InfoGram in Goa, eGram in Gujarat, PRIASoft in Orissa, Panchlekha in MP, Asthi in Karnataka, DRISHTI in WB • Most of these projects focussed on IT infrastructure & software related to Certificates, Tax collection & Fund Management
Feb-May '06	NREGA & BRGF launched – Provided big thrust to Panchayats and brought them to centre stage Increasing role of Panchayats in flagship schemes
Apr- Jun '05	National Advisory Council (NAC) in Apr, 2005 suggested • A "National IT for Panchayati Raj" project to monitor fund flows • Recommended back-end support at all levels of PRIs / PR departments for operationalization of services
	DIT included e-Goverance for Panchayats as a MMP under NeGP

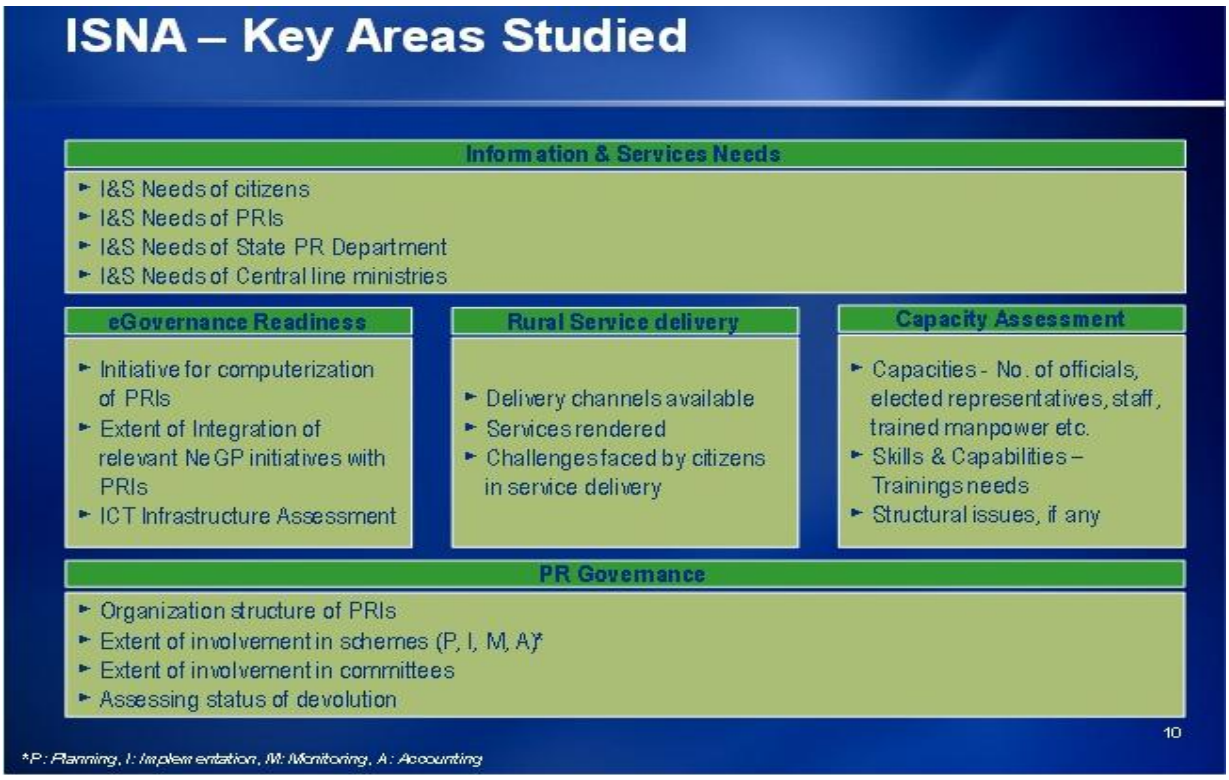
Under e-panchayat project, village and blocks panchayat offices will be provided with hardware and software tools like desktop computer, web camera, printer, scanner, pendrive, UPS etc. The state and union territories will follow PPP for the implementation. The services will be procured form private players through competitive bidding process.NIC is working to form GIF so as to build uniqueness in PRIs across the country. Some preliminary studies were conducted by ministry like Information and services need assessment see Figure 4. ISNA),Business process re-engineering(BPR) and preparation of Detailed project reports(DPR) state wise. ISNA helps to identify and prioritize the service and information needs of citizens and expected service levels of citizens and other stakeholders.BPR aims to fine tune the service delivery process and DPR reports throw light on cost and investment estimates along with project conceptualization. E-panchayats MMP would provide a unique code to each panchayat in the country. panchayats would be transformed into single delivery gateway and would own its individual website. This project would help to build district plan from grass-root level. It would also regulate and monitor fund inflows and outflows and their utilization in a transparent way. The accounting would be done by taking into account details of expenditures and receipts. Cashbooks, registers and other accounting tools would be generated at each panchayat level. The performance measurement would be done on regular basis. The evaluation of implementation of schemes will be done in a measurable and quantifiable way. the social audit report would be captured and events and details conducted by Gram Sabah would be managed. The software would help to make services according to convenience of citizens. Thus it would infuse citizen centricity which is an important pillar of E-governance. This would also facilitate a grievance redress system where complaints by citizens can be noted and sorted out. Most importantly the portal would have all information related to training and capacity building of panchayat office bearers.



