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# **Which is the future for ICTs-based services in agricultural extension in India?**

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## List of abbreviations and acronyms

AES	Agriculture Extension Systems
DoA	Department of Agriculture
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
ICT	Information and Communication Technology
IBRD	International Bank for Reconstruction and Development
IFPRI	International Food Policy Research Institute
IT	Information Technology
ITU	International Telecommunication Union
NFI	New Food Innovation
NGO	Non-Governmental Organisation
NSSO	National Sample Survey Organization
UK	United Kingdom
UN	United Nations
R&D	Research and Development
SSM	Soft System Methodology
T&V	Training and Visit
VSAT	Very Small Aperture terminal
WB	World Bank
WLL	Wireless Local Loop

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## Abstract

In the process of agricultural extension and information dissemination, ICTs (Information and Communication Technology) has a unique potential to empower people their development. In India, the current agrarian sector suffers from depletion growth, directly leading to food security and rural development concerns. Several reasons can be highlighted for that, such as a global lack of institutional support, vulnerability of the farming class towards globalization exposure, rural infrastructure constraints, poor supply chain efficiencies etc. In such a context, the Indian agricultural extension systems (AES) are playing a fundamental role in leveraging the rural socio-economic situation, by catalysing agricultural efficiency and improving livelihoods and incomes of rural communities. However, AES strategies are judged inappropriate to effectively reach and empower rural people in the process of diffusion of information and technology. The information is deemed inappropriate, outdated and irrelevant for most of the farming classes. On the other hand, the rise of the ICTs and mobile phones penetration has been one of stunning change in rural India over the past decade. ICTs uses in rural areas presents a unique opportunity to reinvigorate actual information transfer patterns. Indeed, ICTs could become key enablers in democratizing information access to a wider agrarian community, improving the dynamism in information exchange to agricultural recipients and finally empower people in their extension.





## Forewords - Why this report?

It is important to understand how did we get this question. In March 2017, New Food Innovation Ltd (NFI Ltd, Nottingham, UK) started collaborating with a group of partners within a 2-year research project with Universities, Food Companies and Governmental institutions in India and in the UK (*See Appendix 1: List of Partners*). The project is supported and financed by the British governmental Innovate UK agency, that aims to encourage innovative development either nationally or internationally. Here, the goals of the India-UK project are twofold. The first purpose of the consortium is to experiment and develop a new commercial rice milling and separation process that increases rice harvest yield, minimises energy consumption and food waste in small/medium rice batch production context. The second purpose of the project is to optimise rice by-products uses (either coming from field such as straw, or being a co-product from the milling process such as bran and husk) in order to be beneficial for the local communities. In this partnership, New Food Innovation had the responsibility to either explore global rice waste valorisation techniques, and to find an appropriate dissemination strategy within an agroecological approach.

With the lens of an agroecological student, the soft system methodology was applied to view the Indian agricultural system holistically, and understand its multidimensional features. The preliminary goal in this research was to understand the current Indian agrarian scenario and its opportunities in rice waste valorisation techniques, but also to understand which approach could be taken in order to have the greatest impact within the farming communities. The soft system approach geared towards a primary agroecosystem analysis, that has been done applying tools as information gathering to identify key themes, rich pictures, interviews, literature review, and landscaping. The primary agroecosystem analysis revealed important themes that was the segmented and linear nature of the current communication strategies and information flows inside the farming community, and how the absence or non-availability of accurate data is detrimental to leverage rural people's decision-making power. Indeed, there is no dearth in agricultural knowledge around waste valorisation and agroecological solutions that are tailored to the local needs of the farming community. The key issue was found to be rather the lack of communication and expansion around these solutions, and the need to get them visible within the farming community to empower people. The preliminary agroecosystem analysis resulted in a change of scope of the research: the goal was not to create one generic solution around rice waste recovery technique, but rather to

democratize all the existent knowledge and know-hows that are tailored to the local context. India being “the epitome” of the world (i.e. Culture, languages, geographical features, agro-climatic situation etc.), one practical solution around rice waste recovery could not answer all the needs of the Indian heterogeneous farming community. The challenge is rather to facilitate the merging of global and local context-driven solutions, mostly created by the agrarian community itself. By doing so, and from a systemic approach level, the goal of the research is not to simply transfer techniques and knowledge around rice waste recovery in the farming community, but rather empower people and initiatives that already have been making a difference. In this context, this report aims to deliver a state-of-the-art of the agricultural extension systems’ abilities to provide and facilitate information sharing within the Indian agrarian community, highlighting information gaps and new opportunities to democratize all these agricultural knowledge and solutions to a wider rural mass, improve the dynamism in information exchange to agricultural recipients and empower finally farmers in their extension.

# Introduction

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## **State of Indian agriculture and challenges**

In India, the agricultural sector is placing great focus in ensuring national food security, and in the process, the overall national security of the country. Since the Trade Liberalization in the 1990s, India has become the fourth fastest growing economy in the world thus far in 2017 (World Bank Group, 2017), with an impressive annual 8% economic growth rate, mostly driven by the industry and service sector (Figure 1). Sectors such as IT services, automobile industry and the newest technologies start-up hubs are currently booming. However, the neo-liberal policy regime established in the 1990s has been largely criticised for a general neglect of the agricultural sector. Indeed, the flourishing industry and service sectors bypassed the agricultural stratum, which in contrast experienced a sharp deceleration in its growth rate and a steep decline in its contribution to the national GDP (Figure 1). Agriculture share of the total GDP was 38% in 1975, was reduced to 18,3% in 2015, and is projected to fall to ~ 7-8% by 2020 (FAO, 2017). Though India is no longer seen as an agricultural economy, this sector still continues to support more than half a billion people, providing employment to almost 60% of the total Indian workforce. Specifically in rural areas, where up to 70% of households depend primarily on agriculture for their livelihood. With a population predicted to reach 1.5 billion by 2030, the decline in agricultural growth ought to be an issue of grave importance in ensuring national food security, food availability and livelihood security for both rural and urban India.

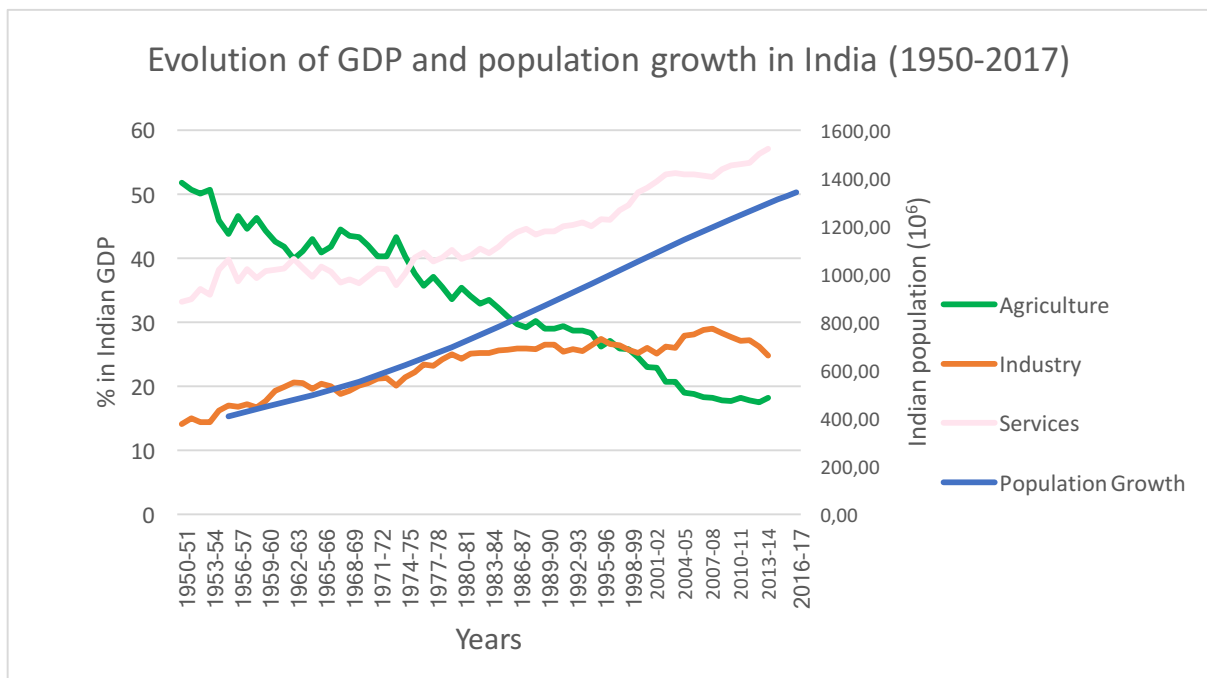
Many issues have emerged concerning food security in India in the last three decades. With the liberation of the global market, state intervention in agriculture has been consciously reduced in order to make way for the new markets worldwide. While the public investment in the agricultural sector has declined, the post-reform has facilitated an increase in the cultivation of cash crop. This has had a significant effect on food sovereignty. (Personal interview with S. Chandru, 2017). The vision of agriculture is no longer to only produce food, but to produce cash to compete in the world market. The traditional cropping pattern (eg: Vegetable, fruits, rice, wheat, coconut...) has shifted towards cash crops (eg: Sugarcane, cotton, tobacco) which need higher investments on inputs like fertilisers, seeds, irrigation and

adoption of new technology etc. This phenomenon leads to farmers' dependency on high cost inputs, often resulting in agricultural debts that has pushed several farming households into poverty (NSSO, 2005). Given the importance of the agricultural sector for employment and rural development, a number of studies have examined the declining growth trend of the sector. Several of them highlight the lack of government support as a main reason for the agricultural crisis. One such study, Suri (2006) argues that the agrarian distress is due to decline of public investment because it has pushed Indian agriculture into the global markets without any appropriate support. Examples of this being the growing costs of cultivation, volatility of crops output, market vagaries and lack of remunerative prices. Narayanamoorthy (2007) in comparison proposes that the decline of public support failed to provide the needed infrastructure for farmers to develop their activities (roads, electricity, irrigation being mentioned first). For example, the author suggests that poor irrigation progress led farmers to rely heavily on groundwater irrigation which, beside increase their cost of cultivation, has had a significant impact on groundwater depletion resources.

As well as the lack of government support, the accessibility of formal credit is very low and thus the new production initiatives are shrinking in the whole food supply chain. This lack of innovation and investment in the food system has led to a real "Technological fatigue" as mentioned by the Prime Minister on 53<sup>rd</sup> Meeting of the National Development Council Help in May 2007 (V.M. Rao, 2007). The whole Indian food supply chain is affected (high logistic costs, very traditional operations units, poor cold chain units, food wastage etc.) Translated into numbers, the BBC Worlds News is stating that about 40% of food in India is waste within the supply chain, and so 40% of food is wasted before it reaches the customer (BBC World News, S. Kannan, 2014).

In India, the future of sustainable agriculture growth, food security, poverty and hunger reduction will mostly depend on the performance of small and marginal farmers, as they represent more than 80% of the Indian farming landholdings. As described below, agricultural systems are changing and smallholder households must face new challenges from globalization exposure such as food security, increasing population pressure, climate change and related loss of biodiversity, change in consumption patterns, trade liberalization (eg: market volatility), inefficient supply chains and others. Agricultural systems are fast changing, and agriculture is becoming increasingly knowledge-intensive (G. Sylvester, 2015). To cope with the globalization challenges, farmers need to access a wider range of

information, networks and services allowing them to adapt to dealing with issues such as agricultural stagnation, climatic variability, market uncertainty etc. (J. Glendenning *et al.*, 2010). The availability, accessibility and applicability of agricultural knowledge and research outputs are the keys to addressing a range of issues related to food security and rural development. Indeed, there is a continuing need to provide up to date information to those at the front line of production, thereby ensuring greater food security for the ever-growing Indian population.



**Fig. 1:** Evolution of national GDP and population growth in India (1950-2017)  
**Source:** Adapted from the Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India (2016)

### Scope of agricultural extension in India

Agricultural extension plays a crucial role in ensuring agricultural efficiency, food security and improving rural development and livelihoods. In India, farmers are supported with many sources of extension services, including agencies in the public sector (eg: institutes, directorate, research centres), private sectors, NGOs and community-based initiatives. The goals of such services are to facilitate information and technology transfer to farmers whilst making advice services available to them. This has the aim to support them in achieving desirable agricultural development and in doing so greater ensuring their

livelihoods. Since the Green Revolution in the 1970-1980s and the acknowledged unsustainability of the Training and Visit systems (T&V) (J. Glendenning *et al.*, 2010), India's extension system continues to experience major changes to best fits farmers' needs. However, results from the National Sample Survey Organization conducted in 2005 (NSSO, 2005), revealed that only 40% of farming households had access to one or more sources of information, raising concern for the remaining 60% who were reported ignorant of the changing dynamics of the agricultural sector as well as other basic knowledge. More recently, another study was made by A.K. Sharma (2014), monitoring farmer's satisfaction with agricultural extension services ("Farmer's satisfaction with information sources and services: a study on farmer's opinion", 2014). Results showed that majority of farmers reported below average satisfaction with traditional extension systems (public libraries, community information centres, universities specialists, governments meetings, minikits etc.), whereas the most important information sources remain relatives (85% family members and 52% neighbours) radio (75%) and television (48%).

To cope with the low level of outreach, new approaches to agricultural extension systems (AES) in India continue to evolve. The linear, inflexible and technology-focused nature of the AES organization was identified as major issue of poor farmers' satisfaction in grey literature. The AES hierarchical top-down approach was criticised, said to cause information disparities within the farming community. Indeed, as suggested by G. Sylvester (2015), the traditional approaches to agricultural extension in India have been isolating and increased the vulnerability of small-scale farmers. This is due to the fact that the technology and means of knowledge transfer were not designed for marginal and small-sized farmland. The author mention that there is a need for new approaches that are tailored to address the diversity of culture, language, geography and other socio-economic and environmental factors in India, tailoring the information in light of local context. While technology transfer still has relevance, an integrated, multi-disciplinary and holistic approach to AES (that goes beyond crop productivity) is laudable as agricultural development in India takes place in a very heterogeneous farming community. Knowing that India is home to vast agro-ecological diversity, with its wide variety of agro-climatic regions and production systems, broad range of socio-economics conditions in the rural population, J. Glendenning *et al.* (2010) also suggests that a situation-specific agricultural extension approach could enable information to reach a more diverse range of smallholder farmers.

