TRANSFORMING HARYANA -PROGRESSING HARYANA

Working Group Report on

Agricultural Extension

In Haryana

Haryana Kisan Ayog

Government of Haryana

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Agricultural Extension In Haryana

2017

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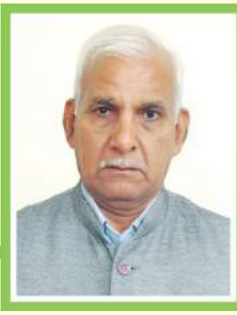


FOREWORD

Agriculture has been identified as one of the lead sectors for growth and more so to meet the Millennium Development Goals. Obviously this sector needs strategic technological empowerment and policy support at both state and national levels. The agriculture sector has major stake in transforming rural economy in state through creating employability for rural human resource, support to industrial development and ensuring food security in the country. The recent experiences suggest that high GSAV growth without consistent and rapid agricultural growth is likely to accelerate inflation in the State which would jeopardize the larger growth process. Therefore, the growth of Agriculture and Allied Sector continues to be a critical factor in the overall performance of the State economy.

Government of Haryana has taken initiatives to reorient and up-scale its technology and policy intervention programs on farm and off farm sectors to achieve the objective of doubling farm income by the year 2022. Consequently, Haryana accorded high priority to accelerate production of cereal crops, milk, honey, fish, mushrooms, fruits and vegetables to meet the demands. It will obviously need efficient and cost-effective technologies along with a time appropriate agricultural extension system. The Ministry of Agriculture and Farmers' Welfare of the State in association with Agricultural Universities and ICAR continued to promote the use of participatory approaches in extension, that helped in making rapid strides in agricultural revolution in the state.

Now the land and water constraints, climate change, changing consumption patterns in rural & urban areas, emergence of e-trading, need for alternative sources of energy, emerging diseases & pests and focus on global markets are driving the developments in agriculture nationwide. The management of collective natural resources, value & market chain management, and collective input supply and e-marketing are new emerging opportunities for public and private entrepreneurs. Furthermore, the Innovations in agriculture have become the order of the day. Therefore, the knowledge insensitivity of agriculture sector is more evident now than ever before.

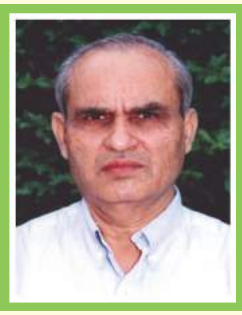
I understand that agricultural extension plays a crucial role in promoting agricultural productivity, increasing food security, improving rural livelihoods, and promoting agriculture as an engine of pro-poor economic growth. Looking at the whole scenario, I feel that our approaches and tools of extension need to be sharpened to address the challenges and harness the opportunities by making this sector more competitive and remunerative.

I am happy that the Working Group on Agricultural Extension headed by Dr J.C. Katyal, Ex-Vice Chancellor CCS Haryana Agricultural University, Hisar has gone through all these aspects and came out with a very useful report with critical recommendations. Hope this report will help planners and agricultural field functionaries in the state to make extension services more efficient and effective.

October, 2017

(Ramesh Kumar Yadava)

Dr. J.C. Katyal
Former, Vice-Chancellor, CCSHAU, Hisar
Chairman, Working Group



PREFACE

Agriculture, though an economic activity, is considered a noble profession in India, more so in the State of Haryana, it is embedded in the native traditions, folklores, faith and religious practice. Agricultural history is some 10,000 years old. Comparatively, its saga in this tiny State of the Indian Union is believed to be incepted just before the Harappan Civilization (~2500 BC). Like any other place, chronicled growth of ancient agriculture in Haryana, swung with the deviations in normal precipitation and pest invasion. The State inherited this unpredictable setting when it was carved out of Punjab in 1966. Since then, strikingly as it is, agriculture in Haryana has undergone a dramatic transformation. This otherwise recurrently food-deficit region has not only emerged as self-sufficient, but today it proudly contributes a substantial part of its production forwards building national food security also. With the scientific methods of farming replacing the native practices, the present day agriculture is more productive, settled and resilient. Fondly called Green Revolution technologies, i.e., dwarf varieties, agro-chemicals and irrigation water, since 1966-67 have contributed impressively to the improvement in crop productivity (i.e., food grains 4.8 times; rice 2.8 times and wheat 3.5 times) and production (food grains 6.8 times; rice 17.9 times and wheat 11.7 times). Along with others, agricultural extension (AE) has played a pivotal role in achieving this tremendous feat. AE did so by enhancing access to and willing acceptance of Haryanavi farmers on application of necessary knowledge and skills. As elsewhere, in Haryana too, introduction of the National Demonstration Scheme since 1964 and Training and Visit (T&V) System of AE since early 1970s stimulated spread and impact of yield-catalysing inputs.

However, with the passage of time, combination of HYV seeds, fertilizers and irrigation was unable to defend the top yield growth rates i.e., ~3%, peak reached during the first 30 years of Green Revolution plummeted to less than 1.5% during the next 30 years. Not only that but the AE services that played a crucial role in establishing credentials of GR technologies were found wanting also to reverse the slide in productivity growth. Furthermore, neither the increased use of inputs nor the infusion of superior genotypes could salvage the situation. Coincidentally, happening of GR beginning 1966 and its downfall after 1990s, followed closely the evolutionary rise and collapse of AE services. With this development, Haryana Kisan Ayog constituted a Working Group on Agricultural Extension in Haryana (vide # HKA/15/5795-5805 dated 21 August 2015) to review and analyse the state of AE and examine the role of private sector, NGOs and farmers' associations in strengthening it further. Inter alia the Working Group was also mandated to recommend a way forward with mechanism and processes on technology generation, refinement and dissemination in making technology transfer system more vibrant, efficient and effective.

With the above background, the Working Group Report was developed by examining the evolutionary pathway of the current system of technology transfer in Haryana. The manuscript adopts a sequence of write up, which is guided by: (i) the Terms of Reference set by the Haryana Kisan Ayog, (ii) input from the Members of the Working Group on Extension and (iii) outcome of the meetings and interactions of the Working Group with the peers and stakeholders. In

consonance with the deliverables of these wide-ranging consultations and to strengthen the write up further, the Report presents a contextual assessment of the current AE system. In pursuance of that the final document features definition and concept of technology transfer, history, past performance and current shape and structure of extension apparatus. Varying conditions of Haryana farmers, farming and farms remain the epicentre of this appraisal. Noticeably, the Report leans more towards a bottoms-up approach, which advocates participation of and interaction with the farmers. It also proposes to engage with the private sector and harness the power of ICT in accelerating the speed and real-time transfer of technology.

The Working Group Members wish to place on record, the exemplary advice, guidance and assistance received from the Chairman and members of the Haryana Kisan Ayog in completing this arduous task in a highly professional way. They also acknowledge with grateful appreciation the highly practical and on-the-ground directions given by the various stakeholders – farmers, extension functionaries, KVK scientists and researches. Logistic and professional support provided by the authorities of the CCS HAU and LUVAS are acknowledged with gratefulness. Last but not the least, the working Group records with thanks the time-to time-assistance rendered by the Staff of the Haryana Kisan Ayog, specifically Dr Sandeep Kumar, Research Fellow in contributing to the smooth functioning of the Working Group.

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ACKNOWLEDGMENT

I am very glad to say that Haryana Kisan Ayog has completed its fourteenth report on Agricultural Extension in Haryana. The Working Group on Agricultural Extension in Haryana has analyzed the present status of Agricultural Extension System in the State and proposed a new look extension system which focused on developing public-private partnerships and mainstreaming role of KVKS, progressive farmers, input dealers and entrepreneurs. Capacity building of farmers in groups (FPC) on raising productivity and income and conserving health of natural resources in all aspects. Technology transfer system needs to be modernized based on ICT and need based but progressive training of extension staff. The Group has made concrete recommendations to prepare for a new-look Agricultural Extension model for the State.

I am extremely grateful to Dr. Ramesh Kumar Yadava, Chairman, Haryana Kisan Ayog, for providing valuable guidance and necessary support in preparation of this report. His generous direction and encouragement helped the Ayog in timely preparation of this extensive report. I am also highly thankful to Vice Chancellor, CCHAU, Hisar, for his support and assistance.

I present my sincere gratitude to Dr. J.C. Katyal, Former Vice Chancellor, CCSHAU, Hisar for sparing his precious time as Chairman of this Working Group. though he was too busy and pre-occupied. His able leadership and guidance made the report possible in time. I am indeed thankful to members of Working Group namely; Dr. R.K. Malik, Former DEE, CCS HAU, Hisar, Dr. B.S. Duggal, Former MD, HSDC, Panchkula, Dr. A.M. Narula, Former Zonal PD,ICAR KVKs, Dr. R.B. Srivastava, Former Associate Director Planning, CCSHAU, Hisar, Dr. S.R. Garg, Former Director Extension Education LUVAS, Hisar Mr. Ajay Vir Jakhar, Chairman, Punjab Farmer's Commission & Bharat Krishak Samaj and Dr. Sandeep Kumar, Research Fellow, HKA & Nodal Officer of this group for their untiring and commendable efforts to prepare this precious report.

I am also thankful to Dr. Gajender Singh, Mrs. Vandana, Research Fellows and other staff members of HKA for their valuable assistance in preparation of this document.

I am sure this report will be very helpful in revamping the Agricultural Extension System in the State and receive attention of line departments.

Finally, I am thankful to the all the stakeholders of the State who put forward their valuable suggestions in preparation of this report.

October, 2017

(R.S. DALAL)

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Introduction

Fuelled by the Green Revolution (GR) technologies i.e., dwarf varieties, agro-chemicals and irrigation water - agricultural extension (AE) played a pivotal role contributing to impressive improvement in crop productivity and production. AE did so by enhancing access to and willing acceptance of farmers on application of necessary knowledge and skills. This engagement inspired intensified use of the GR inputs, which bolstered productivity growth, building thereby a basket-full of production.

Back to back cropping involving excessive tillage and increasing use of fertilizers, pesticides, herbicides and irrigation water propelled land use intensification. The resultant euphoric rise in productivity (food grains 6.5 times; rice 2.8 times and wheat 3.5 times) and production (food grains 6.8 times; rice 17.9 times and wheat 11.7 times) since 1966-67 propelled the State from an otherwise food deficit region to a front ranking area contributing to national food reserve. In the Haryana State of India, as elsewhere in India introduction of the National Demonstration (ND) scheme since 1964 and Training and Visit (T&V) system of AE since early 1970s stimulated spread of yield-catalysing inputs. This in turn, as narrated, gave a dramatic push to the growth in productivity and production of food grain crops, more specifically rice and wheat. The availability of superior technology - especially improved varieties that responded to other components of technological packages, was a key variable. Heavily subsidized supply of electricity spurred the adoption of GR technologies. In fact, the proportion of electric power consumption by agriculture sector (mainly for irrigation) increased from ~22% in 1966-67 to 44% in 1990-91 (Chaudhary and Harrington, 1993). Government support also included changes in produce pricing policies (introduction of MSP), expansion in credit and input supplies, development of markets, rural roads and electrification (McGuirk and Mundlak, 1991). During these years “this total support package”, which helped spread of GR technologies was genuinely addressed and implemented. Training of a large number of scientists, capacity building of agricultural institutions and the improved infrastructure of input industry were the other elements of the public supported package. In technological terms, induction of high yielding varieties, enhanced use of fertilizers and irrigation along with transfer of knowledge and skills (AE) to manage these inputs laid the foundation for

transformation of Haryana agriculture, what came to be known as 'Green Revolution'.

However, with the passage of time the GR inputs were unable to defend the top yield growth rates reached during the early years of its happening. For instance, the rates of growth that peaked at about 3% after inception of GR, plummeted to ~1.5% within 30 years (Katyal, 2015). This negative trend - a global phenomenon, affected Haryana agriculture too. The AE services that played vital role in establishing credentials of GR technologies were found wanting is reversing the slide in productivity growth. Regular increase in input use and infusion of superior genotypes failed to salvage the situation either. Coincidentally, happening of GR beginning 1966 and its downfall after 1990s, followed closely the evolutionary rise and collapse of AE services. This happened because the primary focus of AE on increasing productivity was at the cost of decline in health of natural resources (soil, water, biodiversity and climate). Even the response of the National Agricultural Research System (NARS) to appropriately right-track changes in research and extension was not forthcoming. Typically, both research and extension did not create space giving due credence to the needs and perceptions of the primary stakeholders i.e., farmers. This distance widened the gulf between the technological inputs required to decelerate the fall in productivity growth and those which were routinely being offered.

From the point of contribution of technology transfer methods, historically (see above), began with the launch of the ND. It was significantly strengthened with the introduction of T&V method of AE in early 1970s. Coincidentally, fall of T&V system of AE just before 1990s and the recorded slide in peak productivity growth rates happened one after the other. Findings of several studies are witness to that (Anderson, *et al.* 2006).

Furthermore, by now it was clearer than ever before that mindless anthropocentric (man-made) intensification of manufactured inputs and natural resources encouraged rise of yield-disturbing adversaries like simplification of pest spectrums that encouraged pesticide use followed by development of pest resistance, greenhouse gas emissions led climate change, micro-nutrient driven hidden hunger, diminishing soil organic carbon, surfacing of salinity, waterlogging and depletion of biodiversity. None of these factors can be dealt the way the existing system of AE works. There is no feedback mechanism that links the needs of the farmers with extension system. In the absence of proper advice from the stakeholders, the recommendations made in the linear model fail to attract their acceptance in totality. In this age, when the technological developments responding

to unanticipated scenarios have to be founded on a holistic approach imbibing response of the client cultivators, the extension system has to shun piecemeal solutions and be more participatory than ever before. The top-down AE system of yesteryears following general recommendations is found wanting in dealing with these new and peculiar developments. Consequently, farmers are not receiving a full set of right knowledge and knowhow on neutralizing the impact of diminishing response of HYV to fertilizers and other inputs matching with the needs of their farms. Location and situation specificity of the emerging problems of today's agriculture like climate change, have given rise to a suspicion that GR technologies have suffered from a fatigue and have thus lost relevance. This, however, does not seem to be true. Information gathered thus far signals that without changing the input use, routinely managed farmers' yields happen to be far inferior to the side by side conducted demonstrations with full package of location-sensitive practices. It is apparently a case of extension gap (demonstration yield - farmer yield), which confirms that farmers were not extended the right technical advice on adoption of a new package of practices suiting their situation. This appraisal irrefutably makes a case on GR technology application fiasco rather than the lost relevance of GR inputs.