There was extensive consultative approach followed for e-Panchayat study project

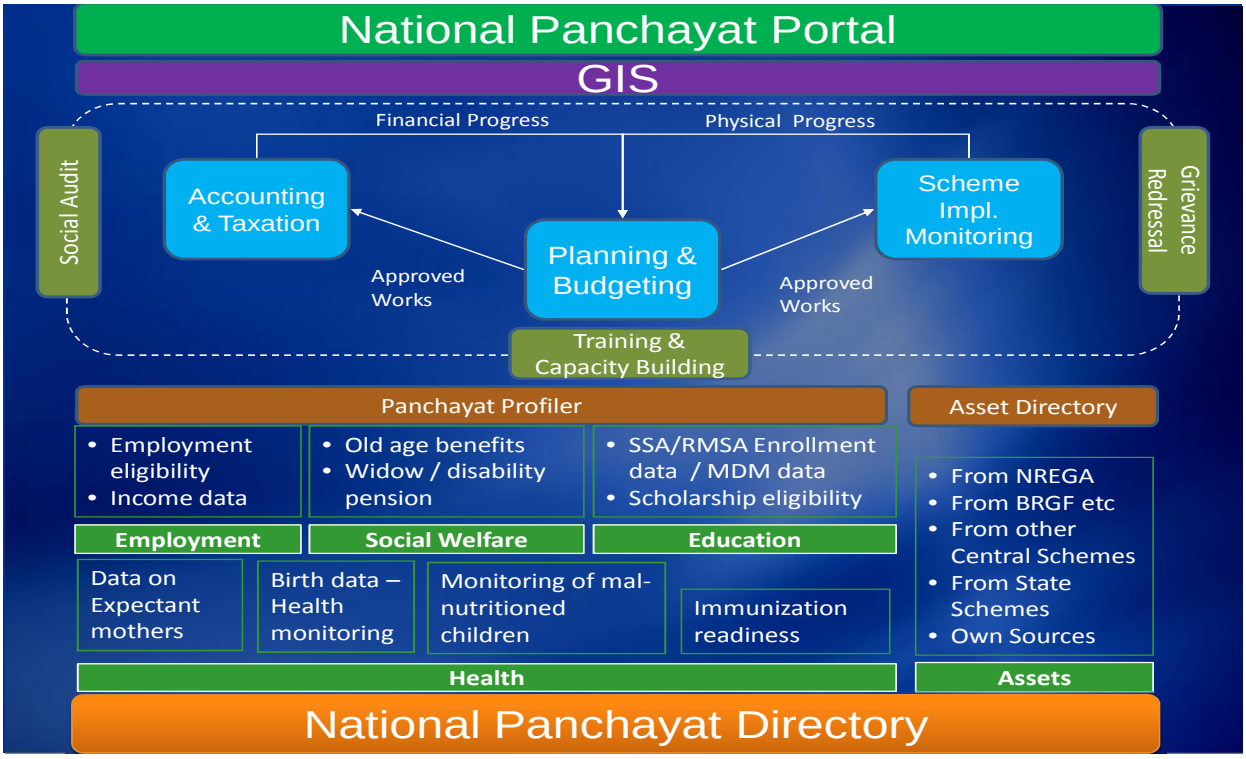
- **11** Central Line Ministries consulted
- State PR Department was the anchor & over **10** State Line Departments consulted
- **Block Administration, BP** consulted and their needs assessed
- **GP, Field level functionaries** consulted and their challenges & needs assessed
- **23 Central Schemes** studied to understand the data / information needs from grassroots & existing challenges
- **District Administration, ZP, DRDA** consulted & their opinions sought
- **Citizens** interacted and their aspirations & challenges captured by conducting Gram Sabha & one-to-one / focused group interactions
- Assessment of **existing ICT initiatives** done
- Plan to leverage the SWAN, SDC & CSC wherever available





There will be following applications installed for the better usability of the e-Panchayats.

	Application	Description
1	National Panchayat Directory	Unique codes to all Panchayats, delimitation of Panchayats, will link all applications of e-panchayats
2	ActionSoft	Scheme Implementation & Monitoring
3	Asset Directory	information of assets & utilities created and maintained by Panchayats. This would evolve into an on-line Panchayat Assets/Utilities directory
4	ServicePlus	To facilitate delivery of services to citizens
5	Panchayat Portals	Web site for each panchayat, integration with other software applications for panchayats, to act as a single delivery gateway, using single sign-on.
6	Panchayat Profiler	Socio-economic Information, Socio-demographic Information, Public Infrastructure & Services, Geopolitical Information of panchayats
7	PlanPlus	Panchayat-wise Perspective Plan, Draft Plan, Action Plan & head wise estimates of the budget
8	PRIASoft	Capture details of receipts & expenditure by PRIs, generate cash book, various registers, Utilization Certificate for various schemes
9	Social Audit	Social audits conducted by Gram Sabha, the action taken report etc.
10	Grievance Redressal	For citizens to lodge his/her grievance, its redressal
11	Basic GIS Applications	Maps of panchayats & integrate with other applications for panchayats such as Panchayat Profiler, Planning & Budgeting, Asset Directory etc. so that a spatial view of the profile/plan of a panchayat can be obtained by overlaying various non-spatial data.
12	Skill Management	To take care of training needs of Panchayat officials including elected representatives



Through the practices mentioned above we can conclude that Indian rural setup is going to be proved an important driver for the Indian development. Although its contribution in the Indian GDP is comparatively less than that of services & manufacturing sectors of Indian but now it is geared up. Innovations are the key drivers of the developing economy. I don't think that day is far behind when the Indian rural innovation can be the benchmark for

the world and it will show the path of development for the underdeveloped, developing as well as developed societies of the world.

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