## ICTs expansion in India

Conversely to the agricultural decline in contribution to the national GDP, the development of Information and Communication Technology (or ICT) is witnessed as a major driver of the Indian economic growth. The ICT sector in India is about to experience a veritable revolution in rural areas: by 2020, 75% of new internet user growth will come from rural areas (NASSCOM, 2016), which will represent about 315 million Indians, compared with the 120 million today. India has bypassed the US as the second-largest smartphone market (after China), with the robust annual 30% penetration growth, because of fierce price competition. Mobile telephony is becoming one of the cheapest in the world and enabling rural Indians to get connected and fast. This is particularly important for those living for example in hilly terrains that would otherwise be largely isolated from the outside world. Mobile telephony will soon have a profound impact on rural Indian improving communication and networking linkages among the farming community.

ICTs, as referenced in IBRD & WB (2017), are any “device, tool, or application that permits the exchange or collection of data through interaction or transmission - ICTs are an umbrella term that includes anything ranging from radio to satellite imagery to mobile phone or electronic money transfers.”. New, small devices (eg: nanotechnologies), infrastructures (eg: cloud computing facilities) and above all application (eg: money transfer or item-tracking within the global supply chain etc.) are proliferating in the Indian rural scenario (IBRD & WB, 2017). ICTs can become key enablers of the agriculture sector by democratizing the information access, bridging the information gaps and providing real time information to all recipients. To face the communication difficulties of existents AES, ICTs show great potential to improve the synergy and communication efficiencies within the agricultural sector, empowering its upstream and downstream members with current, dynamic and interactive level of data and knowledge exchange.

Therefore, this report aims to demonstrates the criticality of information transfer in the Indian agricultural scenario, and related challenges and opportunities in providing and facilitating information sharing in farming communities. To understand the Indian agricultural environment in a holistic way, an agroecosystem analysis will be drawn in the first part of the results, in order to highlights the three key themes that structure this report: Information disparities, farmer empowerment, rural development and food security. Then, the second part

of the results aims to deliver a state-of-the-art of different strategies of AES, identifying their key challenges and performance in information transmission. To lead towards the discussion, the last part of the results will provide the socio-technical landscape in rural India, highlighting the growing trend for the cyber-extension and ITCs-based services. Then, having analysed the results, the discussion will first highlight the potential of ITCs to support AES strategies by addressing the three key themes found in the agroecosystem analysis (Information disparities, farmer's empowerment, rural development). The goal is to understand in which sense ICT could create a new synergy in information dissemination systems, either by democratizing agricultural knowledge to a larger rural mass and empower farmers in their activities. Last, supported with the analysis of different ITCs-based agricultural services, various entry points for ITCs application in India will be proposed. A conclusive SWOT will then answer the problematic and close this report.



# Methodology

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## **The Soft System Methodology**

The Soft System Methodology (SSM) was applied in order to understand the multidimensional features of the Indian agricultural scenario and related potential for ICTs uses in information dissemination. The SSM is used to support and structure thinking about complex organisational problems, helping to develop a multiple-perspectives framework of a system that could first appear messy and lack a formal problem definition. By acknowledging that the Indian agricultural system is performed by various stakeholders with different perceptions, at different levels and under all sort of formal or informal groupings, the agroecosystem analysis operated under the SSM helped to highlight the key themes and related “soft” problems of the area of research. Key themes are emerging systemic properties that could have significant impacts on the agroecosystem studied. Indeed, from a systemic approach, the three key themes of this report (i.e. Information disparities, Farmer empowerment, Rural development and Food Security) are working with each other: The need to empower farmers and bridge information disparities (i.e. criticality of communication and information transfer within the AES), which is for rural development and food security concerns, which comes back to farmer empowerment. Having this systemic understanding about the current agricultural scenario helped to target its opportunities and potentials that could be done around the key themes, and, after few conceptual modelling and further investigation, was revealed to be the opportunity of ICTs in information dissemination.

With the help of Checkland’s seven-stage Soft System Methodology diagram (Figure 2), we will now summarize tools and chronological steps that constructed the reflection of this report:

A. **Foreword - Problem finding:** *Why this situation? Why it is considered as problematic?*

→ Preliminary investigation. Tools such as landscaping, rich pictures, stakeholder interviews were used to understand to scope of the problem and define the area of research. Here, as explained in the “Foreword – Why this report” section above, the situation was seen as problematic because of the lack of visibility and expansion around local “know-hows”, agroecological solutions, agriculture-related information etc. in the farming community. After the preliminary agroecosystem analysis, the context is given: there is a need to democratize all this knowledge and context-adapted information in order to empower farmers in their extension.

→ The area of research is understood: New challenges for the agricultural extension systems (i.e. Food security and farmer empowerment), criticality of communication and information transfer in the agrarian community, and after: opportunities for ITCs.

B. **Facts findings:** *What is the current scenario? What is going wrong? How the problem affect people? Which potentials, needs etc.?*

In-depth investigation. The goal is to illustrate the richness and complexity of the current agrarian scenario (eg: structure, processes, climate, people and stakeholders, issues, interest...), and identify the key themes in the area of research. Indeed, this helps to target efficiently the needs and possibilities that can be done around the key themes found, thus determine which approach should be taken to better address them.

→ Creating a database of scientific papers (Indian agrarian scenario, role and strategy of agricultural extension systems, socio-technical landscape, farmer incentive surveys etc.)

→ Stakeholders interview and incentives, conferences

→ Framework of agroecosystem analysis (see part I), leading to root definition: “More and more marginal farmers, with low bargaining power (lack of information access and monopolies) who need to face new agricultural challenges from globalization exposure (eg: climate change, general neglect from government, agricultural growth in depletion, economic vulnerability, food security concerns etc.)”.

→ Key themes are identified: Information disparities, Farmer empowerment, Rural development and Food security.

**C. Idea finding: Information gathering.** *Where we want to go? How to have greatest impact?*

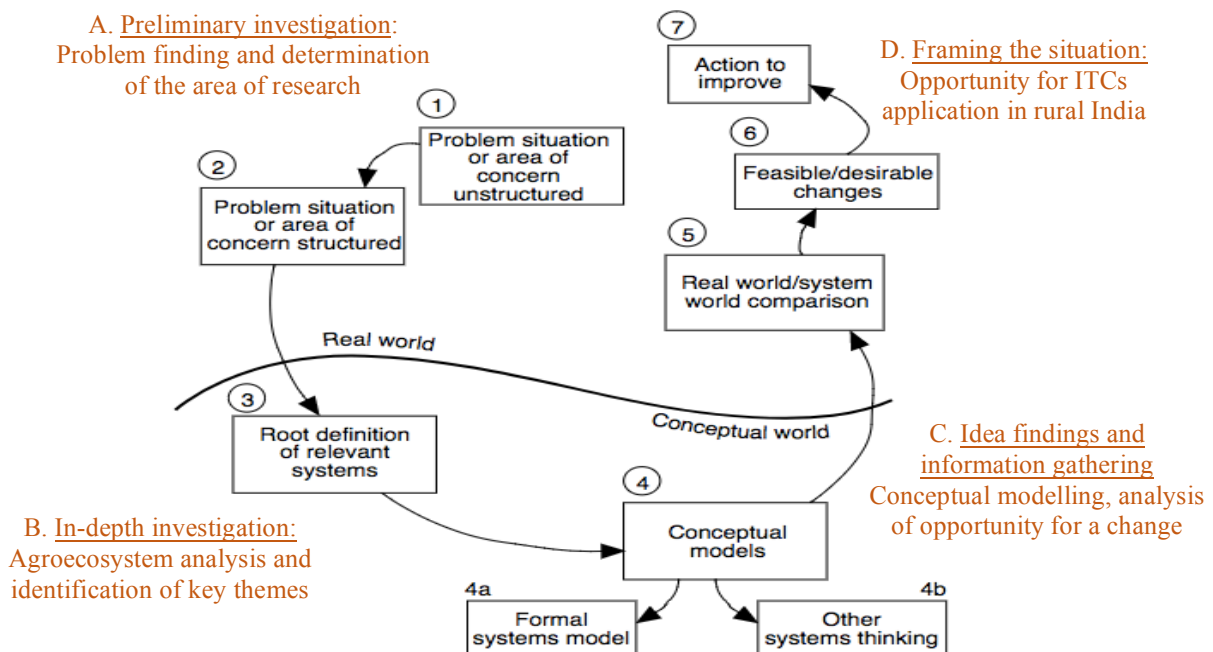
Having understand the current scenario, analysis of opportunity for a change: the emerging trend for cyber-extension. The ITC sector is in total expansion in rural areas and revealed to have a great potential in disrupting current AES’s information dissemination strategy. ITC has unique potential to open-up communication barriers, empower people in their own development and creating visibility to a wider agrarian mass.

- Stakeholder analysis, webinar, literature review
- Conceptual modelling, mind mapping

**D. Framing the situation:** *Which potential of action? Opportunities for ITCs implementation in rural India.*

Analyse and sort the data collected around cyber-extension, evaluate the different strategies of ICTs-based services and its impacts to the Indian agrarian environment. Leads towards recommendations and viability assessment for ICTs application in rural India.

- Tools such as SWOT Analysis, landscaping have been used.



**Fig. 2:** Checkland’s seven-stage soft system methodology  
Source: Nandish V. Patel, 1995

# Results

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## I. Agroecosystem analysis

According to the World Bank latest edition of Global Economic Prospect (2017), India is known as the fourth fastest growing economy in the world thus far in 2017. With a population that could surpass that of China's around 2024 (World Population Prospects 2017 Revision, UN Department of Economic and Social Affairs) and an annual 7-8% economic growth rate driven by industry and service sectors (eg: IT service or chemical, healthcare and retail industries), it seems India has boarded for an endless expansion journey.

However, one of the paradox of the Indian remarkable economic growth is that the agricultural sector, providing employment for approximately 60% of the total workforce, showed a sharp deceleration in the growth rate these last decades (Figure 1). With an ever-growing population expected to reach 1.5 billion in 2024, this ought to be an issue of great importance in ensuring national food security, food availability and livelihood security for the rural India. New challenges are emerging, and agricultural development will have to tackle wider dimensions that extend beyond agricultural productivity and food demand. In this section, we will try to presents a systemic framework of the Indian agroecosystem, which can be resumed in the figure 6. The framework<sup>1</sup> is based on trends, drivers and challenges that shape the agricultural development and related food security today. It aims to provide a global understanding of the Indian agroecosystem with a focus on seven key domains that are influencing and shaping the growth, sustainability and efficiency of the Indian agriculture: People and society, food supply chain, agricultural systems, markets and economics, policies, technology and environmental factors.

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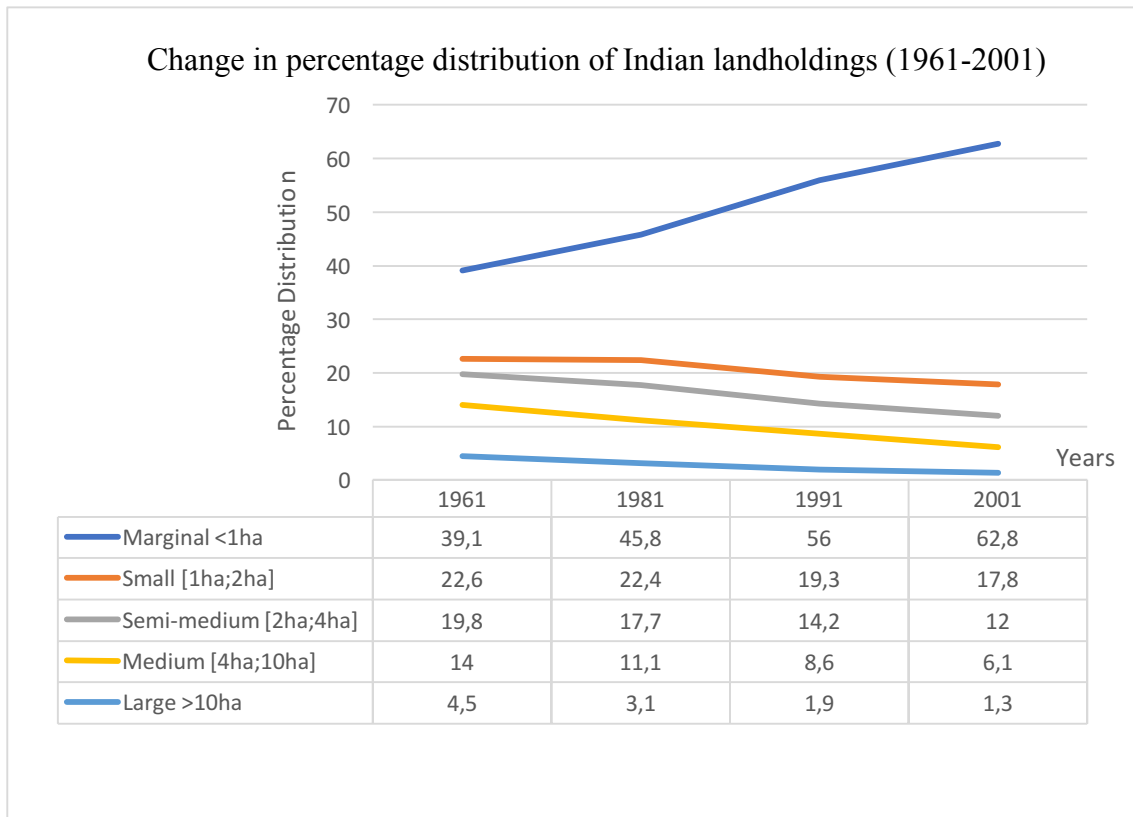
<sup>1</sup> It is to keep in mind that the suggested framework is a theoretical overview on the actual Indian rural scenario, and does not automatically reflects the whole agroecosystem in-depth. Effort were made to get the newest data possible (less than 15 years ago).

## People

By reaching 1,5 billion inhabitants in 2024, India is projected to become the most populous country in the world, surpassing China. This expanding nature of the population has some significant implications for the agricultural environment. Indeed, as part of a wider process of demographical growth and urbanization, the agricultural land boundaries spatially shrink, leading substitutions of cultivable lands and fragmented farms for urban development (V.M. Rao, 2007). The shrinking size of farmland is a persistent trend unique to India, as is shown by shows the figure 3. According to the Indian Agricultural Statistics Research Institute (2001), the share of small holdings (between 1 and 2 ha) and marginal holdings (<1ha) accounted for approximately 80% of the total land holdings (estimated 98 million out of 120 total land holdings), versus 60% in 1961 (Figure 3). More recent data was found in Gahukar (2011). the per capita landholding was 0,15 ha in 2000, 0,136 ha in 2010 and a projected 0,1ha per capita in 2050 (Figure 3). Factors that contribute to the shrinking size of farming area are, besides others, landlessness and subsequent labour scarcity. With half of India's arable land remaining in the hands of 7% of the total large landholders, smaller land holders are competing each other to get land titles and access the other half of the farming area. Arable land is becoming increasingly difficult to access, and therefore many of the rural unemployed are drifting towards the cities.