With the above background in front, this report examines the evolutionary pathway of the current system of technology transfer with specific focus on Haryana. It adopts a sequence of write up, which is guided by: (i) the Terms of Reference set by the Haryana *Kisan Ayog,* (ii) input from the Members of the Working Group on Extension and (iii) outcome of the meetings and interactions of the Working Group with the peers and stakeholders (Annexure-I). In consonance with the deliverables of these wide-ranging consultations and to strengthen the write up further, the report presents a contextual assessment of the current AE system. In pursuance of that the final document features definition and concept of technology transfer, history, past performance and current shape and structure of extension apparatus. Varying conditions of Haryana farmers, farming and farms remain the epicentre of this appraisal. It leans more towards a bottoms-up approach, which right from the beginning garners and strengthens participation and interaction with the farm-folks. The proposed AE method is rooted in the socio-economic conditions, follows a utilitarian but participatory approach. It also engages with the private sector and harnesses the power of ICT. Additionally, the new AE model focuses on: (i) imparting practicable knowledge and skills on location-sensitive right crop choices and methods supporting income and employment generation, (ii) nurturing sustainable natural resources management,

(iii) combining modern farm practices with native resources and indigenous wisdom, (iv) loss free harvests, (v) preliminary produce handling/safe storage and (vi) consumers/ markets/trade.

TERMS OF REFERENCE	
1.	To analyse strength and weaknesses of TTS to understand specific gaps.
2.	To identify, analyse and establish specific causes opposing scaling-up of innovations.
3.	To examine level of private sector involvement in TT and to propose effective ways to encourage their active participation.
4.	To suggest role of farmers' associations, NGOs, women's groups and specifically the youth and to propose their future role in strengthening TT.
5.	To suggest measures for capacity building to ensure more effective TT.
6.	To recommend 'Way Forward' and mechanisms for both knowledge and technology dissemination and to have more involvement of all SH.

1 HISTORY, CONCEPT AND DEFINITION OF AE

The term 'extension' has Greek roots. It originates from 'ex' – meaning out and 'tensio' – meaning stretching. Education is an integral part of extension. With that proviso, extension stands for education – the education that is stretched out to the farming community beyond the bounds of the educational institutions. This pedagogy in common parlance stands for imparting non-formal and informal education.

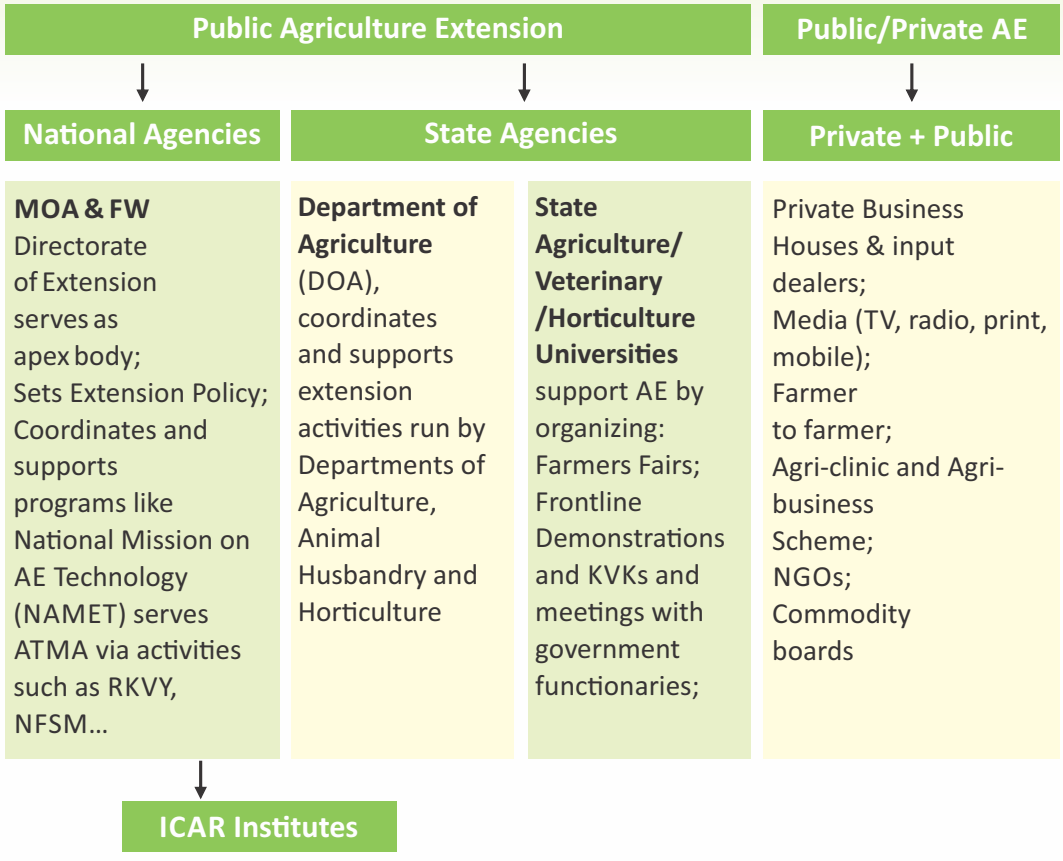
From this report's stand point, word extension signifies unfolding and delivery of crop productivity and farm efficiency enhancing new knowledge and knowhow to farmers. It, therefore, connotes cultivating right information among those who are outlying university farms and proper classrooms. In simple terms, extension is an out of school system of education. In that context, 1st use of the phrase extension was made in England for the development of education during the 2nd half of the 19th century. It was, however, in 1867 when it was designated as 'University Extension' to serve the educational needs of the society far away from formal classrooms, but close to their homes (Jones and Garforth, 1997). It was, the outbreak of potato blight in 1845 in Ireland that gave birth to the need for 'agricultural extension' (AE). Launch of "Farmers' Institutes" somewhere in 1860 in the United States marked the beginning of direct interactions between know-hows and do-hows. By 1890, passage of the 2nd Morril Act paved the way for establishment of “Land Grant Colleges”. With this development, the Farmers' Institutes, a limited movement, became a National Institution. What followed was establishment of Cooperative Extension Service in 1914. This agency obligated Land Grant Colleges to perform the task of AE. The purpose was to help diffusing practical and useful information on agriculture and home economics to farmers and to encourage its application by them.

In India, AE evolved as public supported activity. This inherited legacy from the days of British Empire continued after India's getting independence in 1947. To date, Government funded institutions continue to extend this service. In the independent India's Constitution, agriculture, including agricultural education,

research and extension was placed in the State List (Entry # 14 State List). Accordingly, main technology transfer machinery is with the State Governments in the country. Nevertheless, Central Government and its Institutions steer and assist technology transfer as a kind of front-line activity by way of devising new programs, coordination and funding. Somewhere, beginning early 1990s, public AE started showing some kind of fatigue in its impact. At that point in time, non-public AE, first led by the non-governmental organizations (NGOs) and then followed by the entry of private traders/business houses started making its presence felt. Since then the private AE has gained in numbers. Now, it is an important force, albeit far limited in reach than the public AE. Nevertheless, even in small parcels their impact is noticeable with measurable depth. With this brief background, an account on the evolution, growth and state of both public and private AE is narrated in the following paragraphs. Before that, present set up and sources of AE in India is presented in Figure 1.

Historical Perspective: The history of AE in India is perhaps older than it is generally projected (refer to Menon, 1997). In 1819, the then British Empire (East India Company) conceptualized founding of the Agricultural Experimental Farms. These farms with time grew as Agricultural Colleges, which ignited the cause of scientific farming. In its truest sense, however, conception of AE in India was seeded by bringing in of 12 American cotton growers who were mandated to teach native peasants as to how to grow that crop. Also, to infuse good cultivation practices, the then Madras Government imported steam ploughs and a battery of tilling implements. Expectedly, both the experiments transplanted from the alien lands failed. Soon, the Imperial establishment realized that no useful purpose of technical advice could be served without investigating the character of native soils and agricultural situation. Today, we understand that technical recommendations do not serve much useful purpose, if not aligned with the local bio-physical properties of natural resources and intrinsic socio-economic conditions of the farmers. Value of location- and situation-specific technologies was confirmed by a Committee headed by Sir John Russell in 1937 (refer to Menon,1997). Inter-alia the Committee exhorted scientists to validate findings of their investigations by conducting experiments across diverse farmers' field conditions. This commandment on direct responsibility of scientists to cultivators inspired the establishment of National Demonstrations in 1965. Also, another recommendation of the Russell Committee concerning need for 'really competent men' to manage AE gave birth to integrating education, research and extension when State Agricultural Universities (SAU) were being established on the pattern of Land Grant Colleges of US beginning 1960.

Fig .1. Profile of Agricultural Extension (AE) in India - Summary



There were several other pre-independence, public- supported events that impacted transfer of knowledge on scientific farming. Among these: (i) Gurgaon Experiment 1927 promoting development of agriculture, and (ii) Nilokheri Experiment 1947 favouring evolution of agriculture as agro-industry are worth mentioning. Both these initiatives piloted inception of AE movement in the present-day Haryana as elsewhere in the country. However, these were the recommendations contained in the 1929 Report of the Royal Commission on Agriculture that directly linked infusion of science to growth of agriculture. Establishment of Imperial (now Indian) Council of Agricultural Research was a land mark step in pursuance of that proposition.

Post-independence AE Initiatives: In the independent India, the then operational Grow More Food Scheme attempted to lease further life into the extension side of the Agricultural Departments. According to Menon (1997), reorientation of Agricultural Education to stimulate role of extension in improving crop productivity failed to make any visible headway. It was the Grow More Food

Committee 1952 that scripted the concept of modern day extension. Setting up of an AE body to reach every farmer was a key proposal made by this working group. In pursuance of that goal, it supported a decentralized structure and organization of AE in India. Inclusion of farmers' role in implementation of the Grow More Food Scheme was the first-time recommendation on enhancing effectiveness of the AE. It won't be an exaggeration to state that the present-day construct of ATMA (Agricultural Technology Management Agency) is a possible annex and a strengthened version of the blue print suggested by the Grow More Food Enquiry Committee 1952. On an overall basis, the proposed AE was seen to assist in the coordinated and comprehensive development of all aspects of rural life and financial system. It sought to improve farmers' economic health through diversification - based on extended emphasis on dairying, horticulture and value addition and processing. Aim of Community Development Program 1952 was to facilitate achieving that objective; what today we call 'integrated farming' or 'mixed farming'. Though inclusive in content, financial constraints limited the reach of the program to a few selected activities only. Nevertheless, giving due consideration to people's desire to expand the program and government's genuine commitment to improve rural economy through agricultural performance, in 1953 a National Extension Service (NES) was inaugurated across the length and breadth of the country. However, because of an overambitious spread, NES could hardly create any visible impact. Government of the past realized that it would be preferable to shift the focus of AE on some 'intensive cultivation areas'. These compact blocks represented zones with assured water supply and fertile soils (Menon, 1997). In effect, this regional specificity overrode the thinly spread community development efforts by concentrating exclusively on irrigated tracts. With the passage of time, this concept gave birth to launch of Intensive Agricultural District Program (IADP) or the Package Program during 1960-61. The core aim was to achieve rapid growth in production through intensive use of inputs and techniques in agriculturally stable areas. The outcome was a mixed bag of success. The failure and success primarily depended on adequate availability of seeds of region-specific varieties. In 1964, on the pattern of IADP, an intensive Area Agricultural Program was flagged off. Its launch coincided with the new potentiality created by the birth and introduction of input-responsive, dwarf varieties; nick-named 'high yielding varieties' (HYVs). Undoubtedly, outcome of IAAP was spectacular, albeit its impact was limited to irrigated and relatively risk-free areas and large farmers. Consequently, neither did it inspire marginal and small farmers on use of inputs, nor did it influence poor state of agriculture in rainfed regions. Rather it is believed to have widened the gulf between the resources-rich and resource-poor farmers (http:// www. syngentafoundation.org/__temp/Gowda _Extension_

Systems_India.pdf). Then being a close jacketed centralized system, the program lacked ownership down the line. It blatantly ignored the value of capacity building necessary for utilizing knowledge and skills on efficient management of inputs like fertilizers and irrigation. Also, the research findings – the so called technologies were evolved by inducting objectives that did not match with those of the farmers and their farms; hence, have limited adoption time after acceptance. These were the principal shortcomings of the IAAP, which weakened its reach and more importantly the impact.

Majority of the Government of India (GOI) Schemes, discussed thus far, suffered from a common flaw of being supply-centric (take it or leave it kind of model) but not demand driven (what farmers wanted). Moreover, these projects followed a top-down model. It means superior office set the tenor and substance of actions and activities on transfer of knowledge and skills, leaving hardly any room for location- and situation-specific corrections. Above all, these schemes proved ineffective in addressing typical technology transfer (TT) needs of marginal and small farmers (M&S) who constitute 87% of the 138 M farm holder. Individual-centric traditional extension has hardly any chance to reach all. In order to mainstream specific TT wants of this group, projects like: Small Farmers Development Agency 1969, Marginal Farmers and Agricultural Labourers Program 1969, District Rural Development Agency 1976 and Integrated Rural Development Program 1978 were put into motion. Undoubtedly, setting up of these projects showed GOI's genuine commitment on alleviating scourge of poverty from the rural areas; yet by and large these failed to measure up to the expectations on improving the economic environs of the beneficiary peasantry (http://www.syngenta foundation.org/temp/Gowda Extension_Systems_India.pdf). Fragmented implementation plan, want of community-based interventions, centralized control and little convergence of activities and programs of AE with other projects impeded the accomplishment of target success.