With the secondary and tertiary sectors booming (Figure 1), the rapid expansion of semi-urbans and urbans boundaries powerfully impact rural life styles. Where once rural areas were disconnected from cities, now rural communities have multiple links with urban areas and are acquiring urban features. New urban boundaries are spreading out with their urban life styles. With the rise of the middle class in urban area and related lifestyle preferences, there is a shift in consumption pattern\_ either for food or retail references, that will impact the food supply chain system (see next section "Food Supply Chain").

Often referred as the "Epitome of the World", it is known that the geographical and cultural pattern in India is unique. Being a large country with a large population, the Indian agroecosystem find its richness in its diversity: distinctive ethnic groups with more than 1500 spoken dialects (22 officially recognized), with a large diversity of agro-climatic settings (hills and mountains, wet lands, desert, sea coast...) and related diversity in agricultural production systems (irrigated, rain-fed, coastal etc.)



**Fig. 3:** Change in percentage distribution of Indian landholdings (1961-2001)  
**Source:** Indian Agricultural Statistics Research Institute, New Delhi, 2001

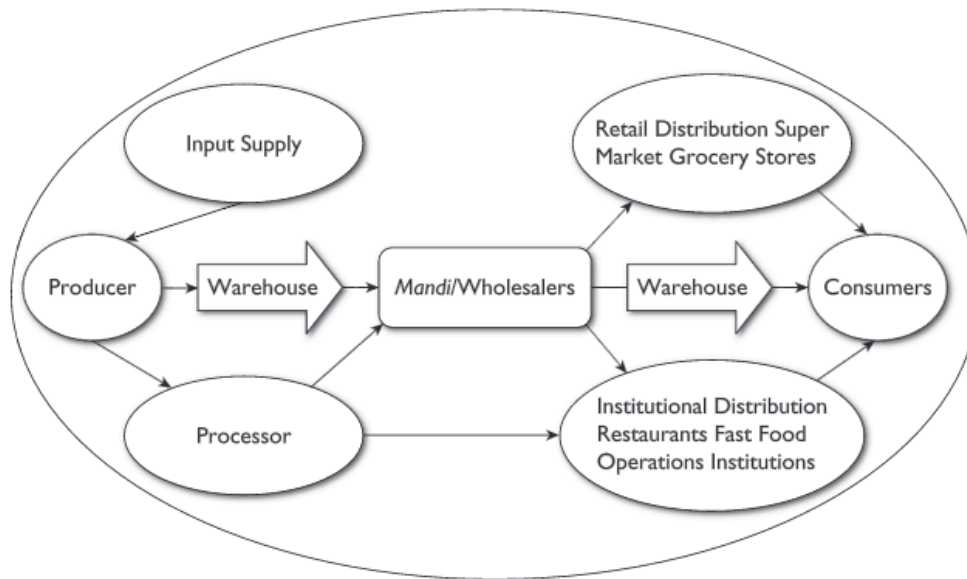
## Food Supply Chain

Feeding the burgeoning urban and rural mass is one of the biggest agricultural challenges facing India today. As mention Pingali and Khwaja (2004), the fast-growing economic rate induce change of lifestyle preferences, especially noticeable in food diets. Indian diets shift away from traditional products such as food grain to high value products like dairy products, meat, vegetable and fruits. Thus, the challenge for the overall food supply chain requires not only an increase in food supply efficiency (production, distribution) but also a diversification of activity in order to meet the escalating food demand.

Today, 40% of the food produced is wasted within the Indian food supply chain, meaning 40% is wasted before it reaches the customer. Several reasons can be highlighted for that, such as the inadequate cold-chain infrastructure, poor logistics and lack of communication within the supply chain (S. Parwez, 2014). First, there is a shortage and

misallocation of cold chain storage facilities. According to S. Narayanswami and C. Balan (2014), 60% of India's cold storage are located in only 4 states - Uttar Pradesh, Gujarat, West Bengal and Punjab - while the remaining 24 states and the bulk of the country are left underserved. Also, as mentioned the Times of India in April 2014 (V. Mohan, 2014), the cold storage capacity is roughly 50% short of the cold storage requirements. Indeed, the cold storage requirements in India are estimated to be around 61 million metric tonnes to minimize food wastage, but currently represent for around 32 million metric tonnes (V. Mohan, 2014). Then, the Indian supply chain remain highly traditional. The existence of many intermediaries – 6 to 8 middlemen in average between the farmers and consumers - blocks the process efficiency, that can lead to transportation delays, obsolete losses and reduced margins for farmers (in India, farmers currently received in average 30% of the final price, versus 70% in USA). Also, from S. Mittal *et al.* (2010): “In traditional Indian markets, commission agents and traders dominate the supply chain and are the major price setters. Most Indian farmers are dependent on them for information.” Without appropriate information support, the monopolistic agents (i.e. “Mundi”) drastically reduces farmer's bargaining power (eg: outdated information, no real-time market price etc.). Moreover, poor distribution systems and infrastructures (eg: ports, roads, electricity) also increase logistics costs and supply chain efficiency.

S. Parwaz (2014) is saying that the major issue in the Indian supply chain is the lack of integration between different sub-systems of the chain (Figure 4). The author is pointing out the lack of information and data exchange among members stating that “Each participant in the chain acts as an independent agent with a very low level of relationship. [...] Collaboration and relationship management along the chain is key instrument for integrating the supply chain system and the ability to establish effective relationship is necessary to reach supply chain success.” This lack of coordination and communication among upstream and downstream members of the supply chain can also lead to the “Bullwhip effect” as argue V. Sharma *et al.* (2013). The Bullwhip effect is the unpredictability and variability of inventory planning and forecasting potentials due to improper information management, that can lead to overstocking or stock-outs in the inventory. The Bullwhip effect can also impact the agricultural systems, as in absence of timely information, farmers bargaining power may decrease as they are not able to decide what, when and how much to sell in the market.



**Fig. 4:** Agricultural supply chain network in India  
 Source: Sazzad Parwez, 2014.

### Agricultural Systems

The Indian farming landscape is dominated by subsistence farmers (80%), who need to face the challenges that results from exposure to globalization, integrated world markets and competition with larger production farms. First of all, after India entering in the era of globalization in the 1990s, all sub-sectors of agriculture have undergone a growth deceleration, except for the horticulture sector which has shown significant growth” (Table 1)

**Table 1:** Growth rate in output of various sub-sectors of agriculture, constant prices

Period	Crop Sector	Livestock	Fruits and vegetables	Non-horticulture crops	Cereals
1980-1990	2,71	4,84	2,42	2,77	3,15
1990-1997	3,22	4,12	5,92	2,59	2,23
1997-2005	0,79	3,67	3,28	0,05	0,02
Evolution (1980-2005)	- 70%	- 25%	+ 35%	- 80%	- 95%

Source: Adapted from K.K. Kakarlapudi, 2012.



The grey literature highlight several reasons for that Gahukar (2011) mention poor level infrastructures (irrigation, roads, electricity) and relatively low yields compare to other markets as shown in the Table 2: the crop productivity is lower in India compare to other Southeast Asian countries.

Table 2: Comparative crop yields in 2000-2003 (tons per hectares)

	<i>India</i>	<i>Developing Countries</i>	<i>World</i>
Rice, paddy	2.9	3.8	3.9
Wheat	2.7	2.7	2.7
Sorghum	0.8	1.1	1.3
Pulses	0.6	0.7	0.8
Ground nuts	0.9	1.4	1.4
Soybeans	0.9	2.1	2.3
Cotton lint	0.2	0.5	0.6
Sugar Cane	67	64	65

Source: K.K. Kakarlapudi, 2012

From an agronomic point of view, K.K. Kakarlapudi (2012) highlights several factors that impacted agricultural growth rate, as shown in table 3. Indeed, except the credit supply, almost all the factors turned unfavourable after 1997. Gross cropped area and net sown have declined, which was not compensate by an increase in crop intensity. The diminution of gross cropped area could be linked with the shrinking size of farm as seen in the section before. As argues Gahukar (2011), the table 3 also highlight the decline in irrigation area and electricity access towards the years.

Moreover, the integrated world markets have led to for an increase in cash-crops cultivation. The traditional cropping pattern (eg: Vegetable, fruits, rice, wheat, coconut...) change towards non-food crops (eg: Sugarcane, cotton, tobacco) which need high investments on inputs like fertilisers, seeds, irrigation and adoption of new technology etc. This phenomenon, beside to create farmer's dependency towards high cost inputs, has aggravating agricultural indebtedness that pushed several farming households into poverty. Moreover, disparity between high resource farmers and low resources farmers is an increasing issue. Indeed, the actual public extension system is often criticized for its neglects in small-scale

farming in the process of technology dissemination, because they have lower ability to invest in cost expensive inputs to adapt to the newer markets. For example, S. Dev (2012) give the example of the inability for the small-scale farmer to access to the flourishing horticulture markets because of their lower ability to invest on irrigation techniques (large farmers tends to capitalize on cheaper source of irrigation techniques rather than small-scale farmers have to rent water). Another disparity between different scale of farming systems can be found in the policy system and government allocations. Indeed, Gahukar (2011) point out that poor farmers were excluded from several schemes and subsidies due to debt burden and decreased farm incomes, that will be detailed on the following part.

Table 3: Evolution of the growth rate in area, input use, credit and capital formation in agriculture (1980-2005) (percent/year)

<b>Variable</b>	<b>1980-81 to 1990-91</b>	<b>1990-91 to 1996-97</b>	<b>1996-97 to 2004-05</b>
Gross cropped area	0.43	0.43	-0.48
Net sown area	-0.08	0.04	-0.55
Cropping intensity	0.51	0.39	0.07
Gross irrigated area	2.28	2.62	0.51
NPK use/ha NSA	8.255	2.401	2.044
Electricity consumed in agriculture/ha NSA	14.162	9.39	-0.159
Area witnessed crop shift (per cent)	5.6	5.6	4.8
Terms of trade	0.189	0.947	-1.63
Public sector net fixed capital stock/ha NSA	3.939	1.872	1.976
Private sector net fixed capital stock/ha NSA	0.642	2.134	1.721
Total net fixed capital stock/ha NSA	2.085	2.01	1.838
Credit supply/ha NSA	3.81	7.466	15.336

Source: K.K. Kakarlapudi (2012)

## **Markets and Economics**

The inception of the economic reform in the 1990s (i.e. Trade liberalization) provoked major changes in the agricultural sector. As states S. Dev (2012), “The economic reforms did not include any specific package specifically designed for agriculture”, because it initially focused on industry, tax reforms, foreign trade and investment, banking and capital markets.

Entering to the world integrated market first enhanced significantly cash-crops cultivation (i.e. High value products) because of their higher remunerative prices, which stifled food grain cultivation that are considered as less profitable crops (Table 1). Cash crops are mostly non-food crops (eg: Cotton, tobacco) and fruits and vegetables, which need high investment on agricultural inputs (e.g. Seeds, new and cost-effective technologies, irrigation) to compete with the world market. The growing reliability on cash crops has led pushed the farming community into economic distress due to the high input costs and the highly volatile output. Moreover, the trade openness had led to a drastic reduction in subsidies (see “Policy” section) and in credit allowance to the farming community, that significantly hindered the infrastructural development and investment on production initiatives, such as technology, machineries and irrigation systems. Indeed, as states K.K. Kakarlapudi (2012): “The Indian farming community is mainly represented by small and marginal farmers (80%), that could not take any investment activity without financial support by the credit institutions”.

Overall, the reduction of subsidies on agricultural inputs, the high costs of cultivation and unpredictable output prices due to the international market competition has become key points for the agricultural deceleration growth.

## **Policies**

Since the 1990s, Indian economy has reached an impressive rate of growth, performance mainly driven by the booming sectors of industry and services (Figure 1). However, the flourishing two sectors bypassed the agricultural sector, which at the opposite showed a sharp deceleration the growth rate, as mentioned in the section above. Indeed, the neo-liberal political strategy adopted after the 1990s had several consequences on the agricultural sector, mainly reflected by the deceleration in public investment both at national and state level since 1980 (Figure 5).

During the pre-reform (i.e. Green Revolution), the self-sufficiency in food production was reached mainly thanks to government support (e.g. Price supports, credit assistance, marketing facilities) which allowed the farmers to increase production capacity with low input costs, and allowed the creation of institutional support structures in rural areas (primarily in irrigation and electricity) (K.K Kakarlapudi, 2012). On the one hand, farmers were heavily relying on the support of the state for their development. The drastic fall on subsidies and credit allowance, coupled with the international market vagaries (low prices and output

volatility for cash crops) has led to distress in the farming class, as mentioned in the previous section. On the other hand, the fall of public investment after the economic reform significantly weakened the institutional support. Rural infrastructures (e.g. Roads, electricity, watershed management...) are essential features to revive rural development and livelihood (D. Singh, 2014). For example, the Table 3 below shows that the electricity consumption in agriculture drastically fallen, with a growth rate reaching the 14%/year from 1980 to 1990 to a negative -0,16% growth rate during 1997-2005. In rural India, firewood and chips are still the most important source of household energy (eg: used for cooking), followed by dung cake and LPG (Liquefied Petroleum Gas). Also, the public expenditure on research and extension slowed down. D. Singh (2014) states that the Indian government is, proportionally to their GDP, spending 50% less in agricultural extension and R&D than the other Southeast Asian countries. This could be one of the explanation of lowest yields in India compared to other Asian Southeast countries (Table 2), as well as the slowdown in crop diversification, that would require more investment on cold storage, rural road, communication marketing network, warehouses etc (P. Singh, 2014).

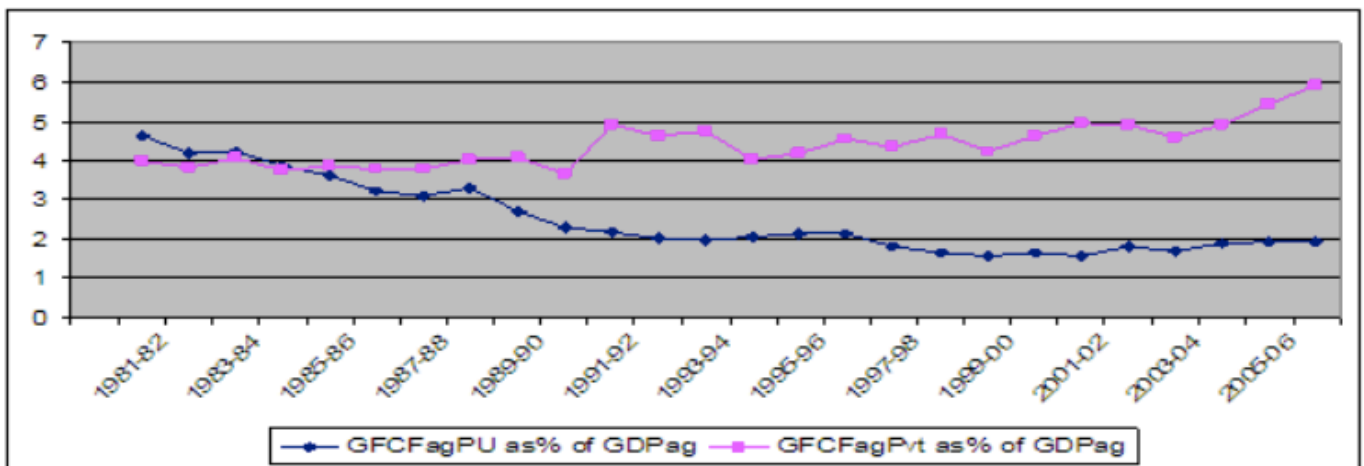


Fig. 5: Ratio of GFCF (Gross Fixed Capital Formation) in public and private Sector in Agriculture as percentage of GDP.  
 Source: Dr. Poonam Singh, 2014

## Technology

In the light of the political context mentioned above, the Prime Minister sounded the alarm in the opening speech for the National Development Council held on 2007:

“Small and marginal farming has become an unviable position; until farming was made viable at this scale, it would be virtually impossible to reduce rural poverty and distress... There has been lack of any breakthrough in agricultural production in recent years. There is a technology fatigue” (V.M. Rao, 2007)

First, the improved technologies were reported inaccessible to farmers: the 2005 National Sample Survey Organisation (NSSO, 2005) reported that 60% of farmers had not accessed any source of information about new technologies and practices to support their farming practices in the past years. Moreover, the supply chain is also affected by this technology fatigue, with high logistic costs and decreased performances due to very traditional operations units (see section “Food Supply Chain”). For example, only 2% of vegetable production and 4% of fruit production are being processed in India to ensure quality control, compared with other developing countries like Brazil (70%), Malaysia (83%) and Philippines (78%) (Balaji *et al.* 2016). The lack of appropriate technology to sustain the food supply chain’s efficiency is a subsequent cause of a considerable food spoilage within the food supply chain (i.e. 40%, S. Kannan, 2014 ). Another example happening within the supply chain is the lack of modern packing methods to prevent losses in handling and transit losses, inducing deterioration of food quality. India lacks of modern technology to counter the food wastage happening within the supply chain. (Balaji *et al.* 2016).

## **Environmental Factors**

With 329 million hectares, India had a wide number of complex agro-climatic situations, with a wide range of rainfall distribution, temperatures, relief patterns etc. However, there are common environmental themes that all the country has to overcome, such as groundwater pollution and depletion, air pollution, general climate change and monsoon unpredictability.

Water development is one of the major concern in Indian agriculture. The poor irrigation surface rate has compelled farmers to rely heavily on groundwater irrigation. According to Gahukar (2011), more than 50% of India’s irrigated land is fed by electric pump that directly extract groundwater, which result in a groundwater depletion rate of around 10cm every years. Although significant progress is being made in water resource development, challenges in water availability and quality remains critical for either

households uses, sanitation and agriculture. As the ‘Water in India: Situation and Prospects’ (A. Cronin, 2014) mention, water insecurity and poor water quality remains a major cause of child mortality and morbidity, especially among the poor (Table 4). Indeed, India lost more than 600.000 children under 5 years old in 2010, due water, sanitation and hygiene diseases.

The rapid urbanization, as part of a wider process of demographical growth and industrialisation (see “People” section), had led to a drastic rise in large cities with a million plus population over the last decade (M. Chandra, 2015). The booming urban mass is consequently affecting air pollution (e.g. Fuel and biomass burning, vehicles emission) and water pollution (untreated sewage, agricultural run-off etc.) Mahesh Chandra (2015) continues: “Although India has made lots of effort in regulation of environmental pollution since the 1970s, the country is still ranking low on air and water pollution levels compared to the rest of the world. [...] There is a lack of resource and technical infrastructure to face the pollution challenge.”

Concerning climate change, S. Dev *et al.* (2010) argues that it will become a key challenge for food security, livelihood and agricultural production especially for the small-scale farmers, which, living in a fragile environment, could not have the resilience needed to face an immediate and ever-growing risk of climate vagaries. Indeed, from the “Down The Heat: Climate Extremes, Regional Impacts and the Case for Resilience” report (World Bank, 2013), “The expected 2°C rise in the World’s average temperature will make India’s summer monsoon highly unpredictable”, leading to increased vulnerabilities from the farming class towards more frequent and damaging flood, drought and forest fires.

Table 4: Infant Mortality Rates (2010-2013) and Life expectancy rates (2013) for selected countries.

<b>Country/Year/Infant Mortality Rates</b>	<b>010</b>	<b>013</b>	<b>Life Expectancy</b>	<b>2013</b>
Canada	5	5		82
China	14	11		75
Denmark	3	3		80
<b>India</b>	<b>46</b>	<b>41</b>		<b>66</b>
Japan	2	2		84
Korea. S	4	3		81
Singapore	2	2		83
United Kingdom	4	4		81
United States	6	6		79

- Mortality rates under 5 years per 1,000 live births

Source: M. Chandra, 2015.

## Mapping the agroecosystem: Understanding challenges and opportunities

Here is a proposed framework of the agroecosystem analysis that was described below, with a focus on seven pillars: People, agricultural production systems, food supply system, policies, markets and economics, technologies and environment. The agroecosystem analysis resulted in three recurrent key themes (represented in black in the Figure 6), that are information disparities, food security and rural development and farmer empowerment.

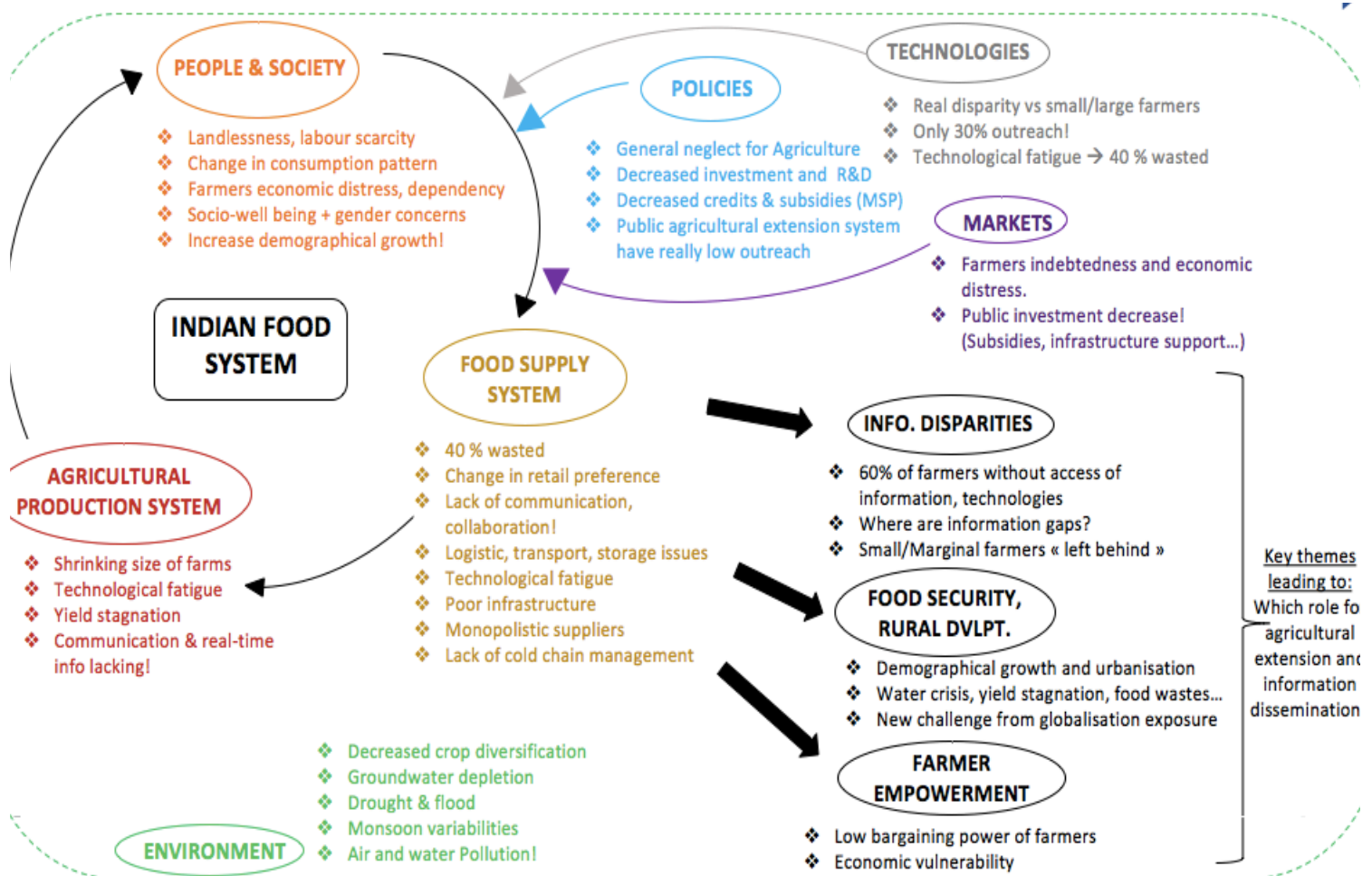


Fig. 6: Proposed mapping of the Indian agroecosystem.

New challenges are emerging in the Indian agrarian scenario, and agricultural development will have to tackle wider dimensions that extend beyond agricultural productivity and food demand. From the agroecosystem analysis that is mapped in the Figure 6, three key theme can be highlighted, respectively: Information disparities (i.e. social disparities, low level of outreach, poor supply chain efficiency due to inappropriate data sharing etc.), food security and rural development (i.e. demographical growth and

urbanisation, water crisis, agricultural depletion growth, food wastage within the supply chain, general neglect from government of the agricultural sector etc.) and the need of farmer empowerment within their supply chain (i.e. Monopoles with the “Mandi” system, economic vulnerability, low bargaining power, low decision-making power). Key themes are emerging systemic properties that could have significant impacts on the agroecosystem. The three key themes are interrelated as one is dependent from the other. Here, there is a need to empower farmers in their development by providing real-time, accurate and context-specific information in order to face the emerging new challenges from globalization exposure. Information and technology provision seems to be significantly lacking within the farming community, and could play a key role in leveraging either agricultural productivity and wider rural concerns. To validate so, we will now analyse the performance of organizational structures for information flow of AES, trying to understand its different strategies and its related challenges.

## **II. Information flows and related challenges for agricultural extension systems.**

The bane of Indian agriculture is not lack of technologies and R&D efforts, but inadequate and inefficient dissemination of relevant information to the farming sector (Shalendra *et al.*, 2011). The transfer of agriculture-related information appears to be a challenging task because it involves real-time transfer of data and knowledge, to address context-specific needs of a wide diversity of farmers (see I: “India has Epitome of the world”). Indeed, to improve agricultural production and supply systems, information dissemination will need to be tailored to the needs of farmers that are working in diverse settings and agro-climatic conditions, with wide panel of cultural, socio-economics, environmental and political affiliations, and for some of whom who are illiterate. With the emergence of globalisation and liberalisation, modern agriculture is fast becoming knowledge-intensive and information-driven. Traditional models of information transfer have failed to meet the ever-ending information demand by the farming community (Sazzad Parwez, 2014.). Indeed, most of the agriculture information transferred is found to be out of date, irrelevant and non-replicable for most of farmers needs (A.K. Sharma, 2014). Effective decision making is then drastically



reduced at every food system stage level, from crop to final produce, as absence or non-availability of accurate data is detrimental to leverage farmer's bargaining power.

### **Information networks.**

As argues S. Mittal *et al.* (2010), "access to information is identified as one of the key enablers of enhancing agricultural growth". So far in India, current models of agricultural information networks are largely based in extension services (AES), either represented by private, public or NGOs entities.

However, today these extension services have really low level of outreach in the farming community and reveals a poor degree of satisfaction by farmers. The National Sample Survey Organization (NSSO, 2005) demonstrates that at the all India level, only 40% of farmers households have access to one or more source of agriculture-related information (source such as radio, newspapers, fairs, NGOs...), and extension workers and public extension system were accessed by only 5,7% of farmers (NSSO, 2005). The applicability and coverage of these services remain highly limited. AES have difficulty in targeting knowledge and support needs of farmers, that could ease current agrarian crisis and rural distress (eg: increasing rural migration towards urban areas, economic vulnerability, farming seeing as non-viable activity and so on (*see part I*)). Indeed, the National Commission on Farmers (2006) analysed the causes of the agrarian distress and observed that farmers have the general feelings to be "left-behind" in large parts of rural India. Moreover, A.K. Sharma (2014) studied in a questionnaire-based survey the farmers' opinion and satisfaction on information access: For the farmers who accessed the information, much of it has been found out of data, irrelevant ("Old and Routine") and not applicable to their specific needs. The data revealed that farmers were below average satisfaction through extension activities such as fields days, exhibits, farmers' fairs, Train & Visit system, agriculture tours etc.: these sources of information were criticized to be less effective for farmer empowerment in the agricultural sector, and leaving farmers with very low level of information or resources at the end. The quality and relevance of information provided by extension services are also highly variable geographically. For example, as shown in the NSSO conducted in 2005, there were a large interstate disparity with access of information from the extension workers, because of the segmentation of the extension workers and related institutions, which have their own organization, personnel numbers and program focus in each state. Most of the current extension services in India work independently from each other, and the information and

knowledge flow within agricultural production and supply systems are either inexistent or very poor. Effective information flows and knowledge transfer among various members of the agricultural production and supply chains systems will be a key to strengthen the Indian food system environment.