T&V System of AE: With the realization on the merit of improving depth of knowledge and know-how of vast diversity of farmers, World Bank and other International Development Agencies felt that a system of extension must communicate face to face with the clientele. This gave birth to the Training and Visit (T&V) system of extension. Developed in early 1970s, it was introduced in India by the World Bank as a component of the Chambal Valley Project in 1974 (Anderson *et al.*, 2006). Key elements of the T&V system were: (i) capacity building by organizing system-wide (from senior officers to down the line to village level workers and farmers) training in use of Green Revolution (GR) technologies (HYV seeds,

fertilizers, irrigation...); (ii) putting up hoardings and distribution of pamphlets carrying scientist scripted messages on farm management and (iii) ensuring supply of key GR inputs at subsidized rates. Training followed hierarchical pathway – the training received by the senior extension officers (Deputy Director of Agriculture or DDA) percolated to the field level workers (Agricultural Inspectors) in their subordinate offices. The extension functionaries so trained guided the village level workers (VLWs). The latter group visited villages and coached a few selected farmers (lead farmers) in the art and science of modern agriculture. The farmers, thus contacted, demonstrated and imparted the knowledge and skills learnt by them to others. The prime focus of the T&V technology transfer was on irrigated rice and wheat. Because of near analogous growing environment across locations prompted by irrigation, the spread of new seed, agro-chemicals (fertilizers) and standard agronomic practices moved at a reasonably fast pace. Learning from the experience of lead farmers and also by seeing the in-field performance stimulated acceptance of GR inputs by otherwise non-adopters. This exalted transformation paid rich dividends in significantly elevating productivity led surge in production (as detailed in a later section).

Noticeably, these were the rich and big farmers, having means for irrigation and money to buy seed, fertilizers, plant protection chemicals and farm equipment, who benefitted maximum from the GR technologies. They also attracted more trainers and trainings on use of the GR practices. M&S farmers on the other hand remained, generally on the margins of T&V system of TT. Also, having limited means of irrigation and financial resources to buy new inputs, M&S farmers could hardly benefit from the discovery of fertilizer responsive new seeds. Results of several studies on the effectiveness of the T&V system confirmed that it favoured large cultivators more than the M&S farmers. In fact, an in-depth review by the World Bank – the promoter of the T&V system, revealed that the village level officials (VLOs) preferred visiting large farmers (Feder and Zilberman, 1985). Then the vast majority of the VLOs with their narrow expertise were only able to transfer technology descending from the top and that too applicable to irrigated rice and wheat. Consequently, they were severely handicapped to respond to the complex knowledge and know-how requirements of small land holders, whose livelihoods are closely linked to mixed/integrated farming (e.g., a system of farming enterprise that comprises of growing crops and raising livestock together). This situation typically represents Haryana agriculture, where integrated farming is the rule of sustainable life and living. Additionally, T&V system did not connect to the technological needs of rainfed farmers. Neither did it network with the real life TT

programs like Lab to Land, Operational Research Programs, Krishi Vigyan Kendras and Front Line Demonstrations. On an overall basis, these limitations and low calibre of field staff overshadowed the effectiveness of T&V extension scheme for a State where M&S farmers and rainfed situations, respectively abound in number and extent. Then the top-down crop based approach, which espouses the transfer of ready-made uniform solutions, rather than those customized to suit specific locations (biophysical environment) and situations (farmer's socio-economic status), dented severely its relevance and usefulness. With these systemic weaknesses, T&V system of TT failed to sustainably influence: (i) those who needed it most, (ii) marginalized farm families whose life and living depends on integrated farming and (iii) regions faced with complex problems forced by nature and man (i.e., dryland tracts, flood prone areas, flirting weather events and problem soils). Coming 1990s, routine training, mandatory visits and researcher invented messages proved grossly inadequate to match emerging needs of "multifunctional agriculture", farmers' aspirations on more income and avenues for employability and problems like soil health decline and climate change. It was the exclusive emphasis on elevating yields by increasing the use of energy-dense inputs (fertilizers, irrigation) that fuelled noticeable loss of soil health and climate change. Then the functionaries managing T&V system lacked expertise on advancing information on consequences of mindless use of fertilizers and water. Result was a significant fall in performance of agro-inputs (particularly fertilizers) leading to fall in response ratio and decline in productivity growth. These developments proved fatal for T&V. It faded and collapsed during 1990s.

Broad-base AE: The lessons learnt from the T&V system gave birth to thinking on broad based extension (BBE), which espoused decentralized institutional arrangements on TT, client participation and farming system approach. Examples of BBE are: (i) Single Window – Broad Based Extension Model (Maharashtra), (ii) Panchayati Raj Institutions (Kerala, West Bengal, Madhya Pradesh) and (iii) the SAU–Farmer Direct Contact (Punjab) (*agricoop.nic.in/policy_framework.htm)*. Typically, Single Window Extension Model (Maharashtra) unifies working of Departments of Agriculture, Horticulture, Animal Husbandry and Fisheries as a single agency. The prime aim of the system is to promote advisories on all aspects of agricultural activity from a single window. Being a bottoms-up demand driven model, it provides prominent position to farmers in this networked structure. With this linkage mechanism, farmers organize themselves as Common Interest Groups or Functional Groups and articulate their needs and problems during technology development, refinement and application.

This interaction offered more inclusive ways of converting technologies into innovations. This change takes place by way of lead practitioners' feedback on technology needs, development, diffusion and adoption. Also, the group leaders work as role model and take charge of demonstration and dissemination of new knowledge and know-how to others.

A comprehensive exercise on the application of broad-based technology development and dissemination has started gaining appreciation in Haryana since 2006. The focus was on elevating wheat productivity to above 4 tons in a time-bound manner. At that point, the then Director of Agriculture, Mr R.K. Khullar exhorted the scientists in the Annual Agriculture Officers Workshop to give only two proven interventions that would help the State hoisting the otherwise staggering wheat yields. In response the two interventions namely the early wheat sowing before 31 October and 100 % seed treatment with appropriate chemicals were adopted as key elements of the strategy to be launched across length and breadth of the State. The Haryana Agricultural University through its KVKs approached each Panchayat of Haryana villages and the DOA through its village level workers went to schools to teach students the importance of the above two practices. The aim was to create a network effect of early sowing and seed treatment. The approach paid dividends. Wheat productivity of the State, which was 3.8 tons/ha during 2005-06 rose to 4.2 tons/ha in 2006-07. Additionally, the positive response to early sowing and seed treatment was discernible only in districts where technology transfer via Village Panchayats and school children were taken as a mission. This focused approach taught that straight forward technologies and comprehensive extension of the otherwise untapped but influential means can create swift and lasting effect. This methodology representing a kind of participatory way of technology identification and its transfer is the soul of ATMA model of extension being detailed in the following section.

ATMA System of AE: In order to create a unified BBE, during 1990s the Agriculture Technology Management Agency (ATMA) model was created. Conceptually, ATMA imbibes decentralized decision-making, moving from State Headquarters to the district level offices. A second objective is to increase farmers' participation and input during program planning and resource allocation. A third goal is convergence for enhancing coordination and effectiveness of overlapping development programs by integrating working of different Departments like Agriculture, Horticulture, Animal Husbandry and Fisheries. In addition to these structural changes, Agricultural Extension Division (GOI), while enunciating an alternative policy frame work for ATMA program, informed that focus would shift

from the component-based AE to a farming system driven technology transfer. Agricultural diversification, marketing and links with private processors for value addition will be the other elements of the new methodology. In order to capture farmers' needs and feedback, the alternative ATMA model for the first time places emphasis on formation of producers' groups at the village level (*agricoop.nic.in/policy_framework.htm*). Inclusion of scheme on integrated pest and soil fertility management is a significant departure from earlier exclusive stress on synthetic pesticides and fertilizers. No doubt, new-look ATMA structure and program seem holistic and well-intended in support of sustainable growth of agriculture, but suffer from several imperfections. According to Kapoor (2010) these imperfections are: (i) incomplete decentralization below block level, (ii) poor linkage with the ICAR institutes, SAUs, KVKs and (iii) weak alignment with the stakeholders (Kapoor, 2010). However, GOI's new Policy Framework addresses several of these identified shortcomings in the earlier ATMA model (*agricoop.nic.in/policy_framework.htm*). Once professionals mentor ATMA organization, institutional arrangements are introduced and processes are set that include farmers' demands and plans on implementation, monitoring and evaluation scheme, it is projected that new ATMA model will make an iconic beginning in the public supported TT history. For this to happen, first requirement would be that scientists share their research goals with what farmers perceive as solutions and pursue as their needs. Secondly, it will necessitate functional arrangements fortifying autonomy down to producer groups. Thirdly, for making smallholder-centric research and participated management a reality, developing farmer-right technologies and package of practices will be necessary. This will happen only when research, district-level administration and State's Agriculture and Allied Department are brought on one platform.

Responding to these critical issues and weaknesses, Department of Agriculture and Cooperation (DOAC), Ministry of Agriculture (MOA), GOI, introduced a Modified Extension Reforms Scheme in 2010 . The aim was to bring the then existing 17 different extension programs under the umbrella of ATMA. Following that conceptualization, in 2015, MOA (now Ministry of Agriculture and Farmers Welfare) established the National Mission on Agricultural Extension and Technology (NMAET) as the next step for reaching the objective on amalgamation of these schemes. Inter alia the NMAET is seen to help creating a judicious use of modern ICT for dissemination of information on popularization of right kind of technologies by strengthening individual and institutional capacity. So that adoption of region-specific technologies remains unhindered, the NAMAET will support mechanization, availability of quality seeds, plant protection... In

pursuance of that NAMET organizes itself into following 4 sub-missions:

i. Sub Mission on Agricultural Extension (SMAE)
ii. Sub-Mission on Seed and Planting Material (SMSP)
iii. Sub Mission on Agricultural Mechanization (SMAM) and
iv. Sub Mission on Plant Protection and Plant Quarantine (SMPP)

The above division of NMAET into sub-missions is for administrative convenience, since in real functioning these are inextricably linked to each other. Through these sub-missions the intent will be to steer aggregation of Farmer Interest Groups (FIGs or Farmer Producer Groups, FPGs) (vikaspedia.in/.../national-mission-on-agricultural-extension-and-technolo...) at the village level and Block Technology Team at the Block level. Both these set ups will feed necessary information to Farmers Advisory Committee at the district and further on to Governing Board at the MOA headquarters. After effecting these improvements now ATMA will be structured as is depicted in the following organogram (Fig 2) as given by MANAGE.

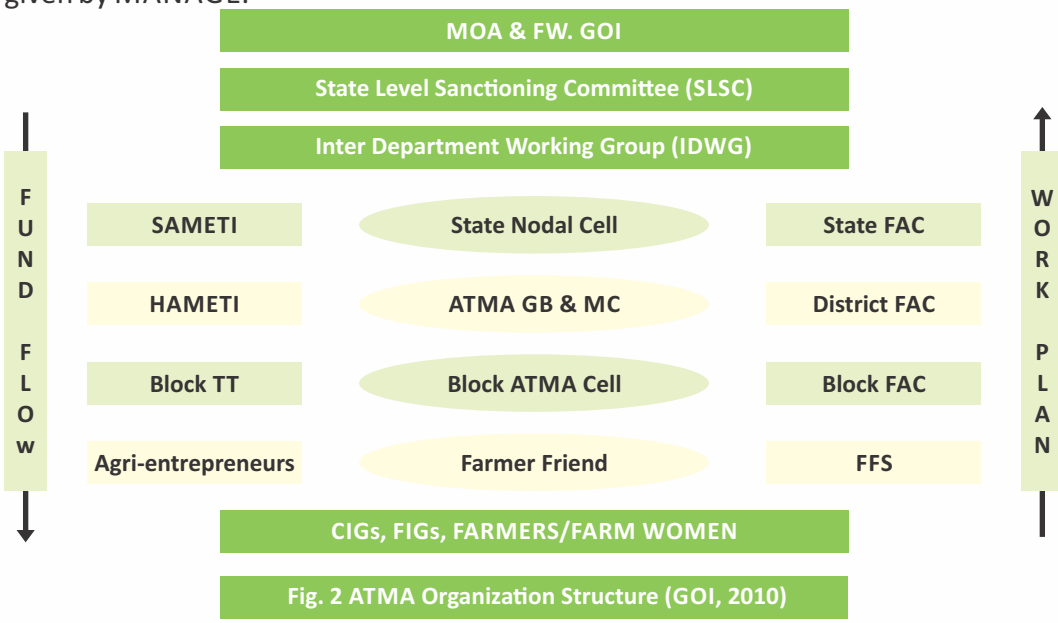


Fig. 2 ATMA Organization Structure (GOI, 2010)

SAMETI State Agricultural Management and Extension Training Institute;
HAMETI Haryana Agricultural Management and Extension Training Institute (district level);
FAC Farmers Advisory Committee; TT Technology Team;

ICAR's Initiatives: Indian Council of Agricultural Research (ICAR) from time to time attempted to strengthen the implementation of the centrally supported AE programs. It launched initiatives like National Demonstration Project 1965, Krishi Vigyan Kendra (KVK) Scheme 1974, Operational Research Project 1975, Lab to Land Program 1979, Frontline Demonstrations on Oil Seed and Pulses, 1991, Technology Assessment and Refinement through Institution-Village Linkage Programme (TAR-IVLP), 1995, National Agricultural Technology Project (NATP) 1998 and National Agricultural Innovation Project (NAIP) 2007. These initiatives representing 'front line extension' brought farmers closer to the scientists, but feebly invoked wide area impact. This was not surprising, since ICAR's programs do not represent the traditional methods of extension. Rather these are aimed to influence and improve existing practices of technology transfer. In that sense, ICAR's goal is to institutionalize development research in front-line extension and extension education.

Krishi Vigyan Kendra: Since 1974, when the concept of **Krishi Vigyan Kendra** (KVK) was first introduced by the ICAR, number of KVKs has grown to 652 by 2016. It is the single largest network of frontline extension system in the country. The main mandate of a KVK includes: (i) verification of location-specific technologies by testing before application, (ii) following assessment creating awareness among farmers on new technologies, (iii) organization of front-line demonstrations on improved technologies and capacity building trainings related to these for farmers and grass roots level extension workers, (iv) production and supply of new seed and planting material facilitating adoption of new technologies, (v) work as knowledge and resource centre on modern technologies supporting public, private and non-governmental organizations involved in improving the agricultural economy of the district. This undoubtedly is a laudable mandate on linking researchers and farmers, since it holds promise for enhancing depth of possible impact of research on farm productivity. However, reach of farmers to information and advice extended by KVKs (NSSO 59th and 70th Rounds) does not seem extensive; merely 1% of the farmers interviewed accessed technical information from all the 652 KVKs put together. Apparently, there is urgent need to significantly improve functioning and visibility of KVKs so that they become closer to farmers than before and are able to generate desired impact of modern methods of farming. One way is their involvement in guiding the working of Farmers (both end women) Producer Groups/Farmer Interest Groups/Farmer Field Schools and in preparation of Strategic Research Extension Plans under the aegis of ATMA.