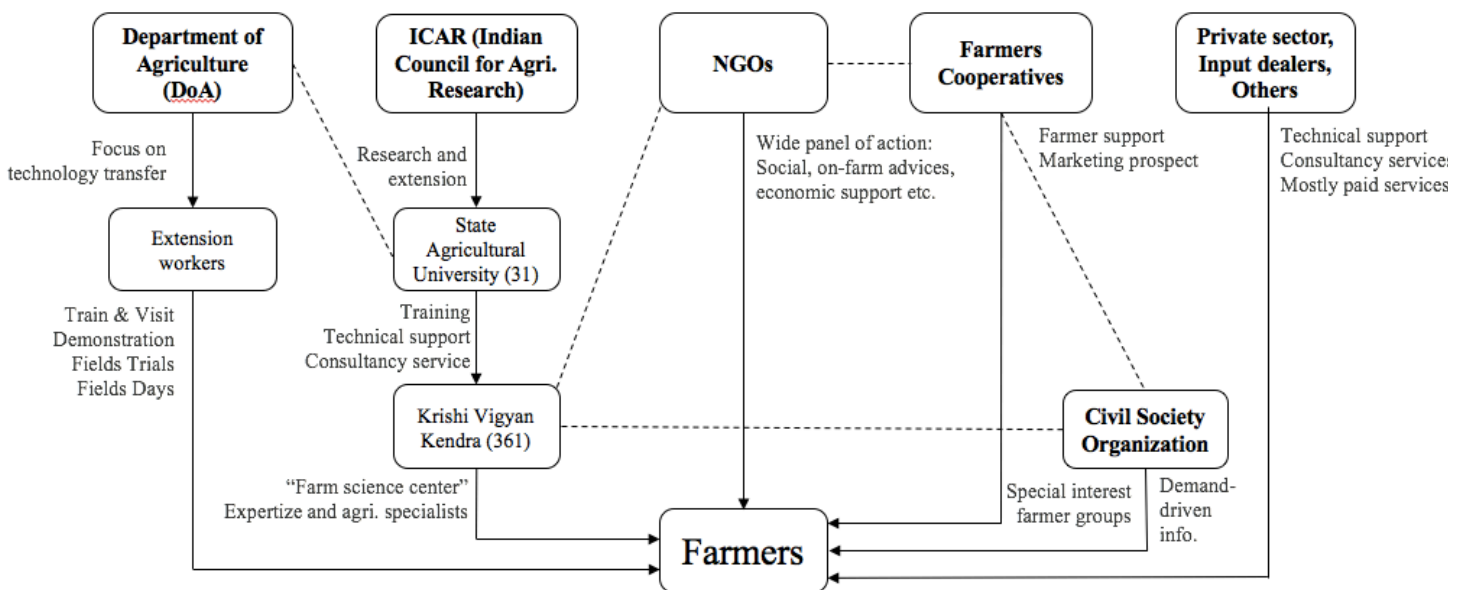
### **Informal networks: Scope of the indigenous knowledge.**

As farmers feel that there is a lack of access to consistent and reliable information for many of their needs, indigenous knowledge and “informal” information networks remain the biggest source of information within the farming communities. The study operated by Shalendra *et al.* (2011) indicates that 85% farmers had elders/family members as a common source of information and 52% with friends and neighbours. This indicates a general neglect for the agricultural extension services because farmers rely intensely on their relatives to get agricultural information. That is how indigenous knowledge remains an important aspect of Indian society’s culture. Indigenous knowledge is defined as a traditional or local knowledge that encompasses the skills, experiences and insights of people in order to maintain or improve their livelihood (S.S. Rao, 2006). In India, farming communities have developed their own body of knowledge over generations: There are millions of local communities and farmers using indigenous knowledge and “know-hows” that provide problem-solving strategies to their community, tailored to their local environment, resources and culture. Insufficient attention has been given to this local knowledge within the mainstream agricultural extension development. Indeed, having this strong agricultural knowledge background, V.M. Rao (2007) criticized the lack of support and absence of bottom-up activation force by the general extension services, that implemented a hierarchical top-down approach to information transfer (see next part). However, some international and grassroots initiatives are trying to give a voice and sustain this consequent agricultural indigenous knowledge. For example, the CBD (Convention on Biological Diversity) is an international agreement acknowledging the role and contribution of local communities and related knowledge in the conservation and sustainable use of biodiversity; the Convention 169 of the International Labour Organization aims to protect and acknowledge the social, cultural and spiritual values and indigenous practices of tribal people; the Traditional Knowledge Digital Library (TKDL) is a national initiative trying to document in a digitized format the traditional botanical Ayurvedic knowledge in order to make it visible to larger groups. However, at the difference of the scientific and technological knowledge, the accumulated indigenous knowledge over the

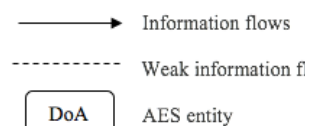
years may not be formally documented and tends to remain confined to communities, which make it harder to develop, sustain and protect. (S.S. Rao, 2006). The documentation and dissemination of indigenous knowledge could support the farming community in adopting integrated farming practices and gain decision-making power.

### Review of extension strategies

In order to understand why farmers are not accessing information and where the information gaps are, the AES strategies will be drawn in this part (Figure 7). As seen on the Figure 7, India has a wide diversity of extension service providers representing the public, private and the voluntary sector (S. Rasheed, 2012). Most of them provide wide range of agricultural advisory services and facilitate technology transfer to improve farmer’s livelihood, but can also play a wider role such as developing rural, human and social capital (e.g. enhancing skills and knowledge for production and processing, facilitating access to markets and trade, organizing farmers and producer groups, educational sustainable natural resource management practices etc) (J. Glendenning *et al.*, 2010). AES provide new information, knowledge and skills through different ways: V&T (Visit & Training), demonstrations, consultancy services, farm schools and exhibitions, and could use different media to disseminate information (eg: Radio, newspapers, physical person such as extension workers etc.) (S. Rasheed, 2012).



**Fig. 7:** Agricultural extension systems (AES) and information flow organization in India. Source: Adapted from S. Rasheed (2012), D. Patil (2006), J. Glendenning et al. (2010)



In the figure 7, we can see that the information transfer is linear and supply-driven. Indeed, the information is produced by researchers, transferred by extension worker or intermediaries and adopted by farmers. This traditional approach has tended to encourage researchers and extension workers to work independently from another, and has tended to isolate farmers as they became passive actors of their own agricultural development. There are only a few linkages between the different institutions (i.e. “Weak information flows” in the figure). Also, the information flow is most of the time uni-directional, that does not allow a two-way discussion between different stakeholders or feedbacks exchange.

### **Inefficiency of information transfer: the challenges for AES**

Despite renewed efforts and investment in AES development, its coverage remains inadequate. Given the significant problems information diffusion and outreach, a number of studies have analysed AES’s abilities to provide and facilitate information sharing in farming communities, highlighting main challenges in the transfer of information and knowledge. Within the public extension systems (who remains the biggest AES entity), a hierarchical top-down approach continues, with a content focusing on technology transfer to increase yields (J. Glendenning *et al.*, 2010). First, the technologies transferred were largely criticized to be inappropriate for the 80% small and marginal farmers: having limited resources inputs, these farmers were not taken into consideration by agricultural scientists, researchers and policy makers while they were designing and implementing the newest package of technology (D. Patil, 2006). Being designed for a favoured stratum of farmers under specific agro-climatic conditions, newest technologies have been slower to spread into smaller farmers’ communities that live into more marginal areas. That is how most of the farmers interviewed in S. Mittal *et al.* (2010) assessed that they lacked access to “consistent, reliable information for many of their needs and often needed to rely on a combination of indigenous knowledge, experience and guesswork to make decisions”. That created a large disparity between large-scale farmers and resource-poor farmers in the access of information and technology, isolating and increasing the vulnerability of small-scale farmers. In this view, G. Sylvester (2015) argues that the information and technologies transferred should be tailored to the local context, considering socio-economic, geographical, cultural features to be relevant to farmer’s needs.

In the current public AES, the information flows are linear and supply-driven (Figure 7). Linear models mean that the information and technologies are seen as a product that is

originated by researchers, transferred by extension workers and adopted by farmers (D. Patil, 2006). Several studies have been done in India to evaluate the effectiveness of information transfer and linkages between farmers and researchers, and experiences reveals that the actual linear model for information flows is inadequate for effective transfer of information and technology to the farmers: it provides scientific and technical support, but lack of genuine two-way communication and the flexibility required to make it responsive to the local situation (G. Sylvester, 2015). Ratnam *et al.* (2006) suggests that the communication is lacking between researchers and extension staff, as scientist does not hear feedbacks from farmers or extension workers. Scientifics have then a discredited exposure the field realities, and farmers are seen as passive actors of their development. A circular and integrated model could envisage a two-way dialogue model, where the interaction between researchers, extension workers and farmers could act as a backbone for implementing a participatory approach, empowering farmers to their own development by considering their resources, needs and priorities (D. Patil, 2006).

Then, while promoting technologies is still needed, this alone could not support farmers enough to cope with globalization newer challenges (see part I). The scope of agriculture is fast changing in ensuring rural development, and largely becoming knowledge intensive. Acknowledging this, a wider definition of AES needs to be integrated, where the focus goes beyond agricultural productivity. As agricultural development in India takes place in a very heterogeneous farming community, AES are needed to address either agricultural and broader rural issues (eg: socio-economic and environmental expectations, food security, poverty alleviation, gender issues etc.) to create effective and sustainable development (D. Davidson, 2006).

Last, the public extension service has limited financial and human resources. The personnel involved is overburden: Over the 1.5 million personnel required, there are only about 100.000 currently working in extension services (H. Gupta *et al.* 2013). Insufficient funds also weaken the technical support and research, which limits the continual development of extension. Also, the public organisation of AES is criticized to be inflexible, showing poor capacity to respond to newer globalization's changes and poor capacity to manage partnerships (S. Rasheed, 2012). The various departments are working in isolation to each other, with weak communication and partnerships power.

Regarding private and the voluntary sector, their extension service providers have increased during the past two decades (S. Rasheed, 2012). Today, the public performance remains the biggest AES, but private and voluntary extension service are fast expanding. Their performance will depend on their capacity to find appropriate partnerships and investment.

The performance of the Indian agricultural production and food supply system can be improved by more dynamism in information and technologies transfers. Today, the information and data exchanged within the agrarian community by AES fails to meet wider rural demands. The information transferred is outdated, routine, inoperable. As far as rural development is concerned, a global synergy and coordination on ongoing efforts between agrarian stakeholders is needed, where speedy and accurate transfer of information could leverage current communication gaps. That is how ICTs could intervene to become key enablers in creating a dynamism and democratizing information access within the agrarian mass. In the next part, we will analyse the state-of-the-art of actual ICTs density and attractiveness in the farming community, and its possible impacts within the rural community.

### **III. Socio-technical landscape of rural India**

The Indian agrarian system is characterized by low availability to modern technology, poor physical infrastructure and overall low degree of connectivity and accessibility of timely and quality information by the agrarian workforce (see Part I and II). Changes in information transfer will play a key role to improve the Indian supply chain efficiency and to sustain rural livelihoods. In this section, we will analyse the socio-technical landscape in India, studying the interface between farmers, information provision and technology uses. Indeed, there is a growing trend on “Cyber-extension”, with the ICTs acting as key enablers in democratizing information access to a wider agrarian mass and create a real dynamism in communication and linkages. From an anthropological point of view, the socio-technical analysis will help us to highlight farmers’ incentive and behaviour towards new communication systems (with focus on mobile phone) and understand how appropriation of new information medium could merge new patterns in the local cultural and social context. Also, from a socio-economic point of view, we will analyse the ICTs penetration and attractiveness in the Indian agricultural sector, and their potential impact within the global food system (D. Malhan and S. Rao, 2007)

## **The trend on cyber-extension**

The Indian agriculture is currently facing a two-faced fundamental development challenge: either enhance farmers' information and communication medium accessibility, but also improve its relevance to local development (D. Patil, 2006). So far in India, current models of such agricultural information networks are largely based in extension services, either represented by private, public or NGOs entities. As demonstrated in the part below, agricultural extension systems are criticized for their traditional approach in information transfer, isolating and increasing vulnerability of the 80% small-scale farmers in India. New approaches in information transfer needs to be considered, that could bridge information gaps by democratizing information access, and address the diversity of farming communities by tailoring the information in the light of local context (i.e. Socio-economic, environmental, cultural, languages, geographical factors).

In such a context, ICTs can become key enablers in the agricultural extension systems by providing real time, demand-driven and context specific information to farmers. As states D. Sharma (2006), the "Cyber-extension" (i.e. Using the power of online networks, computer and digital interactive multimedia to facilitate dissemination of agricultural information, knowledge and technologies) is set to be the major form of AES in near future. Today, the agricultural environment is fast changing and farmers' information needs are becoming more complex. Modern communication technologies (ICTs) has the potential to bridge current information gaps, meeting local-specific and timely relevant information needs of farmers. Indeed, ICTs could act as a catalyst in improving farmers' ability to get connected with knowledge, institutions and networks necessary for their development. (IBRD & WB, 2017) A fast-growing number of start-ups, tech companies and NGOs starts to team-up with the government to introduce new mobile apps for farmers, that provide a wide range of agricultural-related information, such as real-time data about local markets, prices, weather, best practices etc.

## ICTs boom/exposure in rural areas

Changes in information transfer is crucial to either enhance farmer's livelihood and bargaining power and the overall supply chain efficiency. Conversely to the agricultural decline in contribution to the national GDP, the development of ICT is currently witnessed as a major driver of the Indian economic growth (Figure 1). The ICT sector in India is about to experience a veritable revolution in rural areas: by 2020, 75% of new internet user growth will come from rural areas (NASSCOM, 2016), which will represent about 315 million Indians, compared with the 120 million today.

India continues to be one of the fastest growing major telecom markets in the world, with proactive efforts made by the Indian government to transform India into a global telecommunication hub (P. Budde, 2017). For example, with a robust annual 30% penetration growth because of the fierce price competition, India has bypassed the US as the second-largest smartphone market, after China.

ICTs, and particularly mobile telephone, will soon have a profound impact on rural Indian improving communication, information transfer patterns and networking among small farmers. P. Budde (2017) is positive about this growth: "India's mobile market continues to get the bulk of local capital expenditure, as the operators expand their infrastructure." He continues: "A strong increase in telecom subscribers base has necessitated network expansion covering a wider area." Mobile phone network coverage is now expanding at breakneck speed, disrupting all communication barriers and physical broader of the most isolated rural areas. The Vodafone Foundation, the world's largest telecommunication company, is also optimistic for the ICT potentials in rural India: "This rapid spread of mobile technology in rural areas of India offers a new channel for delivering agricultural services and an opportunity to engage rural communities in new ways" (Vodafone foundation, 2015).

Indeed, the ever-growing smartphone penetration in rural areas is leading to new pickups in the modern ICTs usage, and farmers have been able to make use of it in the research of new farming and rural solutions. As a spinoff from this India's meteoric rise as a world leader in ICT services, Indian private companies and NGOs taking advantage to this modern communication technology boom could bypass current public AES in becoming global leader in information dissemination, by disrupting traditional AES pattern. (S. Dev, 2012). However, newer communication technologies are still assessed by Raabe (2008) to be currently under-utilized to access agriculture-related information, despite a high mobile phone



ownership. From the survey made by A.K. Sharma (2014), relatives, accumulated experience and traditional ICTs (radio, TV broadcast) remains the favourite source of information for farmers. In addition to these information medium, farmers also can rely in the support of local organization (eg: credit agencies, input suppliers, NGOs...) (N. Rao, 2007). Together, these services contribute to the local knowledge and information transfer system accessible by farmers to support them and enhance their decision-making power. However, this system is often inadequate and provide limited information (eg: archaic organizations, high transaction costs, time delays...). As states N. Rao (2007): “The role of [modern] ICTs in such a scenario is to provide timely information, increase choice, reduce transactions costs, and contribute to improving the efficiency of decision making to raise rural incomes and improve quality of life of the rural population.” Modern ICTs are underused today partially due to a low awareness around e-Agriculture (eg: ICT are used more for personal uses rather than agricultural or rural development purposes), the isolation of most of ICT-based initiative that gear towards the “pilot-project syndrome” and a general lack of funding (see Discussion).

### **Government efforts to promote e-Agriculture**

As argues S. Tenhuhan (2008): “ICTs density (especially mobile-phones) in rural India has risen as a result of states efforts to expand networks and competition between service providers and phone manufacturers over the rural market, which has led to decreases in handset prices and tariff reduction”

Mobile telephony in India is becoming one of the cheapest in the world, helping rural communities to get connected and expand communication broader. Huge efforts are being made by the government to develop and overcome poor connectivity infrastructures. For example, Digital India is an initiative that aims to transform India into a digitally-empowered society (NASSCOM, 2016) at several scales. Launched in 2015 with a US\$ 18,8 billion investment, Digital India aims to improve online infrastructure and internet connectivity by providing high-speed internet networks in all the villages of rural India. The goals, among others, are to delivering government services digitally (eg: agriculture-related information such as real-time price inputs, loans transparency...) and creating a universal digital literacy. Digital India as showed great results as the number of internet subscribers have increased around 500 million, and is set to touch 1 billion in 2020. (The Financial Express, 2017)

The Ministry of Agriculture is also trying to strengthen and promote e-Agriculture with several initiatives, such as Agrisnet, iKisan, e-Choupal and so on. As an example, e-Choupal has born from a private and governmental partnership, which aims to integrate ICTs for new marketing strategies and serves rural farmers. The e-Choupal model aims to bypasses the physical “Mandi” system (i.e. intermediaries): it allows farmers to improve their bargaining power by eliminating wasteful intermediations, multiple handlings, reducing transaction costs and finally enhancing traceability. The ICTs are used here to leverage agricultural value chain distribution in making farmers part of their supply chain (e.g. ability to buy inputs at lower costs, higher incomes via lower transactions costs, empowerment through the access of information and choices). In order to do so, the e-Choupal initiative have implemented in around 38000 villages internet kiosks that are directly managed by farmers (called *Sanchalaks*, see Discussion) that allows the agricultural community to either access timely information in local language (eg: weather, market prices, farming practices, risk management etc.) and disrupt traditional marketing channels by allowing e-commerce between farmers and manufacturers. The e-Choupal initiative is say to have reached about 3.5 million farmers in 5 years (from 2000 to 2005) in across nine states (Madhya Pradesh, Haryana, Uttaranchal, Karnataka, Andhra Pradesh, Uttar Pradesh, Maharashtra, Rajasthan and Kerela). Such ITC-based solutions are not an isolated case, and a number of them are emerging into the agricultural stratum, and fast gaining interest either from government, institutions, private companies or NGOs.

### **Rural ICTs usage pick up scenario: How mobile phones could impact socio-economic and cultural patterns in rural India?**

The newest ICTs pick-up usages could impact or change socio-economic and cultural patterns in rural India. From a communicative ecology approach (that emerged from the field of media anthropology) we will try to understand how new communication technology will fit into a wider rural context with two different case studies (from anthropological and socio-economic point of view). The appropriation of modern ICTs technology being new in rural India, the case studies aims to show different impacts that could have ICTs - especially mobile phone - on the local and cultural economy of rural India.

**Case study 1: An anthropological analysis on mobile phone penetration in rural India (S. Tenhuhan, 2008)**

In its study released in 2008, S. Tenhuhan presented an ethnographic analysis of the mobile phones appropriation in rural India, and how ITCs were influencing the local cultural, social and political economy. The study was carrying in the village of Janta (West Bangal), where most of the 2,500 inhabitants were paddy and vegetables farmers. The study occurred when the district just had been covered by a mobile phone network. After having conducted interview of the phone owners, he concluded that mobile phones are playing a key role in facilitating multiples relationships and links in areas that used to be isolated. He is arguing that ICTs are a source of dynamism because it has improved “social logistics”, has strengthened communication within communities and intensified the kinship systems. He demonstrates that ICTs are also increasing the efficiency of the market, facilitating alternative political patterns, and helping women to broaden their culturally constructed sphere (eg: increase contact with their village natal etc.), as well as invigorating kinship village sociality. Telephony shapes social logistics, at the same time intensifying the ongoing contest of meanings. Last, S. Tenhuhan (2008) is arguing that instead of homogenizing cultures, mobile technology reinforces those cultural patterns and processes that can be reconciled with emerging social logistics.

**Case study 2: Socio-economic impact on mobile phone in rural India (S. Mittal, S. Gandhi and G. Tripathi, 2010).**

S. Mittal *et al.* (2010) in his study analyse the socio-economic impact of mobile-based agricultural services in five different states of India. Overall, S. Mittal *et al.* (2010) is arguing that the quality, timeliness and trustworthiness of the information provided by ICTs service are tree key pillars that have to be ensured in order to have positive impact on rural people. From its experiment, he is stating that the large majority of farmers reported benefits such as time-saving and cost-saving opportunities, and an increase in convenience (eg: customised content and mobility). Farmers were using their mobile device to get access to information such as seed variety selection, good cultural practices, real-time market prices, weather forecast, input availability etc. The accessibility of these agriculture-related information was reported to change traditional farmer’s behaviour. For example, new marketing information were changing their marketing habits: farmers were reported to try new marketing paths about where and when they could sell their crops, in order to get optimal benefits or to negotiate prices. In this case, having access to agriculture-related information with mobile phone were empowering farmers by enhancing their bargaining power and offering cost-saving

opportunities. Also, mobile telephones could offer distinct benefits as a communication medium in isolated circumstances. For example, the study analyses the case of fishermen that reported positive impact on emergencies and safety concerns from mobile phone. Indeed, they could use it as “a means of two-way communication as well as a means of access to the information service while they were at the sea [...], including dealing with emergencies and acting on weather information time to return safely to shore”. From a general point of view, most of farmers in this study reported socio-economic benefits using mobile phone such as: greater convenience (eg: convenience avoiding local travels, which is cost and time saving), ease in usage (eg: could be purchased in place where there is no electricity, and simply commute to neighbourhoods that do have electricity to charge their phone batteries), enhancing their decision-making power and in some case bypassing local traders. However, the case study reveals that mobile phone did not totally substitute face-to-face communication, as many of the farmer’s queries could not be resolved using only the mobile phone.

Cyber extension has great potential in the Indian agricultural system to fulfil information disparities. ICTs, and particularly mobile telephone, will soon have a profound impact on rural Indian improving communication, information transfer patterns and networking among farming communities. Since the introduction of mobile technology in 1995, the rate of mobile phone penetration has been record-breaking: mobile telephony has overcome challenge of covering the wide rural population by fulfilling these three key criteria: affordability, scale and convenience (NASSCOM, 2016). This is, in between other, due to the enormous effort from government to promote and sustain digital connectivity and networks (eg: Digital India). Mobile phones are also convenient for information transfer as they do not require literacy for their use, and can also attract the younger “tech savvy generation” (G. Sylvester, 2015). Mobile phone is say to impact farming communities in different ways, such as improving social logistics, strengthening communication within communities, improving safety and emergency solutions in isolated circumstances etc. In his study, S. Mittal *et al.* (2010) also argues how mobile or wireless networks could leapfrog the poor wired infrastructures, allowing rural people in underserved areas (eg: hilly terrains) to generate content and consume information services that were previously unavailable. However, it is to remember that ICTs only act as a catalyst to improve farmer’s ability to get connected with the people and the knowledge needed to improve social, rural and economic context, but are not by itself a substitute of existing AES and face-to-face systems.

## Discussion

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### I. Aspirations for ICTs uses in rural India

In a fast-changing agrarian scenario, AES have been recognised to play a fundamental role in delivering the new knowledge and information needed to Indian farmers to face new globalization's challenges. However, AES are currently criticized for their inability to fulfil farmer's needs and expectations (i.e. inappropriate AES strategies that are mainly dedicated on food production and technology transfer; general neglect for the 80% small-scale farmers; irrelevant and outdated information transfer; low level of outreach... see part II). By calling a new debate on agricultural extension role, D. Richardson (2006) adds: "The trend for extension is to shift from agriculture-specific services to broader services to improve rural livelihoods" (D. Richardson, 2006). The context is given: In order to fit actual rural Indian context, extension strategies should acknowledge the multifunctional dimension of agriculture, by either addressing agricultural-related problems (eg: yield stagnation, irrigation concerns, soil depletion... see part I), and wider rural concerns (food security, rural livelihoods and well-being etc., see part I). Having analysed the results, we will in this section discuss and reflect on the potential impacts that could have ITCs in the current Indian agricultural system, and understand in which sense it could create a new synergy in information dissemination systems.

#### **Reflections: from an agroecological perspective, which aspirations for ITCs?**

An area of reflection for AES's improvement paths could target its linear and inflexible nature, that are today unable to address individual requirements of the wide diversity of farmers (eg: Diversity of languages, socio-economics, geographical features ...). As mentioned before, the existent AES has suffered from the linear mind-set of information and technology packages transfer. The information is produced by researchers, transferred by extension worker and adopted by farmers. It is widely acknowledged that this traditional approach has tended to encourage researchers and extension workers to work independently from another, and has tended to isolate farmers as they became passive actors of their own agricultural development.

The simple model of “Conception-Adoption” of the AES’s strategy has succeeded in providing scientific and technical support to a specific stratum of farmers. However, it failed to meet wider rural demands, especially for the 80% of small and marginal farmers that were left behind in the transmission. An indirect cause of it could be that this model was lacking of the genuine two-way communication and participation to make the overall AES strategy responsive and relevant to the local situation, thus involving community in their own development. The farmers were seen as an end-user of the information and technology transferred, without having power to have a voice on it (eg: chose which kind of information they want, exchange incentives or feedbacks etc.). This resulted in a really low level of outreach, in outdated and irrelevant information to the majority of farmers because it didn’t reflect their actual needs - they were isolated in the process of their development. Without interconnectivity and coordination mechanisms between all the agrarian recipients, AES became disconnected from every-day farming practices, and the information transferred quickly had a discredited exposure to fields realities. Indeed, even when agricultural conditions are favourable, the gap of performance between farmers’ fields and agricultural research stations and experiment is highly persistent (S. Dev *et al.* 2010). AES failed to encourage pluralism in their development, without giving credits to a larger multi-stakeholder resources, that all together represents the agricultural innovation process (eg: experimentation by individual farmers, informal networking among farming communities, private sector participation, collaboration among extension workers, researchers and farmers (IBRD & WB, 2017). By doing so, AES strategies did not facilitate the merging of global and local knowledge.

In this context, a paradigm shift from linear information transmission to systemic approach of information transfer could create a real dynamism in leveraging coordination and scope of current AES within the all agrarian community. A systemic approach, sometimes referred as holistic perspective, acknowledge that all actors of a system are linked to each other and their performance is seen as a whole, rather them working isolated from another. Intrinsic to systemic approach is the community participation, which is intended to empower individuals and groups to be included in decisions that affect their lives (D. Davidson, 2006). The bane of Indian AES is not the lack of knowledge or technology availability, but the segmentation of such information. Here, the systemic approach could engage pluralism to overcome the segmentation of AES entities, thus facilitating the merging of global knowledge

within a wider agrarian community by encouraging coordination and interconnectivity between every agricultural actors.

In this cases, ICTs seems to be an ideal tool to disrupt the traditional model of information transfer, because they allow two-way interactions among a wider community of agricultural actors. Indeed, ICTs can be seen as “Communication brokers”: they can open communication flux dynamisms in extending two-way information flow either vertically (eg. Farmers to farmers) or horizontally (eg. Farmers to researchers). This new pattern of interconnectivity could extend communication barriers, promote community involvement, participation and cooperation, and ultimately innovation among the growing array of actors in agriculture (IBRD & WB, 2017). By promoting a bottom-up approach, this new model of communication could become a key mechanism in understanding farmers’ specific needs, knowledge and technology requirement that is relevant to the local context.

ITCs have the potential to empower farmers in their own development, as they will not only be seen as an end-user of knowledge, but they will have the ability to directly connect with the knowledge, institutions, networks needed for their development (IBRD & WB, 2017). With the booming IT industry (democratization of smartphones, rural internet penetration +75% in 2020 etc., see part III), ICTs found a foothold in small/marginal farms and in their activities. ICTs has its relevance in India because it can act as a remedy against rural isolation and exclusion thanks to its wide outreach and accessibility (low cost, convenience and ease of use, flexibility).

However, the ICT-based extension system will never be a replacement or substitution of the existing face-to-face extension systems. ICTs are only a supplement, a catalyst, to improve farmer’s ability to get connected with the people and the knowledge needed to improve social, rural and economic context. The ICT could create a real dynamism and coordination within all the agrarian community in information exchange, but will not replace the traditional forms of communication, networking and knowledge sharing schemes that have evolved in the Indian rural environment (N. Rao, 2007).