AB & AC Scheme of AE: Launched in 2002, **Agri-business and Agri-clinic Scheme (AB & AC)** (Karjagi *et. al.*, 2009) is meant for agricultural graduates for: (i)

supplementing reach of public extension, (ii) increasing easy access to input services to farmers and (iii) enhancing employment avenues (Global Agi-System, 2008). These small agri-business owners either provide expert knowledge, know-how and advice to farmers (Agri-clinics) or offer input and machinery on custom hire basis (Agi-business). It is pertinent to mention, that the AB&AC supported is supported by public seed money, but in its truest sense is a kind of private extension.

During its 14 years of being in operation, there are mixed reactions to the success of AB&AC Scheme. According to findings of a study by the Global Agri-System (2008) a large number of farmers rated the scheme highly satisfactory. These were those farmers who on following the advice of the AB&AC business ventures benefited in terms of increased production arising from the usage of right inputs and need based plant protection measures. But from the point of agri-business owners, the scheme does not seem as popular as was envisaged. For example, of the 75,000 graduates produced from 2002-2008, merely 5% gained employment by opting for AB&AC. More disturbing was the fact that only 47% of those who underwent 2-month training finally opened their service centres. Apart from tedious credit securing procedures, uncertainty of acceptance by the rural folks is a serious limitation. Moreover, expecting farmers making payment for routine services, which otherwise are available free of cost from public extension system, remains a serious impediment in acceptance of the AB&AC scheme. The need is to move away from routine advisories to consultation services in areas of contemporary relevance having potential to generate income and employability on and off-farm. Some examples are: competitive diversification through hi-tech agriculture (protective agriculture), entrepreneurship development advice in processing/value addition, integrated farming in all aspects, custom hiring services in farm machinery and equipment, supplementary activities like setting up of apiary, pre-marketing grading and packaging...

In order to further strengthen the scheme and make it competitive vis a vis established input dealers, it seems necessary that AB&AC ventures are able to maintain unbroken contact with the training centres to seek information while providing advisory services on the one hand and with ICAR institutes and SAUs to update and sharpen their skills in use of fast developing new knowledge on the other. E-connectivity with these institutes will increase reach in gathering real time support. Also, if they gain professional competence in low volume high income yielding agri-businesses (example protected agriculture, comprehensive custom hiring services on machinery and equipment), chances of success would be far higher.

AE by SAUs and ICAR Institutes: State Agricultural Universities (SAUs) through their Directorates of Extension reach farmers through Agricultural Technology Information Cells (ATICs) - a single window-approach for extending advice, information and supply of new seeds and planting material. Then SAUs regularly organize Krishi Melas (Farmers' Fairs), which provide farmers with a unique opportunity to get on the spot face to face advice from the subject matter specialists and real-time opportunity to buy seeds of latest varieties and other state-of the-art inputs. Above all, during these events farmers get to see and evaluate the live performance of new genotypes, machines, techniques and practices. These guided tours to demonstration plots prove very incisive in taking pro- or anti-acceptance decisions on new varieties/methods of farming. Kisan Melas, therefore, continue to remain the most influential tool of technology transfer. A major drawback is the limited coverage, since only a handful of farmers participate in these fairs. This gap is substantially filled, since SAU-scientists are able to establish real time dialogue with huge numbers representing a wide variety of farming community via Radio and TV talks and written blogs in newspapers/popular magazines. Their reach and interaction becomes deeper when scientists answer queries through Kisan Call Centres and involve in field demonstrations, steer exhibitions and mobile diagnostic labs. Intensity of impact from scientist-farmer interaction reaches a pinnacle through adaptive or action research conducted under real life situations. Cultivators seem to place high value and abiding faith when scientists are in their direct contact (PAU Model of Extension).

NSSO data suggest that almost 40% of the direct and indirect information farmers gather on new developments, in one or the other way is contributed by the SAUs Extension Directorates. However, SAU extension interventions have a down-side also. Generally, the SAU advisories focus more on productivity enhancement and inform less on environmental, social and marketing odds of doing that. This problem seems to diminish once SAUs work hand in hand with the State Departments of Agriculture. Training of researchers and TT functionaries adds value to both; former become more responsive to farmers' needs by learning from the latter about the constraints and deficiencies in the existing methods of farming. Like SAUs, ICAR institutes also undertake AE in their respective spheres of research domain. They also organize Kisan Melas and utilize direct contact channels for extending new technologies developed by them (refer to an earlier section).

Private AE

It was in the VI Plan Document (1980-85) that for the first time defined the involvement of non-governmental organizations (NGOs) in the programs on Soil

and Water Conservation, Forestry, Renewable Energy and Environmental Protection. A major intent was to seek NGOs support in strengthening human resource knowledge and know-how, rural skills, use of indigenous resources and an overarching role in technology transfer (Ramakrishana, 2013). Of the large consignment of NGOs in India, all do not concern with farming. Also, many are small and of 'fly by night' kind. The most prominent ones are: BAIF (Bhartiya Agro-Industries Foundation – Development Research Foundation), 1967, SEWA (Self-Employed Women Association), 1972, PARDAN (Professional Assistance for Development Action), 1983, VARDAN (Voluntary Approach for Rural Development Action), 1995 and BASICS (Bhartiya Samrudhi, Investments and Consulting Services (a holding Company of BASIX) 1996. Large NGOs also help small NGOs by allowing them to utilize former's large platform. Typical example is the non-profitable 2005 Sygenta Foundation in India for Sustainable Agriculture that offers partnership to small NGOs on enhancing their impact and visibility.

Majority of the NGOs, albeit not all, involve in wide-ranging programs that directly or indirectly serve the cause of technology transfer. The common methodology adopted by them gives preference to the otherwise unutilized experience and expertise of local people for their own development. In pursuance of this goal, they extend and blend indigenous resources and knowledge with modern techniques and practices. Potentially, because of their proximity to and regular interaction with the farmers, NGOs seemingly act as very effective change agents. Also, working hand in hand with the farmers NGOs have the advantage of extracting quick client feedback on introduced knowhow. This information that scientists otherwise hardly comprehend is vital in analysing adoption constraints. Based on this real-time review, NGOs can sense making mid-course corrections or suggest scientists on fine tuning their technological offerings. Despite these virtues, limited reach constrains their widespread impact. Nevertheless, their iconic working arrangement with native resources and practitioners as an inclusive practice of sustainable development needs to be emulated by other extension systems.

Input dealers represent another prominent private extension group that disseminates information to its customers (farmers) on use of agro-inputs (Table 1). Besides, the NSSO data presented in Table 1, findings of a study (Saha *et al.*, 2015) suggest that the input dealers are more informed to serve the farmers specifically on goods they offer for sale. Accordingly, their advice is largely limited to use of seeds, small implements, pesticides and fertilizers; the most common inventory they stock. They have hardly any clue on standard agronomic practices, new

technologies, machinery and markets. Resultantly, their overall role in holistic technology transfer is rather limited (Saha *et al.*, 2015). Also, overwhelmed by the profit motive, input dealers tend to highlight the superior points about the inventory they are selling. This kind of over drive to dump some non-standard products increases cost of farming and at time possible cropping up of some harmful side effects. Regardless of this deficiency, on ground agro-input sellers numbering 282,000 in India (Ferroni and Zhau, 2011), however, remain an easily reachable, important source of information for farmers (NSSO 2003 and 2013 and Saha *et al.,* 2015). Appropriate training of this otherwise non-holistically informed grass roots level group can be effectively utilized to out-scale application of right technology. In addition to small scale input suppliers, there also exist some well-organized, large input dealers who support agricultural extension. Some examples: Tata Kisan Sansar, Godrej Agrovet, Jain Irrigation, Hariyali Kisan Bazar.

Compared to input suppliers, several multi-service agro-business companies offer crop-specific information and training on most appropriate practices and supporting inputs, relevant weather advisories and buy-back arrangements. E-Choupal propagated by ICT since 2000 seems to be pioneer in utilizing the reach- and time-neutral power of information and communication technology. It not only provides access to markets and right know-how augmenting efficiency of small farms, but also backstops virtual integration of the entire supply chain. Contract farming is another prevalent example of private extension. Many of these companies offer bundled crop insurance products to contract clientele. The freebies could be in the form of affordable group agricultural insurance (Pepsi-CO), cheap credit (HLL-Rallis-ICICI joint venture)and higher assured price than the market (Adani Agri-Fresh).

Table 1 : Sources from which farmers seek information on new farming practices (the data are % the total respondents deriving advice from a particular source of information) (data source: NSSO 2003 and 2013)

Source	59th Round	70th Round
	% of total respondent	
Progressive farmers	17	20
Input dealers	13	7
Extenssion worker	6	6
Radio, newspapers, TV	20	29
KVK	1	3
NGO	1	1
All India	40.4	40.6

In addition to public and privately conceived, planned and run agricultural extension schemes, **farmer to farmer (F2F) extension** is a widespread system of technology dissemination. In fact, findings of NSSO (2003 and 2013) confirm that farmers access maximum information from their colleagues (Table 1). Also, this is the most efficient and effective method to spread new technologies in the areas, which otherwise remain beyond the reach of extension personnel. Called progressive farmers, model farmers, master farmers, lead farmers or master trainers these farmers drive the transfer of information to other folks. F2F extension, however, suffers from a serious drawback. It is the dilution that is likely to happen on transfer of a full basket of a technology package. One additional problem is near absence of advice on tailor made solutions matching with diverse farmers and farming situations.

Still another variant of F2F extension is group extension. In this system farmers organize themselves as community organizations. These are known as Farmer Interest Groups (FIG), Community Interest Groups, Farmer Producer Groups and Farmer Registered Societies. By an Act of Parliament, creation of Farmers Producer Company (FPC) got legal status in 2002. The membership is exclusively open to farmers/producers. Extension of information on new technology and related training with provision of subsidized inputs is one such component of assistance provided by the public institutions (details in a later section). Though not explicit, an elected leader manages the affairs of an FIG/FPC. Ideally, a subject matter specialist with support from the VLO and a representative of a local NGO should backstop the functioning of the group. Presence of subject matter specialist is seen facilitating: (i) organization of capacity building programs, (ii) decisions on technological interventions, (iii) arrangements on input outsourcing and (iii) maintenance of backward (resource pooling, produce management) and forward (marketing of produce) links.

FAO in 1989 called group based learning, as is common with the FIG, 'Farmer Field School' (FFS). On ground, 20-25 farmers are trained by an extension agent for a full cropping season in the art and science of crop husbandry focusing on a key aspect (IPM, Conservation Agriculture, climate management…). In the actual field situation, farmers learn by doing, observing analysing and recording what constitute standard management practices and school specific goals. Arranged on weekly basis, extension agent value adds to farmers' assessment of what new they are practising. He clarifies the doubts and gives additional information on learning points emerging from the record of their observations during field work. At the end of the academic session (crop calendar), the alumni's skills are sharpened further by

adding new information that makes the learning wholesome. Intervention of this kind proves very useful when farmers themselves reorganize FFS for others.

Van den Berg and Jiggins (2007) observed that farmers who attended FFS were able to reduce pesticide use and increase yields, respectively to the extent of 4 to 14% compared to those who bunked it. Efficient and effective extension is among the most valuable outcomes of FFS. Still the system has its own share of problems. Sensitivity due to unequal socio-economic status within the group creates relational problems between the resource-rich and resource-poor members. An associated issue is the tendency of public extension personnel to pay preferred attention to former group giving poor representation to ideas and contribution of the latter category (Feder *et. al.*, 2010). Notwithstanding these concerns, FFS concept seems highly relevant in the context of Haryana, where population of farmers, typically constituting small and marginal class (78% of the total farmers), overwhelm the extension machinery of the State.

Benefit from implementation of FPC scheme in Haryana merits attention. As on today out of pulse and vegetable cultivation that qualifies for technical and input support, Haryana elected to focus on enhancing quality vegetable farming. Accordingly, FPC covers what is called Vegetable Initiative for Urban Clusters (VIUC). Organic farming is one farming technique on which FPC members are informed and educated. The farmers are also given tips on compost making, use of pesticides and related activities. In addition, farmers are assisted in making group purchase of inputs and marketing of their produce.

Ongoing fast pace advances in information and communication technology (ICT) – both electronic and print media – have made possible: (i) the real-time dissemination of messages on new innovations, (ii) immediate advisories on emergent field problems and (iii) short and medium term alerts on developing weather conditions. Defying the bounds of time, space and number of recipients, delivery can go viral in a jiffy. ICT enabled virtual demonstrations, classrooms and networking of public-private TT agencies and dialogue between researchers, extension agents and farmers can be organized matching the real life situations. Hence, whether it is reaching unreached defying boundaries of time, space and number or it is linking diverse institutions with farmers, use of ICT is an economically favourable and technically sound method to disperse messages in a variety of ways. The Virtual Extension, Research and Communication Network (VERCON) of FAO has demonstrated successfully the potential of ICT in improving messaging and linkages between research, extension and farmers. By combining power of human

intelligence and technology, VERCON aims to strengthen creation, storage, sharing, retrieval and dissemination of information not only among service providers but beneficiaries of that service also (ftp://ftp.**fao**.org/sd/**vercon**.pdf).

Though ICT is an exciting futuristic mode of knowledge and know-how dispensation, following conditions need to be met for increasing its application, acceptance and effectivity:

- Creating a proactive mind set favouring ICT.
- Rural ICT infrastructure: equipment, internet reach, speed and backup power.
- Hands-on quality of content while offering capacity building syllabi or inducting new innovations in communication transfer: blending together simplicity, compatibility, congruence, complementarity and continuity with the native means of knowledge exchange and visibility of relative advantage, local proverbs, practices and beliefs, easy to comprehend/ apply and above all responsive to farm and farmer's needs.
- Sustainability of the system: trained human resource, assured funding and continually system up-gradation/content updating.

Till these ICT favouring catalysts are in place, ubiquitous TV can be pressed into TT service. TV is a known influential alternative for displaying and communicating all kinds of farm messages. According to NSSO (2005), farmers accessed far more information from TV than from either newspapers or extension workers. Delivery of quality content and organizing interactive sessions are seen to further reinforce power of ICT, when it comes to influencing farmers' attitude on accepting new and holistic farming methods and informing them on corresponding public-sponsored programs facilitating their adoption. Videos highlighting scientific methods of cultivation and nitty-gritty of off-farm enterprises is another forceful tool of TT and skill-development.