### **Which trend for AES?**

**Pluralism.** As mentioned before, AES today could support individual empowerment, decentralization of decision-making and institutional pluralism. By integrating individual needs to the wider rural sphere (socio-economic, cultural, geographical features...), AES could become more inclusive and responsive to the local context. Pluralism recognizes the heterogeneous nature of the farming community and the subsequent need of diversification in its extension system. Pluralism could help to address wider multi-sectoral rural concerns (eg: agricultural production, social disparities, food sovereignty etc.), because it promotes the pooling and coordination of the various stakeholders, avoiding redundancy of information and unhealthy competition.

**Decentralization.** By considering a systemic approach for agricultural development, a decentralization of the decision-making authority could also have its relevance. Indeed, understanding that the systematic approach is intrinsic to community involvement and local empowerment, the decentralization support a shifted decision-making authority towards lower hierarchical levels (eg: governmental, administrative), rather than high hierarchical levels that could be disconnected from field realities. As states D. Davidson (2006): “Being closer to the people, the new authority should be able to develop context-adapted solutions, with the active involvement of people.” Decentralization could enhance community involvement and a multi-stakeholder participation in the creation, development and management of ICTs-based services. However, decentralization could be difficult to implement in the local context because it needs a proper operational budget and communication efforts for the locals to be able to apply the services needed.

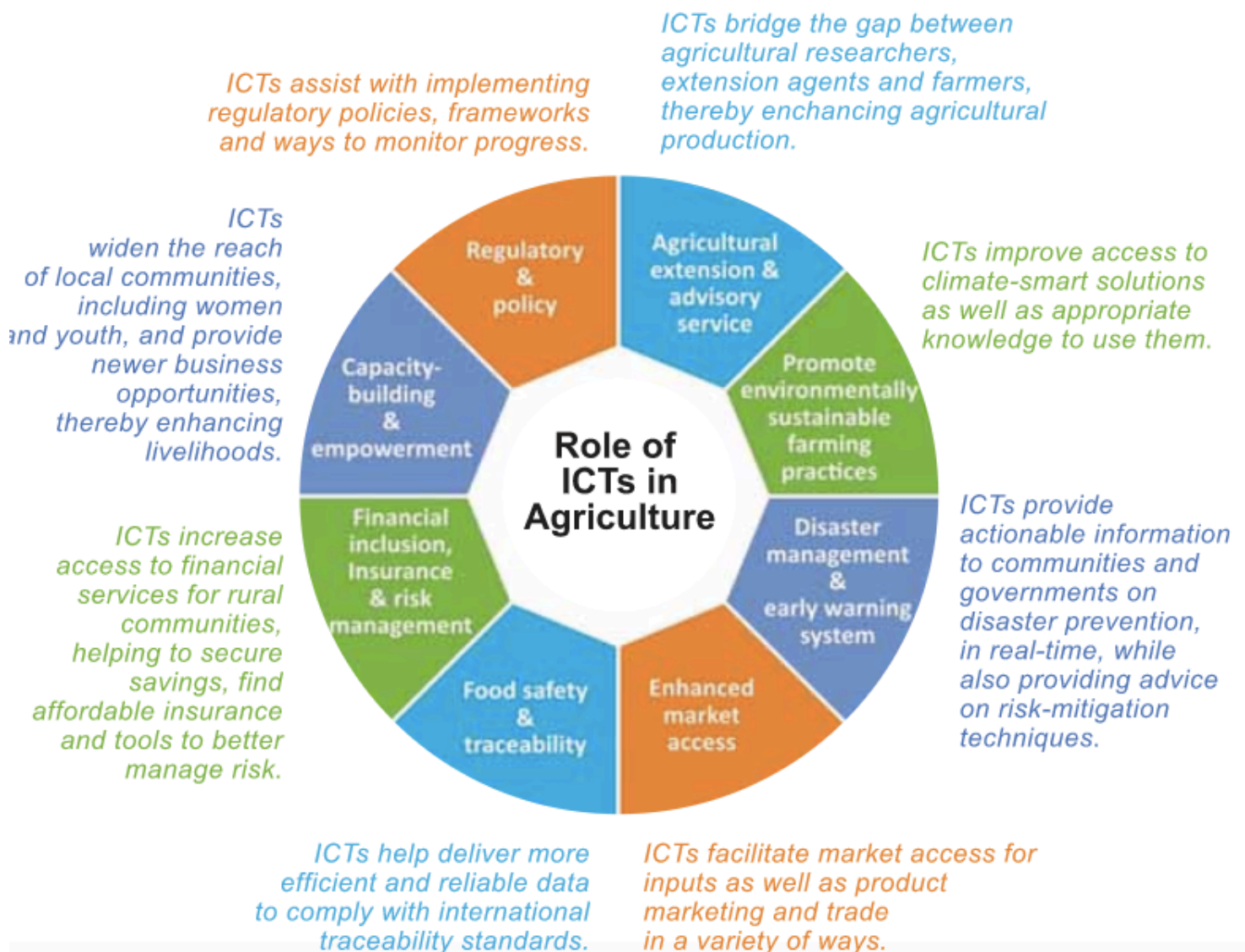
### **ICTs sustainability assessment: FAO’s diagram**

Over the past 15 years, the Food and Agriculture Organization of the United Nations (FAO) and the International Telecommunication Union (ITU) have been investing ICTs’ role in agricultural development worldwide. Both organizations are convinced that ICT represents a transformative force in leveraging rural socio-economic development, and improving the livelihoods and incomes of rural communities and stakeholders involved in agriculture. With the help of several countries, partner organizations and individuals, they released number of studies, analysis and strategy guides that are designed to help national governments and decision-makers in developing e-Agriculture worldwide.



Here, the FAO-ITU organization have analysed and tested many ICT interventions worldwide, with various degrees of success. Their work resulted in the following diagram, that resumed all key sectors in which ICT interventions could have beneficial impact in the farming community (Figure 8).

The representation of the Role of ICTs in Agriculture made by the FAO-ITU organization is holistic: ICTs are not designed to address only one generic solution in the agricultural value chain but could create new opportunities for many wider rural concerns. For example, ICTs interventions could improve food and nutrition safety, through efficient information dissemination, data gathering and analysis, traceability and supply chain management. ICTs could improve vertical and horizontal linkages, by reducing the stratum of intermediaries,



**Fig. 8:** The role of ICTs in Agriculture.  
 Source: FAO and ITU, 2016

making transactions unbiased and transparent. ICTs could create greater markets, with lower transactions and handling costs, lower information disparities and improved market coordination (FAO and ITU, 2016). Through this diagram, ICTs appears to be a great tool in understanding and addressing the multifunctional features of agriculture and rural development, that goes beyond agricultural production.

## **II. Applications of ICTs in rural India**

### **Analyse of existents activities and lessons learnt**

The meteoric rise of IT sector and especially mobile phones in rural India has been one of the most stunning changes over the past decade. ICTs solutions for AES in rural India presents a wide range of opportunities and challenges for the agricultural sector. The availability of timely, accurate and reliable information and technology for the farming community is the main challenge for ICT-based solutions. There are a number of ICT-based initiatives within the AES in India, that can be represented by different entities such as government, co-operative sector, NGOs, private sector. As seen on the FAO's diagram below, ICT intervention could create many opportunities in targeting many different rural concerns. Indeed, these initiatives have developed different strategies and action plan in order to best fit with the local needs (eg: voice messages or SMS to communicate information directly to farmers, creation of connected kiosks in villages, question-and-answer services, video-based learning approach etc. to address different needs). In order to better understand the current ICT context in rural India, a short overview of more or less successful initiatives that have been taken this past decade is resumed in Table 5.

Table 5: Analyse of existent ICTs-based initiatives

Projects	Description	Strategies	Observations/Lessons learnt
e-Choupal	<ul style="list-style-type: none"> <li>- Implement information kiosks (VSAT/Dial up connectivity) in rural villages.</li> <li>- Kiosks equipped with computer, internet connection and printer</li> <li>- Kiosks managed by a <i>Sanchalak</i>: will facilitate farmers to get specific info, such as weather, input sales, best practices...; will contact experts for advices in local languages; will provide direct marketing channel to enable farmers to buy/sell agricultural products.</li> <li>- In 2004: over 4000 kiosks were covering 24.000 villages and servicing over 2.5 million farmers.</li> </ul>	<ul style="list-style-type: none"> <li>- Bypass intermediaries and multiple handlings</li> <li>- Improve transparency and reduce transactions costs with e-commerce.</li> <li>- “Infusion design”: Citizen-centric, accessibility, accountability and transparency. All information kiosks are connected and provide similar services to farmers.</li> <li>- Two-way communication flow between rural people and government (feedbacks, e-mails facilities)</li> <li>- The <i>Sanchalak</i> is the only person authorized at the kiosk and earn fee on transactions.</li> </ul>	<ul style="list-style-type: none"> <li>- Solar battery to power back up</li> <li>- VSAT in case of low internet connectivity → High initial costs</li> <li>- <i>Sanchalak</i> to impart skills of the first-time users</li> <li>- Inadequate finance to get up-to-date infrastructure.</li> </ul>

Gyandoot	<ul style="list-style-type: none"> <li>- e-Governance project launched in January 2000</li> <li>- Promote ICT through rural kiosks to improve governance at district levels</li> <li>- Kiosks are community-owned</li> <li>- Does not give information exclusively on agricultural development (eg: best practices, online prices etc.), but overall rural development (eg: registration for land records, online driving license, rural e-mail facilities etc.)</li> </ul>	<ul style="list-style-type: none"> <li>- Focus on wider rural development rather exclusively agriculture-related information</li> <li>- Charges paid by users</li> <li>- Community-owned, allowing local access for e-transactions (eg: land selling, agricultural machinery...) to bypass middlemen (cost Rs. 10)</li> <li>- Ask-the-Expert facility for agriculture, husbandry and health problems (Rs. 5)</li> <li>- “<i>Customisation design</i>”: Electronic personal profiles for transaction with the government. The user is seen as a client.</li> <li>- Two-way communication flow between citizens and government</li> </ul>	<ul style="list-style-type: none"> <li>- WLL Technology to provide continuous access without any disconnections.</li> <li>- Solar panels for power failures</li> <li>- Diversified services are included in the system → Increase cost of transaction</li> <li>- Not enough revenues generated to be viable.</li> </ul>
Wanara	<ul style="list-style-type: none"> <li>- Cooperative-owned initiative</li> <li>- Connected kiosks to provide wide range of agriculture-related information in local language (eg: market prices, educational opportunities, security, employment scheme...) to the cooperative users.</li> <li>- 6 IT centres are linked to local villages, allowing dial-up connection from village to the servers.</li> </ul>	<ul style="list-style-type: none"> <li>- ICT to increase efficiency and transparency of the state cooperative</li> <li>- Agricultural, educational and medicinal information to the villagers</li> <li>- Communication links facilities between the cooperatives members</li> <li>- Geographical Information system (GIS) facilities</li> </ul>	<ul style="list-style-type: none"> <li>- General lack of funding</li> <li>- Connectivity issues</li> </ul>

Digital Green	<ul style="list-style-type: none"> <li>- Participatory and video-based learning approach</li> <li>- Aims to engage communities and leverage social networks for agricultural extension</li> <li>- Videos are recorded and diffused by farmers, with the help of an expert using ICTs tools (laptops, television).</li> <li>- Video have local relevance because they are created by farmers themselves.</li> </ul>	<ul style="list-style-type: none"> <li>- “Hub-and-Spoke” model</li> <li>- Expert (i.e. <i>Sanchalak</i>) for information transfer</li> <li>- Partnership, community participation and engagement are key (i.e. Made by farmers for farmers)</li> </ul>	<ul style="list-style-type: none"> <li>- Obligation to have a trained community member and screening facilities</li> <li>- Strong community groups are essential for the success of the approach</li> <li>- Staying flexible and maintain qualitative content challenging</li> </ul>
Baliraja WhatsApp groups	<ul style="list-style-type: none"> <li>- Community-owned NGO to gather local farmers in a same discussion groups</li> <li>- Question and Answer systems: farmers from various villages are seeking and sharing agricultural advice, connecting with experts and learning new practices</li> <li>- Flexibility of content: text message, voice message, photo, video etc.</li> <li>- Also Ask-an-Expert facility</li> </ul>	<ul style="list-style-type: none"> <li>- Bottom-up approach: information created and disseminate by farmers themselves</li> <li>- Experts directly going on fields to best fit farmers needs</li> <li>- NGO approach to prevent farmers suicides</li> </ul>	<ul style="list-style-type: none"> <li>- Difficulties in keeping tracks of farmer’s messages</li> <li>- Quality of information and content</li> </ul>

Nano-Ganesh	<ul style="list-style-type: none"> <li>- ICT uses for safety and labour efficiencies</li> <li>- Rural automation of water pumps for emergency uses</li> <li>- Controlling water pumps in remote location with the help of a mobile-phone (“e-irrigation”)</li> </ul>	<ul style="list-style-type: none"> <li>- Electronic modem on water pumps: simple, viable and low-cost</li> <li>- Mobile phone to switch on or off the water pump from any distance (costs and time saving, safety concerns)</li> </ul>	<ul style="list-style-type: none"> <li>- Lack of investment for expansion</li> <li>- Hurdles in keeping the system highly low-cost</li> <li>- Difficult terrain to reach pumps for ICT installation (i.e. poor rural infrastructure)</li> <li>- Irregular electricity supply: demonstrations and tests are difficult.</li> </ul>
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Source: Adapted from N. Rao (2007), N. Gorla (2008), G. Sylvester (2015), Shalendra *et al.* (2011)

### **A strategical issue: The pilot project syndrome.**

There are numbers of ICT applications for agricultural extension in India that were able to provide different services to the large farming communities. Within these applications, several strategy and models were used for information dissemination, that were more or less successful regarding the local context. Because the rise of ICTs in the rural areas is new, strategies to integrate ICTs in the agriculture sector are still evolving to best fit farmers need.

A strategical issue that can be observed is the “project pilot syndrome”. As states N. Rao (2007): “Most partial solutions are likely to fail as they cannot be sustained after the initial euphoria about deploying ICTs wears off”: new ICTs services could have difficulties to be implemented in large scale or to be economically viable. With the analysis of the specific existent projects (Table 5), several reasons can be identified for this “pilot-project syndrome”, that are resumed on Figure 9.