Summary

From the brief review on various systems of AE presented above, one thing becomes amply clear that AE is not a monolithic activity involving only education of individual farmers on new methods of farming. Its content and context change with the location and situation of farming. Accordingly, the substance and approach for creating community-wide awareness and providing information vary. AE, therefore is continuously evolving process that blends transfer of retooled information and skills to community-based organizations on improved knowledge and techniques of crop/livestock management. It is also required to assist the farmers' groups to use

that capacity in sustainably improving productivity, profitability income, employability and resilience without harming the quality of natural resources. On the whole, AE must protect, develop and sustain growth of agricultural industry in all its aspects. Following elements constitute the proposed AE process:

- Transfer location- and situation-right information and skills on new farming methods and practices through participatory review, active research and front-line demonstrations.
- Nurture technology adoption enabling environment (need based supply of inputs and impart of knowledge and skills to manage the same efficiently and in a balanced manner).
- Inspire sustainable productivity, income, and employment growth by supporting on- and off-farm capacity building.
- Inform and educate on cautions and precautions arising as the aftermath of using new inputs and practices on health of natural resources.
- Support formation of farmer producer groups by forging backward and forward linkage to maintain market links (sustained by consumer preferred production), value addition and post-harvest management.
- Above all, along with crop-based technology transfer, need is to give strong impetus to farm diversification by harmonizing crop based agriculture with horticulture, fisheries, veterinary and animal husbandry extension.

2 HARYANA AGRICULTURE – CHALLENGES FOR RESURGENCE

Background: Haryana became one of the States of the Indian Union on 01 November 1966. The present administrative boundaries represent the region that flourished during the Vedic civilization along the banks of legendary river Saraswati. Its pristine lush green forests from which it derives its name from the compound of Sanskrit words – *Harit* (green) and *Aranaya* (forest), provided perfect environs for *Vedic sadhana* (spiritual practice) and writings. In fact, it is here where *Vedas* were written. The other connotation of name Haryana suggests a region signifying 'Abode of Gods' (Hari = lord Vishnu and ayana = home). It is no wonder, Haryana's 5000-year-old glorious history abounds not only in myths and fables, but its glorious past is immersed in the birth of Gita and Mahabharta. It is here the Lord Krishna preached the former and the *Rishi* (saint) Ved Vyas wrote the latter.

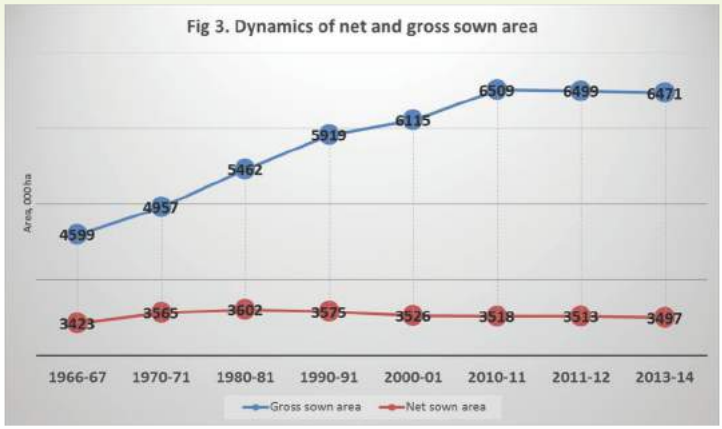
Haryana is located in the north-west of India between 27°39′ to 30°55′ N latitudes and 74°27′ to 77°36′ E longitudes. The altitude in the State ranges between 200 to 300 meters above mean sea level (except the hilly ranges of Shivaliks in the North and Aravallis in the South). The Yamuna River in the East, the Ghaghar River in the North-northwest and Aravalis in the South bind Haryana. The State has bowl shaped topography. As a consequence of this unique physiographic setting, Haryana persistently faces the twin problems of poor drainage and water logging on the one hand and flooding on the other. Despite these odds, Haryana's geographical proximity to the India's capital offers a vast throbbing market for ready off-take of produce its farmers generate.

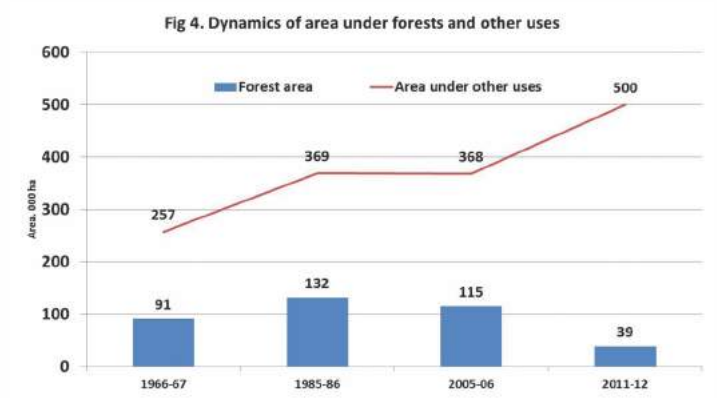
Administratively, Haryana is divided into 22 districts comprising of some 6800 villages. Haryana with a population density of ~573 inhabitants/km^2, supports 2% of the country's population (~1250 million). One out of five Haryanvi males are illiterate; while the corresponding proportion for females is one out of three. Around 65% of the total population lives in villages. Rural Haryanvis depend primarily upon crop cultivation for livelihood; integrated farming also forms a distinctive feature of their earning. Nearly 50% of the workforce derives its

livelihood from agriculture. In relation to that, agriculture contributes just 18% to the State's GDP (SGDP), which is declining with every passing year. This mismatch signals existence of widespread under-utilized productivity of agricultural workforce. Progressive trends on falling contribution of agriculture to SGDP further suggest a relatively faster growth of industrial and service sectors compared to agriculture. Additionally, these developments point out to two possibilities: (i) making agriculture an industrial activity or low volume high value production enterprise like protected farming (details in a later section) and (ii) shifting substantial proportion of agriculturally dependent population to emerging areas of economic activity through education and training.

Use and Setting of Natural Resources: Haryana is among the small States of India; in size it ranks 4th from the bottom. It spreads over an area of 4.4 million ha, which is barely 1.3 per cent of the total geographical area of the country. Based upon the latest land use statistics (2013-14), net sown area (~3.5 million ha) comprises 81% of the geographical area. The corresponding figure for India is 47%. Over the years, net sown area has remained more or less constant (Fig 3), while the gross sown area (contributed by area sown more than once) has increased with time. Compared to the steady pattern of net sown area, land use distribution among other economic and ecological sectors has shown rapid shifts. For instance, since 1966-67 land diverted to non-agricultural purposes (roads, canals, industry, human dwellings etc.) has pitched 95% increase (equivalent to 243,000 ha) (Fig 4). Mainly, rehabilitation of barren and uncultivable land has contributed to this surge. Substantial area has also come from the loss of forests (52,000 ha) and permanent pastures and grazing lands (~20000 ha). Haryana barely has 39, 000 ha forest area; it is 0.9% against 22% for India. Permanent pastures and grazing lands have become nearly extinct from the State (Economic Survey of Haryana, 2015-16).

Net sown area in Haryana is distributed among 1.6 million operational land holdings (institutional land holdings excluding). On an average, each land holder owns an area of 2.25 hectares, which is 50% higher than the national average. Of the total operational land holdings in Haryana, 68% fall below the small and marginal category (land holding < 2 ha); equivalent figure for India is about 90%. Apart from other weaknesses of small and marginal holders, they suffer more extensively from low productivity of agriculturally dependent manpower. It is the per worker output that fuels prevalence of widespread unemployment and underemployment of rural workforce.





Climate: From agricultural standpoint, an assessment on nuances of regional climatic pattern is necessary for preparing robust farming plans. In order to project seasonal moisture availability for successful cropping, UNEP (1992) prescribed aridity index (AI), which is the ratio of precipitation to potential evapo-transpiration. AI is a practical and numerical indicator to present the degree of dryness in the climate. It is, thus, a priori for deciding need for irrigation and corresponding choice of agricultural crops and practices. The lower is the AI of a place; the drier is its climate and accordingly more is the need for supplemental irrigation. On an average, Haryana annually receives 545 mm rainfall (range 300-1100 mm) and loses 1450 mm through evapo-transpiration. The mean AI for the State thus works out to 0.38 (range 0.24-0.75). Based upon the UNEP aridity criteria, Haryana, in general, is divided between arid and semiarid regions with a brief East-northerly incursion of dry sub-humid climate. In response to low AI, development of irrigation formed the essence of happening of Green Revolution in the State. Currently, 87% of the State's net sown area is irrigated.

Water Resources: In Haryana, respective availability of surface and ground water is 0.94 and 0.65 M ha m (million-hectare meter). It means a possible access to

1.59 M ha m of water for irrigation. In addition, the State on an average, annually receives 0.98 M ha m effective fresh water equivalent from rainfall. The total consumptive water demand for the prevailing cropping systems is estimated to be 3.39 M ha m. After subtracting the effective rainfall from the consumptive water demand, the net irrigation requirement works out to 2.40 M ha m. Although potential availability of irrigation water from surface and ground water is reckoned at 1.59 M ha m, the real field level supply does not exceed 1.33 M ha m. This deduction of 0.26 M ha m is attributed to the distribution losses, which occur before the surface (canal) water actually reaches the farmers' fields. Accordingly, the net deficit of irrigation water at the field head comes to 1.07 M ha m. This overall shortfall of 40% is currently met chiefly by overexploitation of the groundwater. As the time passes, this growing abuse is likely to lead to chilling prospects of desertification, challenging sustainable growth of agriculture.

Soil Resources: Soils in Haryana are formed on an alluvial base in the plains. These are built on an accumulation of sediments in the northern sub-mountain Shivalik tract and over crystalline rocks in the southern Aravali hill region. By and large, the Indo-Gangetic alluvial plain covers a large part of the State. A chunk of young alluvial soils is of recent origin (soil Order Entisols, area 28%). These still developing soils have incomplete profile zoning. On the one hand, relatively older alluvial soils (soil Order Inceptisols, area 58%) display somewhat better differentiated soil profile. Alluvial soils in general exhibit fine loamy to coarse loamy texture. These dot almost all districts of Haryana. However, their maximum concentration is found in the eastern sector of the State. Compared to the soils of alluvial origin, wind borne soils (Aridisols, area 9%) hardly display any visible profile development. Aridisols are largely coarse textured, weakly structured, poorly buffered and less in fertility.

From the land use suitability angle, Haryana houses a mix bag of normal and problem soils. One fifth of the total land mass is susceptible to wind and water erosion and about one tenth of the State territory remains seasonally water-logged. Almost 2% of the area is blotched with hills and rock out-crops, which is unfit for routine farming. Although normal and near normal soils cover four fifths (~80%) of the State, these, however are extensively encroached upon by salty patches (~12%), sandy tracts (~12%) and bits of stoniness (~1%).

The intrinsic soil properties built during processes of weathering (see above), farm management and cultivation have significantly influenced soil health parameters. Defined by a combination of chemical, physical and biological indicators, a soil in good health performs two cardinal functions; one sustaining potential productivity and two maintaining environmental services (water stocking, bio-diversity sheltering, contaminant filtering, buffering, moderating climate

change). High intensity cropping comprising of exhaustive tillage, back to back cropping, dwarf varieties, exclusive NPK fertilizer application (current use 224 kg/ha, highly tilted towards N) and irrigation have left an indelible mark on soil's normal functioning. Consequences are loss of soil fertility, physical stability, useful biology, productive capacity, resilience and climate change neutralizing ability. Not only these developments have dented potential productive capacity, but soil health also stands challenged by surfacing of salts due to overdevelopment of groundwater. Additionally, indiscriminate use of pesticides and herbicides has led to appearance of hitherto unknown pests and weeds. Dominance of Haryana agriculture with rice wheat rotation involving cultivation of a select group of varieties has hit hard the crop diversity and has resulted in the disappearance of certain native plant and animal biodiversity.

Agro-eco Zones: For the purpose of land use planning, Haryana's agriculturally important natural resources (soils, climate, water, biodiversity...) have been grouped into two agro-climatic zones (ACZ). First is the "Eastern Climatic Zone" (ECZ). Covering 71% area of the state, ECZ comprises of Panchkula, Ambala, Kurukshetra, Karnal, Panipat, Sonipat, Kaithal, Palwal and parts of districts of Jind, Jhajjar, Charkhi Dadri, Rohtak, Gurugram, Mewat and Faridabad. Second is the "Western Climatic Zone" (WCZ), which spreads on the remainder 29% of the state's geographical area. Districts of Sirsa, Hisar, Bhiwani, Fatehabad, Rewari, Mahendragarh and parts of Jind, Rohtak, Faridabad, Mewat and Gurugram constitute this climatic zone**.** ECZ is divided into 2 sub-regions: Foothill Shivalik and Himalayas (dry sub-humid, mean rainfall 890 mm) and Plains (arid to semiarid mean annual rainfall 561 mm). 'Scarce Rainfall Arid Tract' (mean annual 360 mm) forms the sub-region of WCZ.

The tracts falling under the ECZ is ideal for crop diversification with wheat, rice, pulses, cotton, rapeseed mustard and sugarcane. It is well adapted for raising dairy cows, buffaloes and poultry. Within the sub-zone 'Plains', the areas neighbouring Delhi are preferred for raising vegetables and protected farming. As a whole, the ECZ is endowed with better irrigation facilities, superior quality soils and good overall infrastructure. For instance, this zone is endowed with good class of underground water and accordingly 65% of irrigated area is nurtured by underground water. This zone shares some constraints also *Kandi* area within this zone has serious problem of soil and water erosion and hence that tract suffers from repeated loss of fertile top soil. Plain area because of poor drainage infrastructure remains under the constant shadow of water logging.

Compared to the ECZ, the WCZ is provided more with canal irrigation (67% of the irrigated area) as the underground water is of brackish nature. Wherever underground water is used exclusively for irrigation, there always remains a lurking

threat of soils becoming saline and alkaline. Arid part of this zone exhibits typical vulnerability to wind erosion. This natural setting calls for more emphasis on tree-based agriculture e.g., arid horticulture and livestock based integrated farming. In view of these specific problems, this region calls for induction of programs encouraging conjunctive use of irrigation water and drainage to flush out salts. Also, wind erosion-proneness of the arid tract calls for application of specific soil and water conservation measures (physical and biological barriers) to augment in-situ rainwater soaking and run off harvesting for groundwater recharge to support arable farming. Besides perennial tree-based farming, pearl millet, cotton and cluster bean (guar) are principal annual crops of the rainy season; rapeseed mustard is a dominant crop of the winter season. Where ever, irrigation is possible, wheat is the preferred field crop. The Mewat corner of the WCZ is specifically appropriate for silvi-pastoral agriculture and sheep and goat rearing.

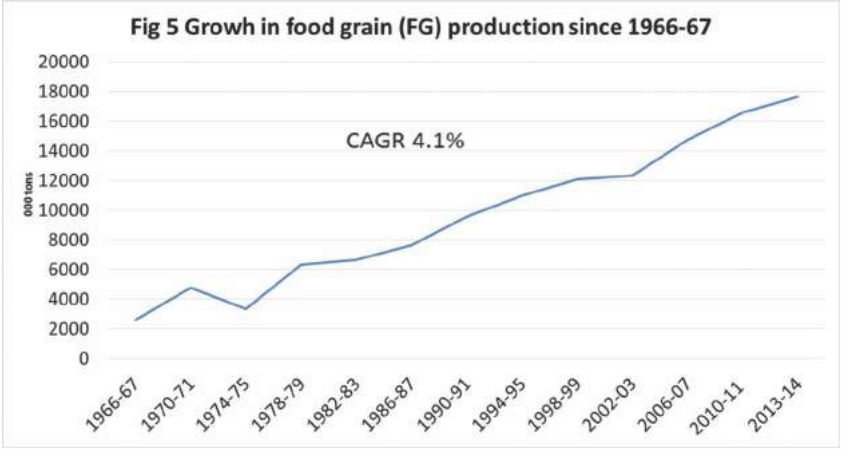
Summing up the state of Haryana's natural resources, past and present accounts of swings in land use statistics depict that all routes for stretching agricultural area any further have already hit the wall. Additional growth in production has, thus, to come from improvement in productivity. It is a formidable challenge due to virtual absence of protective vegetation and unique topographical features, and thus the available land resources remain highly exposed to degradation processes of one or the other kind. Moreover, net sown area is in continuous conflict with competing demand for other uses. Climatic constraints, typified by generally low aridity index, necessitate added strengthening of irrigation water management. Irrigation being mainstay of fuelling use of productivity pushing inputs and having nearly exhausted resources to expand it further, for a sustainable growth Haryana agriculture has hardly any choice except to manage and use the available water resources most prudently, efficiently and scientifically. Provision of effective drainage system (a system that eliminates excess salt built up and prevents their re-entry into root zone) is a must to maximize benefits of irrigation hardware. Soils of Haryana, because of low native buffering capacity, if not managed holistically, remain ever exposed to one or the other process of degradation. With this situation, it is more necessary now than ever before to include organic manure supplements and conservation agriculture practices not only to halt dwindling soil organic carbon but to revive its build up also. Simultaneously, to contain fall in soil fertility, physical integrity and useful biology, it is inescapable to infuse practices that emphasise efficient use of man-made inputs. Then there cannot be a silver bullet solution for sustainable growth of Haryana agriculture in all its aspects. It has to be as per farmer investment position, agro-climatic zone carrying capacity and market-specific demand. Since livestock forms an important aspect of farming, without integrating its contribution to farmers' life

and living, improvement in Haryana agriculture will remain an oxymoron.

2.1 Haryana Agriculture – Technological Elements and AE

Agriculture in Haryana, as elsewhere in India, is considered a noble profession. Though now an economic activity, agriculture still remains deeply embedded in traditions, folklores, faith and religious practice. Globally, agricultural history is 10,000-12,000 years old. Comparatively, in the tiny State of Haryana agriculture is rather young; here it incepted just before the Harappan Civilization (~2500 BC). Similar to other regions of the country, chronicled growth of ancient agriculture in Haryana, swung too with the deviations in normal precipitation and other physical forces of nature. The State inherited this unpredictable setting when it was carved out of Punjab some 50 years ago. Since then, strikingly as it is, agriculture in Haryana has undergone a dramatic transformation. The food grain production has increased to 17.6 million tons in 2013-14, as against only 2.6 million tons when the State came into existence in 1966-67; a whopping rise of 6.5 folds.

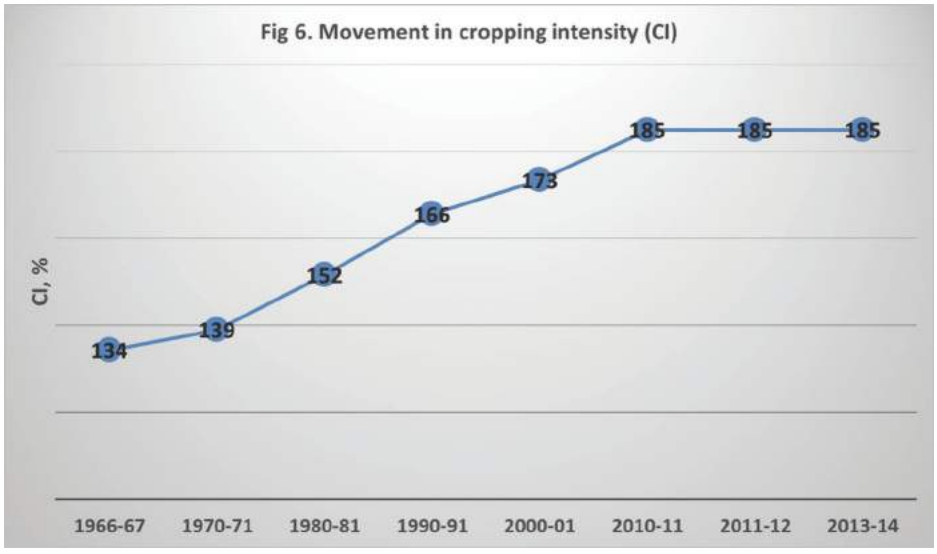
Compared to native methods of farming, modern agriculture in the present day Haryana is more productive and settled. The State has the distinction of attaining food self-sufficiency in the shortest possible period. Currently, Haryana is the second largest contributor to the national food grain basket. Since 1966-67, food grain production has surged at a compound annual growth rate of 4.1% (CAGR) (Fig 5). It successfully overwhelmed the rate of population rise (CAGR 1.7%/annum). Significantly, this feat was less dependent on area expansion (CAGR 0.5%) practices than on productivity growth (3.34%). In statistical terms, productivity contributed 87% to the growth in production; remainder 13% came from area increase. However, the story takes a dramatic turn, when analysis is fine tuned to consider the architect crops (rice and wheat) that amplified food grain production. This is explained in the following paragraphs Of the total food grain



production in 2013-14, 93% was made up of rice (23%) and wheat (70%); their corresponding share at the time of State's formation was just 50% (9% rice and 41% wheat). Expansion in area and cropping intensity (means cultivation of the same parcel of land more than once during an agricultural year) jointly with improvement in productivity (yield/ha) fuelled the commanding position which rice and wheat enjoy today. Being a small State and faced with critical situation on physical allocation of more land for agriculture, Haryana over the years diverted ~1.7 M ha area by curtailing cultivation of coarse cereals (pearl millet, sorghum, maize, barley; area rerouted 816,000 ha) and pulses (area transferred 846,000 ha) (Table 2). Since most of these crops belonged to *kharif* season, a lion-share of the area thus set aside went to intensify rice cultivation. On the other hand, backstopped by assured irrigation and other modern inputs, a strengthened cropping intensity (Fig 6) engineered rise in wheat area.

Table 2 : Shifts in cultivated area of food grain crops

Food Grain Crop	Triennium mean Area (000 ha) (mid values)		Area gain or loss (000 ha)
	2011-12 to 2013-14	2011-12 to 2013-14	
Rice	212	1225	1013
Wheat	867	2502	1635
Peral millet	884	464	-420
Sorghum	257	64	-193
Maize	77	10	-67
Barley	183	47	-136
Pulses	1035	189	-846



Besides area expansion, growth in productivity of rice (yield gain of 2 tons/ha since 1966-67) and wheat (yield gain of 3 tons/ha since 1966-67) helped piling-up of food grain production. Share in food grain production was 64% of area and 36% of productivity in case of rice; with wheat, the corresponding contribution was 49% and 51% (Fig 7 and Fig 8). Forced by ecological and economic reasons, avenues for future area increase seem to be nearly closed. Apparently, it will be the productivity gain that will dominantly contribute to any further addition to food grain production. As in the past, high yielding varieties, fertilizers, pesticides, irrigation and standard agronomic practices – also called GR technologies, will remain relevant and useful in elevating productivity growth in future also. Need will be for the right kind of extension advisories that preach sustainable development of agriculture by focussing together on productivity growth and environmental security.

Fig 7. Relative contribution of area and yield to production - RICE

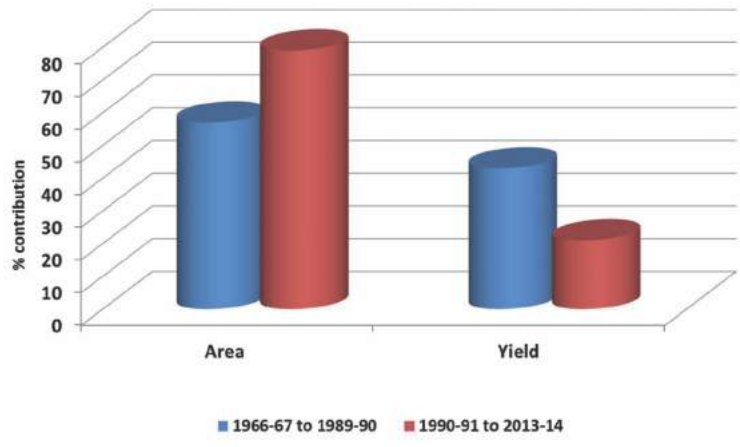
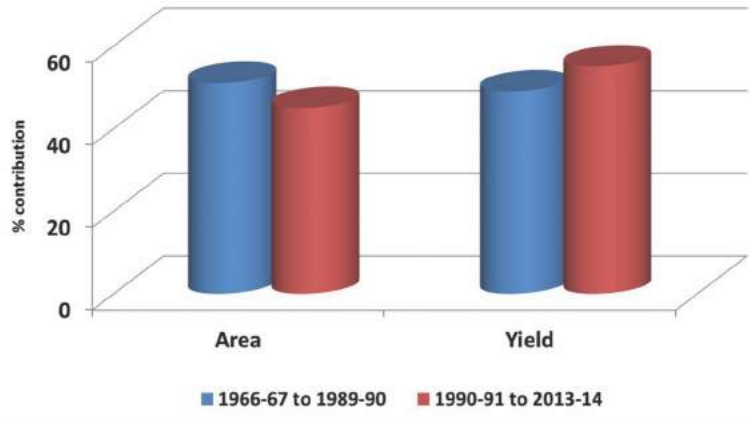


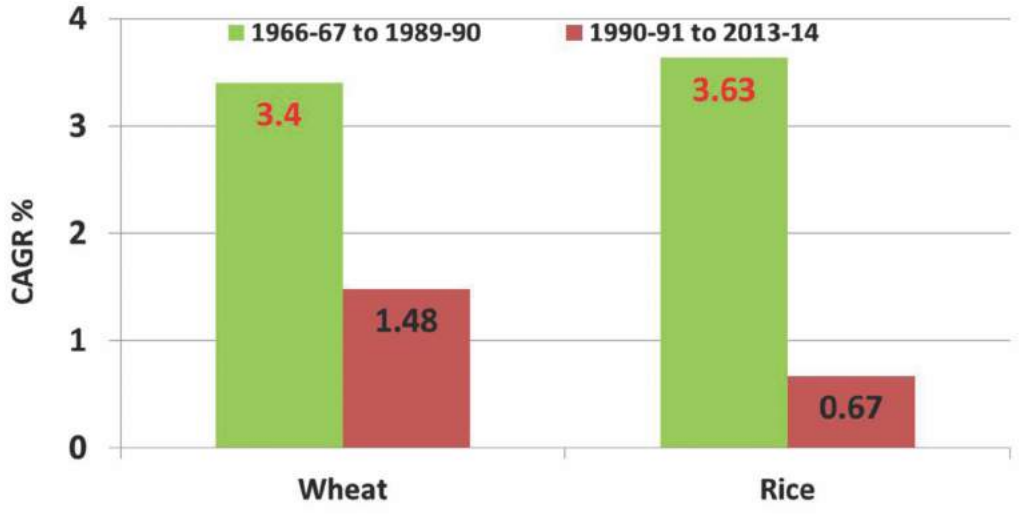
Fig 8. Relative contribution of area and yield to production -WHEAT



In order to understand whether the build-up of food grain production was sustainable over a period or not, time-phased statistical analysis on contribution of GR technologies to the growth was performed. In fulfilment of this goal, the 48-year stretch of GR was segmented into two parts of 24 years each (1966-67 to 1989-90 and 1990-91 to 2013-14). With wheat, during the first 24 years share of area and productivity in food grain production was almost equal (51% vs 49%) (Fig 8). During the next 24 years, contribution of the former declined and that of the latter somewhat increased (45% vs 55%). In contrast, with rice the role of area was far more imposing than productivity; former's respective input to production was 57% and 79% during the early and the later periods (Fig 7). Apparently, regressing contribution of productivity in improving production was a lot steeper with rice. Decaying role of productivity is a matter of grave concern, since area mediated growth, as stated earlier, stands nearly blocked.

In order to make a more robust statistical assessment on dynamics of productivity before 1990 (1st 24 years of GR) and after 1990 (2nd 24 years of GR), the compound annual growth rates (CAGR) were computed. Presented as Fig 9, CAGR values show a depressing picture with the passage of time. For instance, CAGR in respect of wheat productivity fell from 3.40% up to 1990 to 1.48% thereafter. With rice, the degeneration of CAGR was significantly striking, i.e., from 3.60% to 0.7%. With AE in the centre, possible elements that fed Green Revolution and the factors that led to its debacle are being examined.