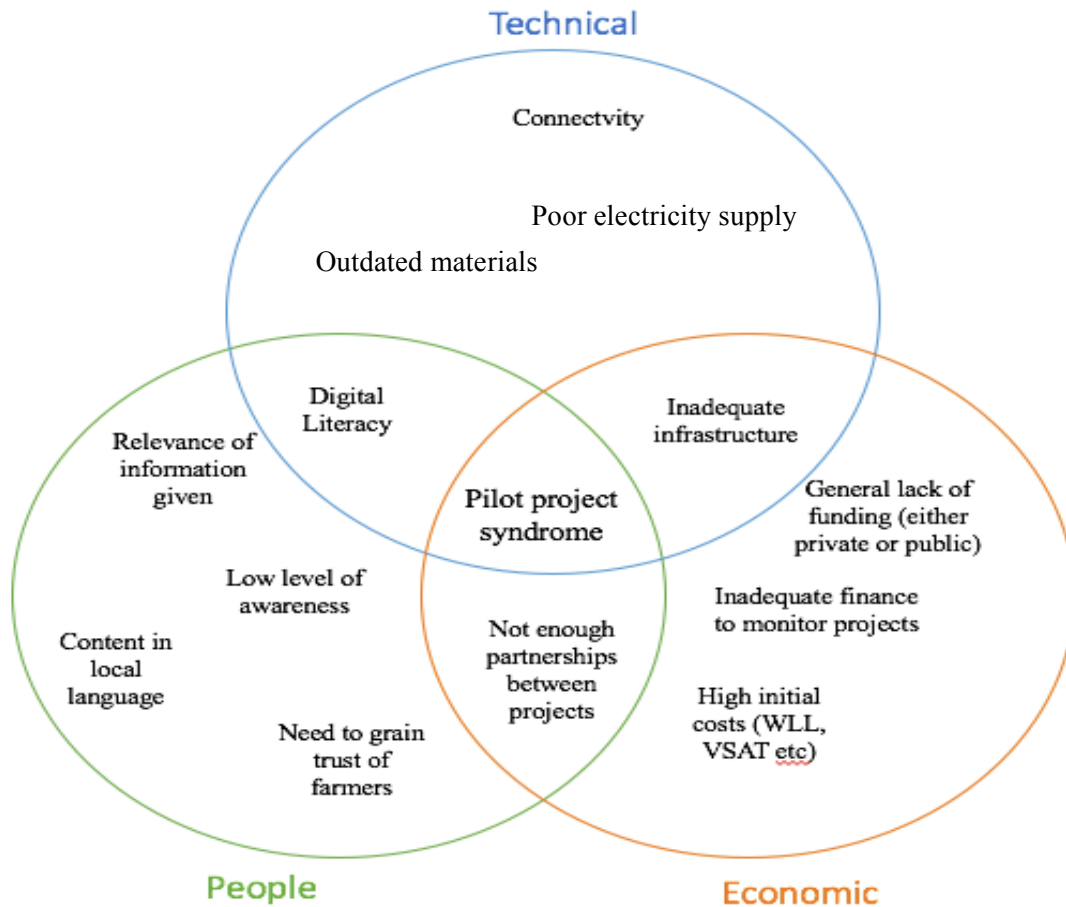


Fig. 9: The “Project-Pilot Syndrome”

The pilot-project syndrome’s causes can be organized in three interrelated pillars, which does not have hermetic borders but rather overlap (Figure 9). From a technical point of view, the most common hurdle in implementing ICTs solutions is the poor connectivity in rural areas, due to the lack of an efficient telecom network and frequent power failures. The Gyandoot project for example suffered from frequent interruptions with dial-up connectivity. The WLL (Wireless Local Loop), WTC (Wireless Cellular Technologies) and solar panels can offer solutions in providing continuous access to telecommunications networks and electricity. However, the installation of such connectivity strategies, in most of the case, are expensive and the funds to equip the kiosks and platforms with operational infrastructure are insufficient. From an economic perspective, the general lack of funding in ICT-application development can also be translated by the limited resource availability to develop sufficient monitoring technics. Even if new initiatives have been developed investing large amount of money, there were a limited financial cohesion to sustain the projects, and most of the

projects never revealed actual evaluation results (S. Tabusum *et al.*, 2014). Also, there were insufficient funds to acquire the infrastructure needed for their development (eg: e-Choupal suffered from the lack of air-conditioned rooms in the kiosks, that resulted in high degradation of the ICT material from the heat and dust). More partnerships could be created in order to facilitate support and initial development of these ICTs solutions. Indeed, ICTs applications were mostly implemented by independent and segmented entities (eg: agricultural education, government, research institutions) that had suffered from the lack of partnerships. These “Island of learnings” (i.e. low collaborative framework) resulted in inadequate financial resources and limited geographical coverage. In this context, the small-scale operation of ICT applications did not create sufficient awareness about the use in ICTs tools in agriculture. Rural people may not be fully informed about existing ICTs strategies and may not adopt and accept the project until they are convinced of the benefits. That is how appointing the *Sanchalak* is seen as a solution by several projects listed above to make the interface between farmers and ICT technology. Being closer to the users, the *Sanchalak* could help in creating awareness among the farming community, impart skills to the first-time users (i.e. Digital literacy) and gains the trust of farmers. Also, from the farmers’ perspective, the information provided by ICT solution were sometime still criticized as an “old and routine” information. (S. Mittal *et al.*, 2010). As states S. Mittal *et al.* (2010): “Generic information triggers dissatisfaction and reduces the frequency with which farmers access the services”. A greater customisation that cover wider concerns than agricultural production may be useful (see part II).

## Recommendations

In the light of AES performance, ICTs could become key actor in information dissemination to support rural needs. The optimal implementation of ICTs in agricultural extension system will, however, depends on its ability to address a numbers of factors such as digital literacy, awareness levels, poor infrastructure etc. (Figure 9). Based on the analysis of several ICT-based model in AES, some practical recommendations for ICTs strategies can be listed in order to better address these various factors, and have the greatest impact in the farming community:

- **Two-way information flow and horizontal/vertical linkages.** The governmental AES systems have been criticized for its linear information flow model (i.e. Researchers to farmers), that has led to inflexibility and inability to address farmer’s needs. Designing a two-way and horizontal-vertical information flows in



ICTs solution could open-up new communication channels and allows community involvement that has a bearing on sustainability, on farmer empowerment and on monitoring evaluation of the AES. Community involvement could also help in capacity building, especially for the neglected segment of society and women (D. Patil, 2006). This new pattern of information flow could disrupt the traditional information transfer system to promote a bottom-up approach, that could become a key mechanism in understanding specific research needs, knowledge and technology dissemination that is relevant to the local context, and facilitate the merging of global and local knowledge and information (D. Richardson, 2006). An open participation of farmer community in design, management and implementation of ITC will better identify and address their needs.

- **The “*Sanchalak*” as a direct facilitator.** The *Sanchalak* is usually from the farming community itself, that will be the direct link between locals and ICT uses, in order to overcome low digital literacy levels and lack of ICT exposures to some farmers. Being physically and culturally close to people, the *Sanchalak* operates at local levels, facilitating the effective use of ICTs and building farmers’ trust in its efficacy (IBRD & WB, 2017). The *Sanchalak* will help to leverage confidence in using ICTs within the community to overcome low awareness and digital literacy, to get the optimum implementation impact. Another approach is taken by IBRD & WB (2017), that mention *Sanchalaks* as “Local Champions” or progressist farmers, who are essential in the ITCs development because they are able to push the initiatives forward and make them visible and interesting to a wider stakeholder population who need them (eg: farmers, agribusinesses, retailers etc.).

- **Customised information (vs. Generic information).** ICTs intervention should provide wide rural information rather than to be focused on simple agricultural development solutions, that farmers tend to classify as “routine information” (i.e. Opportunities for the role of ICTs, Figure 8). Customised information model should be able to identify the needed information to the farming community (context-driven or demand-driven information), that is suitable its every agro-climatic, cultural aesthetics, geographical and socio-economic situations. A bottom-up approach could help target these specific needs regarding the geographical area and develop a demand-driven information dissemination strategy.

- **Integrated model.** The rapid dissemination of information can be done by the effective coordination of several stakeholders in term of resource, knowledge and communication. An integrated model limit the segmentation of stakeholder's entities. To overcome the lack of human and financial resources that have weakened the ability to sustain ICTs project activities, ICTs projects can be ensured by multi-stakeholder governance. Public-private partnerships are now considered essential to the long-term viability of most interventions that use ICT in agriculture (IBRD & WB, 2017).
  
- **A farmer-centred design.** ICT-based solutions should address needs of a country where a majority of farmers are illiterate, where the majority of land holdings are small/marginal and where the level of infrastructure is very poor in rural areas. ICT could be used for their great potential to deliver customized information for every agro-climatic conditions, cultural aesthetics and socio-economic situations. To better assess the information requirements, the service provided should be "farmer-centred", meaning being user-friendly and concentrate on the demand, not the technology available. ICTs are an open land of innovations: the attractiveness of newest ICTs services can be a distraction. Here, the priority is not the technology available, but how they can better serve the farming community. The most effective solutions could be a mix of different ICTs medium for a same project (eg: Radio, phone calls, SMS etc.). In designing ICT-based project, the goal is to remains accessible, convenient and affordable for most of the farming community.
  
- **Being aware of side impacts.** Under certain circumstances, ICT interventions could sometime worsen underlying socio-economic and political inequalities, rather to alleviate them. It can be the case for rural women, that under certain condition could be excluded or face significant disadvantages in accessing information and communication assets and services (IBRD & WB (2017). A full understanding of the regional cultural economy is essential in ensuring that ICT applications will not turn unfavourable for any social groups or activities.

### III. Final SWOT: Which future for ITCs in agricultural extension in India?

Table 6: Conclusive SWOT analysis

Strength	Weaknesses
<p>Farmer empowerment (Democratization of information to wider recipients, bridge knowledge gaps)</p> <p>Acknowledge the multi-dimensional scope of AES, that goes beyond crop productivity (i.e. Figure 8)</p> <p>Low cost and accessible tool (High mobile-phone ownership in rural India)</p> <p>Promote community involvement and participatory approaches</p> <p>Two-way communication flow allows to extend communication barriers</p> <p>Facilitating multiple relationship links in areas that used to be isolated</p>	<p>Low level of awareness around e-Agriculture: Need to gain trust of community</p> <p>Operational hurdles (eg: high cost technology (VSAT) to ensure viable connectivity)</p> <p>Scattered nature of ICT initiatives</p> <p>Low level of partnerships (i.e. Low collaborative framework) and interstate disparities</p> <p>Farmers show low degree of trust and satisfaction in AES</p>
Opportunities	Threats
<p>Booming IT sector in India (Smart phones, internet penetration rate in rural India, wireless connectivity etc.)</p> <p>Interest from many international institutions (FAO, ITU, WB, IFPRI...)</p> <p>Indian Government efforts to promote e-Agriculture (eg: Digital India)</p> <p>Attract the new 'Tech-savvy' generation to farming</p> <p>Extend Private-Public partnerships for ICT-based services</p> <p>Private and voluntary sectors fast expending in AES</p> <p>Break communication frontiers (eg: Accessible for rural people living in underserved areas)</p> <p>Pluralism and decentralization</p>	<p>Deceleration of agricultural growth rate</p> <p>Agriculture is seen as a non-viable activity, farmers feel to be "left-behind"</p> <p>Poor investment in agriculture by the Indian Government</p> <p>General lack of financial and human resource (either private or public)</p>

## Conclusion

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This report aims to deliver a state-of-the-art of new opportunities in information dissemination in rural India. Today, agricultural information transfer mechanisms are mostly generated by the public agricultural extension systems (Department of Agriculture, State Agricultural University etc.), which are often criticized for the linear and inflexible nature of the information transferred. AES have difficulties to meet farmers' needs and ensure rural development, and show low level of outreach and satisfaction within the farming community. To cope with the new challenges from globalization exposure, the AES should play a wider role than enhancing agricultural productivity through technology transfer. Agriculture is fast changing, and ensuring livelihoods and rural development is becoming more and more complex.

In such a context, ICTs have a great potential to widen the scope of AES strategies, by enhancing both rural livelihoods and the agricultural sector performance. Here, ICTs could alleviate information needs of the rural people and empower farmers by providing real-time, reliable and accurate information, acting as a catalyst in AES information dissemination mechanisms (particularly for marginal and small-scale farmers that tended to be excluded from the extension schemes). By disrupting current information transfer patterns, ICTs could break communication barriers and opening-up the ability of the farming community to get connected with the knowledge, information, institutions and networks needed to face new globalization challenges (i.e. Rural development, food security, agricultural productivity etc.). ICTs interventions could acknowledge the multi-dimensional scope of agriculture and rural development, and support related key sectors efficiencies in a holistic way (eg: Enhance market access, financial inclusion, capacity-building and empowerment etc., see FAO-ITU diagram, figure 8).

The phenomenal rise in the Indian IT industry has led to a penetration rate boom of Information and Communication Technology tools in rural India (projected +75% in 2020). Indeed, ICTs, and especially mobile phones, has overcome challenges of covering the wide rural population by fulfilling three key criteria: affordability, scale and convenience. The democratization of ICTs tools is allowing rural India to get connected and fast.

However, because the rise of ICTs in the rural areas is new, strategies to integrate ICTs in the agriculture sector still are evolving. Today, the ICT sector in agriculture is experiencing hurdles in implementing viable projects, which lead to a real “Pilot-Project syndrome”. Low degree of infrastructure and connectivity in rural India, digital literacy and low awareness from farmers, general lack of findings and the scattered nature of the projects are currently curtailing on the long-term implementation of ICT-based service in the agricultural sector. With the analysis of different strategies in ICTs-based services, some models however seem to be successful to overcome these challenges, such as the physical facilitator (i.e. *Sanchalak*) to cope with the lack of digital exposure in rural India, the decentralized approach to decision-making and institutional pluralism that could gear towards more integrated and economically viable projects etc.

ICTs-based initiatives for information dissemination appear as a great candidate to sustainably answer the three key themes of this report: Overcome the current information disparities in the agricultural sector, address food security and rural development concerns by empowering rural people in the process agricultural extension and last democratizing agricultural knowledge and information to some wider agrarian recipients. However, it is important to recognize that ICTs-based services in AES are not designed to replace the traditional forms of communication, networking and knowledge sharing schemes that have evolved in the Indian rural environment. ICTs have their greatest potential in acting as a catalyst, a supplement in existent information transfer mechanisms, for more effective, integrated, timesaving and economic forms of extensions. In order to improve the scope of ICT in the Indian agricultural sector, there is a need to consolidate researches assessing the economic viability of ICT-based services and partnerships, assessing potentials impacts in the cultural economy and side-effects, and above all adopt a participatory-approach in the creation, development and management of such projects.

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# Appendix 1

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