Fig 9. Motion in CAGR of Wheat and Rice



Infusion of science-driven GR technologies (HYV seed, fertilizers and other agro-chemicals, assured water and standard agronomic practices) was irrefutably

momentous in raising food grain production (Fig 5). Other factors that enabled and inspired adoption of GR technologies and thereby maintained the growth of agriculture was in terms of political commitment. Successive governments introduced policies and development interventions that catalysed adoption of GR technologies. A few of these instruments are summarized below:

I. Creation of risk moderating infrastructure (education for formal capacity building, research and development institutions, seed and fertilizer industry, roads and communication, power and markets).

II. Institution of pro-farmer policies (subsidy on critical inputs, cheap credit, financial support on premium to buy crop insurance, minimum support price with buyback arrangements).

III. Establishment of non-formal knowledge and skill imparting apparatus – extension services.

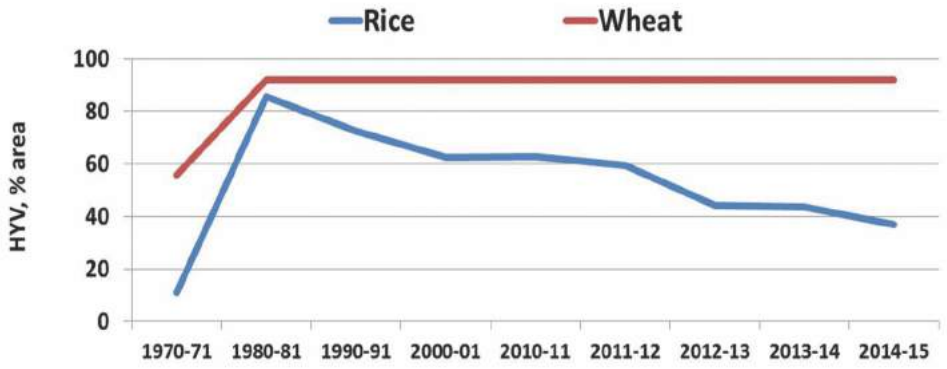
Despite uninterrupted support of these elements, CAGR in food grain production of 5.18% during the 1966-67 to 1989-90 period plummeted to 2.59% during 1990-91 to 2013-14 (Table 3). Since growth in food grain production was stocked up primarily (92%) around productivity of wheat and rice, ups and downs in productivity growth rates of these crops decided the nuances in food grain production. Pattern of CAGR during the two periods, indeed vindicated this thesis (Fig 9). Was then the observed crashing down of productivity and production growth rates, the result of slackening of response to the GR technologies and/or was it due to continuation of the traditional approach on application of GR technologies for productivity-push without including recommendations to deal with adverse consequences of doing that? As will be explained in a subsequent section of this report, it was the non-holistic management of soil, water and inputs and turning a Nelson's eye towards updating content and context of extension advisories that were primarily responsible for degeneration in growth rates of productivity and production of food grains. Consequences of non-holistic management of GR inputs and native resources constraining productivity growth are explained below.

Table 3 : Nuances in CAGR of food grain production following Green Revolution over 2 periods of time

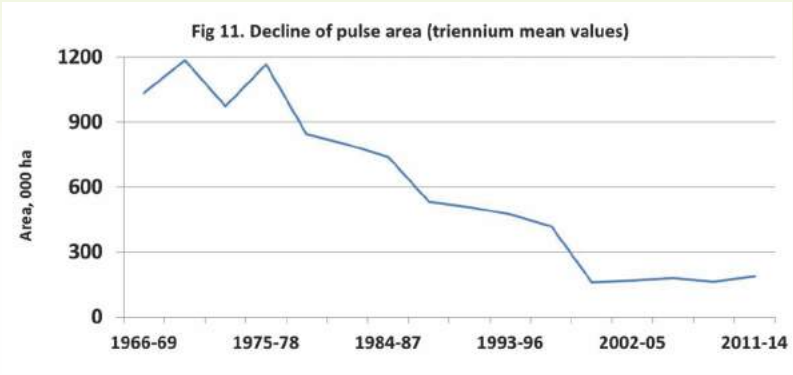
Period	CAGR%
Period 1 (1966-67 to 1989-90)	5.18
Period 2 (1990-91 to 2013-14)	2.59

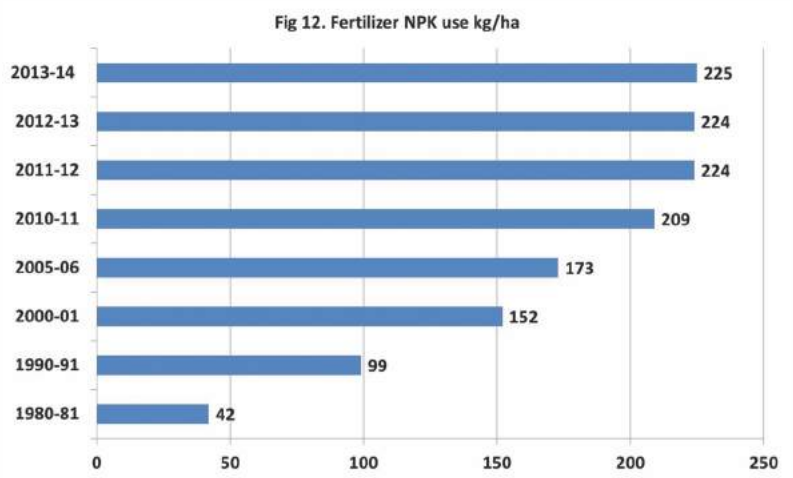
Spread of High Yielding Varieties : Position on the spread of **HYV** is presented in Figure 10. The collated information points out that during the two-time series (before 1989-90 and after 1990-91) coverage remained almost at 100% with wheat, whereas a significant slide was noticed with rice. Apparently, as far as wheat is concerned, progressive spread of HYV was not a factor contributing to the collapse of its productivity growth rates (from 3.40 to 1.48%) (Fig 9). Contrarily, with rice visible descent in HYV area could be an element causing sharp drop in its CAGR after 1990-91 (from 3.4 to 0.67%). Increasing area under low yielding Basmati rice was, therefore, a reason causing productivity growth debacle; since total rice area continued to be around 1.2 M ha.

Fig 10. Time-phased area under HYV of rice and wheat



Crop diversification is a known strategy to minimize emergence of biotic (pests) and abiotic (micro-nutrient deficiencies) stresses. A rising value of crop diversification index indicates decreasing number of crops being cultivated in a unit area or farming becoming specialized with concentration on cultivation of a few crops (Srimar and Meena, 2013). At the time of formation, Haryana farmers used to grow some 15 field crops. Guided by the strength of bio-physical resources, there was a fair distribution of arable area. With time, this balance was upset by diversion of area under pulses and coarse cereals. The area thus lost was allocated primarily to rice. With agriculture becoming rice and wheat specific, there has been spurt in the incidence of pests and diseases. Significant increase in the use of pesticides confirms progress of this negative development. Likewise, a sharp fall in area of intervening pulses (Fig 11) in the rice-wheat rotation fuelled soil health problems (perpetuation of low organic carbon in soils, micro-nutrient deficiencies, weakening of soil physical quality...). Whether it is the mounting pressure of pests and diseases or it is rise in soil constraints, with the sustainable growth in productivity is compromised. Indeed, that has been the fate of rice and wheat productivity growth rates in Haryana.





Consumption of NPK Fertilizers: With respect to NPK fertilizers, consumption rose far more swiftly after 1990s. For instance, per hectare NPK use that was ~100 kg NPK/ha before 1990s went up to 225 kg/ha in 2013-14 (Figure 12). All did not seem well with this numerical growth. A highly disproportional NPK use (NPK consumption ratio), reflected neglect of potassium (K), whose requirements by crops like rice and wheat are equal to that for nitrogen (N). It means, ideally, kilo for kilo, N and K use should have been 1, but on an average since 1970s it was 60. This indicated over-emphasis on N use with persistent disregard to K fertility management. Imbalance in NK use fuelled excessive depletion of soil K reserves (Fig 13) leading to development of its sub-optimal availability levels (Table 4). Accordingly, experimental evidence confirmed that the soils, which were earlier classified as medium turned low in K availability and those that were categorized as high fell into medium group. No wonder, today, 2 out of 3 ha of soil area in Haryana needs K treatment. Rising K deficiency is a serious adversary of maintaining response to application of other fertilizers, more importantly of nitrogenous ones. In face of this development, fertilizer use advisories continue to be mostly general in nature. This goes on despite the fact State has established 34 Soil Testing

Laboratories. Continuation of the disconnect between soil test based needs and actual NPK use recommendations is a major cause of falling response ratio. This in turn severely hurts the attainment of necessary productivity growth rates, which were expected to be sustained in the wake of substantial increase in the intensity of NPK use since 1990s (Fig 12).

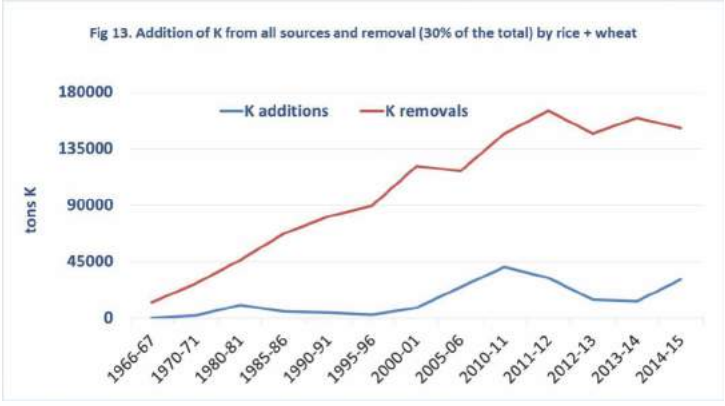
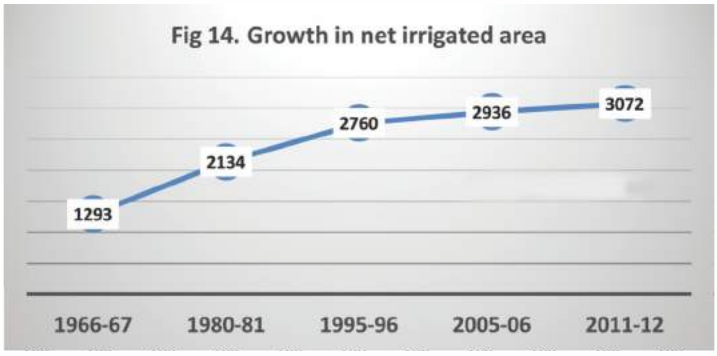


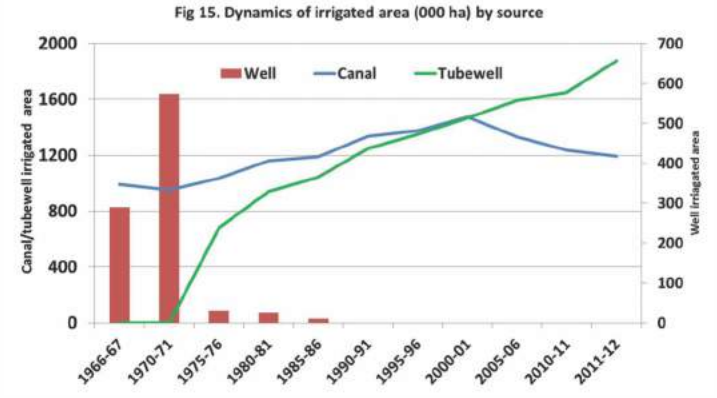
Table 4 : Progressive nutrient imbalance (addition-removal kg/ha) across Haryana soils (Antil *et al.*, 2001)

Nutrient	1966-67	1999-00
N	-22.7	-4.2
P	-9.3	-17.1
K	-35.0	-88.7*
*Reflects spread of K deficiency to the extent of 72% in Haryana soils.		

There were two additional disturbing developments that came in the wake of rising dependence on chemical fertilizers. First was the displacement of traditional organic manures from the scheme of soil fertility management. Second was the shift to relatively pure NP carriers like urea and DAP that unlike conventional ammonium sulphate and single superphosphate did not make antecedent additions of micro- and secondary-nutrients. Exclusion of organic manures led to non-sustenance of soil organic carbon (SOC) (currently ~69% Haryana soils are low in SOC i.e., < 0.4%). Fall in SOC and rise in use of pure chemical fertilizers also provoked emergence of earlier unknown nutrient deficiencies like that of sulphur, zinc, manganese and iron. The result was decline in soil health and loss of productive efficiency of natural resources and added inputs. The end outcome was seen in the form of lost economics (reduced productivity/income) and degraded environment/ecology (climate change). Despite these well-documented consequences of imbalanced NPK use and/or exclusion of organic manures, generalized field recommendations like 120-60-30 NPK continue to dominate the scheme of soil fertility management.

Spread of Irrigation: Growth in irrigation spurred adoption of both HYV seeds and use of fertilizers. Irrigation is, thus, credited with having a major role in impressive growth in the productivity of rice and wheat. In support is cited the data on expansion in net irrigated area. From 1966-67 to 2013-14, it rose from ~1.3 M ha to ~3.1 M ha (Fig. 14); a whopping growth of 240%. Currently, 87% of agriculture in Haryana enjoys the benefit of irrigation. Not only that with an irrigation intensity climbing to 185%, every hectare of cultivated land also gives production benefit equivalent to the otherwise would have required 1.85 times more area.



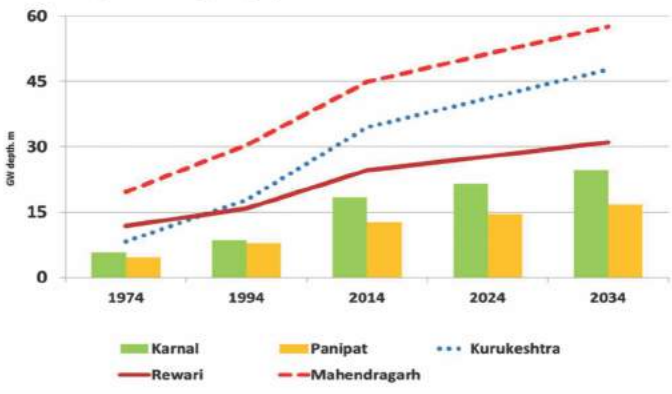


Impressive expansion of irrigation, however, led to some unforeseen consequences. Initially in Haryana, canals (77%), wells (22%) and tanks plus some other sources (1%) were the chief sources of irrigation. With time: (i) canal irrigation increased and then tapered off, and (ii) irrigation by wells, tanks and other sources nearly disappeared by the end of 1970s (Figure 15). From 1975 onwards began, what can be described as 'tube-well revolution'. The momentum, supported by subsidized power, overwhelmed canal irrigation during the next 25 years. In 2013-14, a battery of 752,000 tube-wells irrigated 61% of the net irrigated area, leaving barely 39% to be irrigated by canals. Irrefutably, these developments had significant role in boosting food grain production, but not without economic and environmental

costs. First was the blatant neglect of good management of irrigation water. It pointed to mindless application of irrigation water without regard to crop requirements and installation of proper drainage to remove what was excess. Haryana's saucer shape topography, in fact, intensified the need for effective pumping out of accumulated water from the root zone. To date, drains remain professionally imperfect in application and impact. Since drained water stays in the soil profile by and by it causes water logging and soil salinization. Second, with the grant of nearly free canal water and heavily subsidized power to extract underground water, farmers tend to be least concerned about undertaking practices enhancing water use efficiency. Third is the widespread adherence to high water requiring rice and wheat rotation, which spreads over 3.7 M hectares. The two together consume nearly 80% of the irrigation water resources of the State; 1.2 M ha rice swallows water equal to 2.8 M ha wheat.

Whether it is nearly free canal water or power or dominance of water gazzling rice-wheat farming, sustainable growth of agriculture in Haryana is on the edge. This precarious prediction parallels to no respite either from water logged and saline area and/or fast depleting water-table and accompanying non-sustainable growth in productivity of rice and wheat. According to a report (Suhag, 2016), development of groundwater is 133% in Haryana compared to 62% for India as a whole. Example of existing and projected (built on current trends) depth of ground water fall is depicted in figure 16 for some representative districts. According to this analysis, future is pushing water table to the wall, noticeably in Kurukeshtra and Mahendragarh (Fig. 16). On an overall basis, in 63% of Haryana water table has gone beyond sustainability limits. If this brazen misuse of water resources is not checked, Haryana faces the grim prospects of being engulfed by processes of desertification Besides some extreme policy measures, launch of a water literacy program in partnership with all stakeholders is a must. Agriculture research institutions working jointly with the Departments of Agriculture and Irrigation can play a stellar role in this regard.

Fig 16. Existing and projected state of GW in 5 districts



Crop Intensity: As explained earlier cropping intensity (CI) played a key role in propelling Haryana agriculture to a commanding position. In order to keep pace with the requirements of conventional high intensity cropping, it is necessary to quickly prepare fields for timely planting of the next crop. Accomplishing right tilth in a speedier way is a prerequisite, which in turn calls for employment of machines like cultivators and tractors. No wonder, in 1966-67, there were ~3 tractors for cultivating 2000 ha and cropping intensity was 122%. Today, when the cropping intensity has touched 185% mark, seeding/planting area has risen by 150%. In order to undertake expeditious and thorough field preparation for the next crop, the available number of tractors has risen to 125/2000 ha.

The kind of ongoing exhaustive tillage, however, is undesirable for maintaining good soil health; scientific findings from far and near confirm that vulnerability. Deeper tillage is found to diminish SOC reserves. This loss hurts soil integrity; thereby exposing it to the onslaught of wind and water erosion. Coincidentally, as stated earlier ~70% of the State's soils are deficient (<0.4%) in this vital element – the heart of good soil health. Added to this constraint is the excessive nutrient mining - an aftermath of high volume harvests. Then nutrient loss due to inefficient and unbalanced fertilizer management widens removal-addition gap (example of K is presented in Figure 13). Destruction of SOC and weakening of fertilizer use efficiency serve as prime source of climate change and soil and water pollution. Extinction of forest cover magnifies the speed of shifts in climate patterns. A combined effect of all these adverse events has not only left an indelible mark on the sustainable growth of agriculture, but also seem responsible also for pushing the State to a very uncomfortable position in terms of environment performance index (EPI). Haryana with an EPI value of 0.49 stands 27th (only 5 positions above the worst performer) among the States and Union Territories of India (Table 5). Mitigating adverse effects of high intensity farming by shifting to conservation agriculture practices (minimum tillage, legume intercrop and soil cover) finds little, if any, emphasis in extension advisories.

Table 5 : Environmental Performance Index (EPI) – Position of Haryana among some States of India

State	EPI	Ranking
Andhra Pradesh	0.80	1
Gujarat	0.69	7
Tamil Nadu	0.66	9
Punjab	0.55	23
Haryana	0.49	27
Delhi	0.42	32

*Environmental Performance Index ranking reflects state of air pollution (suspended particulate matter; N_2O and SO_2) forest cover, water quality, water management and CC (on line: environmental-performance-index-epi)

On an overall basis, it appears that Haryana Agriculture stands on the cross roads. It is faced with twin problems of reviving productivity growth and building health of its natural resources to sustain factor output of man-made inputs. In this pursuit, the experience gained thus far (refer above) indicates that response to usual application of GR technologies like HYV seeds, NPK fertilizers, irrigation and back to back cropping, deteriorated with time. It by no means confirms fatigue of modern practices, since their development followed sound scientific principles. Rather the available evidence points to extension imperfections prompting rise of 'productivity-inefficiency'. It signals falling response to GR inputs driven both by mishandling and partial adoption of 'full routine' of a technology.

Seven examples of productivity-inefficiency and related flawed treatment to GR technologies are cited below:

i. Cereal-cereal rotation removing intervening legume intercrop and/or valuing diversification (Result: rising cost of cultivation, decay in soil integrity and biology).

ii. Stress on exclusive use of agro-chemicals without due importance to their efficient, balanced and integrated use (Result: escalating investment, dipping soil quality and rising climate change).

iii. Generalized technological recommendations giving a goby to specific needs of a location and situation (result falling returns and expanding pollution).

iv. Exhaustive tillage unescorted by land management practices and adequate soil cover (Result: crash in soil health and rise in climate change).

v. Use of irrigation water in the absence of land levelling, precision application techniques and efficient drainage and overdevelopment of groundwater forgetting need for recharging (Result: water logging, salinity, depleting water quality, deepening groundwater level).

vi. Burdening of extension responsibility with tasks pushing supply of subsidized inputs rather than fulfilling demand for new knowledge and skills on their safe management (Result: unchecked growth of farm adversaries like land degradation and climate change provoking relentless fall in productivity growth); lack of inter-departmental convergence fueling exclusive focus on crop-based advisories when the need is to harmonize those with the recommendations on improving diverse farm enterprises like horticulture, livestock farming, fishery...(Result: inflating public investment due to multiplicity and duplicity of departmental activities and farm advisories).

vii. Emphasis of technological interventions on elevating food production disjointed from income enhancing and employment generating activities like protected agriculture, bee-keeping, fishery and loss-free post-harvest handling, storage and overall management (Result: mounting post-harvest wastage lessening profitability).

This 7-point synthesis shows that the extension machinery continues to stick to one-point agenda of increasing food grain production. Retrospectively, this was the right approach when country was food deficit and the priority was to change that situation. Green Revolution inputs/technologies, in short term, were highly effective in achieving that goal. With time, however, response to high-energy inputs crashed, because content of extension advisories did not adequately advocate the practices that countered the consequences resulting from their intensive and exclusive application. Non-holistic administration and continued dependence on routine methods and measures fuelled deterioration in the health of natural resources. This unchanging approach dented severely the efficiency of added inputs. Result was significant decline in response to added inputs fuelling thereby the fall in productivity growth rates (Fig. 9 and Table 3).

In sum-total, part-application of a technology package and/or 'non-holistic management' of native inputs or added inputs proved self-harming to growth in productivity. Incidentally, holistic management means enhancing economic output (yield) with minimum damage to natural resources responsible for accomplishing that output. Until now, increasing input use has been the strategy on nurturing productivity growth without countering the coincidental generation of negative developments like: loss of soil organic carbon and useful biology; emergence of deficiencies like that of micronutrients, potassium and sulphur; deepening water table and surfacing of salinity; groundwater pollution and climate change. Cropping up of these adversaries is not sudden but has got piled up steadily.

2.2 Haryana Agriculture – Non-Technological Elements and AE

Apart from traditional technological menu, there are social/demographic, institutional and policy factors influencing level of acceptance, application and benefits of improved know-how. These relate to: land holding size and burden of work force dependent on agriculture; convergence inspiring partnerships and networks, provision of subsidized inputs and market links.

In Haryana, out of ~3 M cultivators, 40% are women; 1.6 M are land holders. Of the land holders, 46% belong to marginal category (holding size <1 ha); average holding size 0.45 ha. A recent report entitled “Does it pay to be farmer in India?” -

published in the Hindu (June 27, 2015) showed that by investing in fertilizers, improved seed and good agronomy, 'a farm household needs to have at least 1 hectare of land to make ends meet every month'. It means about one half of the land holders in Haryana, despite accepting Green Revolution technologies have barely to subsist on agriculture as means of livelihood. Also, this category and more specifically the class of women cultivators is the one, which extension machinery reaches the least when it comes to transfer of new technology and skills (details in an earlier section).

Of the total workforce (~8.8 M), 4.3 M (~50%) belong to farms and farming (cultivators plus field labourers). On the basis of distribution of GDP among agriculture, industry and services, 50% of the total workers contribute barely 17% to the State GDP. This disparity displays more of pseudo-employment, since in rural Haryana statistical rate of unemployment is less than 5%. The challenge of agriculture or for that matter of agricultural extension is to make productive these otherwise underutilized workers. Technological interventions that modernize mixed farming, promote diversification and lead to value addition to agricultural produce come in the forefront. Because of dominance of near and absolute landlessness, there are limits to create employment for every working member of a tiller's family through on-farm activities alone. There is a need to simultaneously expand scope of the off-farm activities that enhance income for more number of workers from less land. On the lines of the Netherlands, marginal farms in Haryana will have to transform as into high-technology biological plants (factories), rather than treading the path of traditional crop-based farming systems. In that pursuit, focus will have to shift towards 'protected agriculture' (poly-houses) and market-demand linked value-adding enterprises. On the protected agriculture, State DOA has projected possible generation of 1.2 million new jobs needed for managing activities like cultivation, supervision, processing, packaging and transport of innovative farm output (Planning Commission, 2009). However, the success of protected agriculture would hinge upon availability of trained human resource, necessary inputs, tools and tackles, induction of relatively cheap and energy efficient poly-houses (refer to an earlier report published by the HKA) and availability of easily accessible and affordable credit. Since, (i) uninterrupted supply of quality electricity remains doubtful, and (ii) diesel-run poly-house atmosphere control being expensive and being a cause and global warming, need would be to go for environmentally sustainable structures. Such models minimize need for fossil-fuel energy and maximize tapping of green-energy reinforced with conservation and recycling turnovers. Also, value adding processing and other areas like fish farming, floriculture, mushroom cultivation, apiary etc. not only create a gainful

self-employment but multiply jobs for others also. Apart from secondary or tertiary processing (examples: juices, pickles), strong emphasis needs to be placed on preliminary (examples: grading, packing) and primary (examples: cut vegetables, dried vegetables, juice concentrates/vegetable purees) processing too. Whatever may be the level of raw produce treatment, organizing cultivators as a producer company/ farmers interest groups and its affiliation to a franchisor (a known production house) and his brand is necessary to widen the scope of reach to markets. This model is a projected prerequisite for producing a minimum critical volume of branded product and founding a successful and sustainable agri-entrepreneurship. Current extension personnel are poorly equipped with basic skills of successful marketing and administering a value-chain activity of this kind.

Above all, beyond the realm of technology transfer (AE), there are 2 major institutional imperfections impacting the sustainable growth of agriculture:

Similar to country-wide prevalent model of technology transfer, DOA undertakes agricultural extension activities in isolation from of other closely related sectors (horticulture, animal husbandry, fishery etc.). Ploughing a lone-furrow setup is contrary to the multifarious needs (ranging from fast depleting natural resources quality to falling farm income in the face of abnormal recurrence of violent weather events) of a farming system. It also makes a farmer run for disparate advice from one agency to another. Multiple-sourced information cross-cut different version rather than compliments. Not only does it add to a farmer's woes, but duplication unnecessarily inflates public investment also. Convergence in functioning of different functionaries is necessary to value add by making extended farm services wholesome. **A single-window extension is the way-forward. It means, advice and inputs are integrated and made available from a common site.** Following inception of the State, multiplicity of development departments and opening of new research institutions by the government are at odds with the single-window extension. Although the move was for stepping up growth of agriculture in all its aspects, carving out of an independent Horticulture Department out of Agriculture and Fisheries Department out of Animal Husbandry has increased hassles for the cultivators. The needy farmers have to move from one department to another looking for solutions on problems confronted by them. They generally end up getting advice in the assigned subject area handled by a particular department. Apparently, such non-holistic solutions neither compliment nor serve the total needs of an integrated farming system, which farmers practice. Incidentally for farmers, growth of crops' enterprise is as important as is improvement in their horticultural activity or livestock operation. Convergence in functioning of diverse

programs is necessary to quicken the pace of sustained growth of agriculture for productivity and profitability.

Manned by depleting number of human resource and without a policy support espousing life-long learning though training, Department of Agriculture (DOA) is largely engaged in implementing endless legacy programs like: provision of nearly free canal water and cheap power for extraction of underground sources; differential subsidy on NPK nutrients and preferential buyback arrangements with MSP support only for rice and wheat. These popular, although not so rational, measures not only overshadow the adoption of efficient input management techniques, but also fail to inspire diversification of agriculture, which is necessary for raising farm income and saving quality of natural resources. Moreover, freebies in the form of subsidy, encourage wasteful use. Resultant inefficient input-management turns to become a potent instigator of natural resources degradation and climate change. Need is to tag provision of subsidy on inputs with efficient use rather than their over-use. Organizing farmers into producer groups/companies/ farmers interest groups and enriching their knowledge and skill economy with right education and training in the area of crop diversification and precision farming by adopting efficient agro-chemical, water and energy management practices and low volume high value agriculture are the key elements of a proposed strategy on minimizing wasteful use of subsidized inputs.

Topping the above listed technological and non-technological elements that have to do with the lasting impact of AE, it is recommended to: (i) give suitable incentives for the genuine practitioners of efficient and competitive diversified methods of farming and (ii) infuse policy support favouring adoption of low volume high value agricultural practices. On an overall basis, need will be to reinvent a technology transfer system that not only makes agriculture efficient and competitive, but also makes its growth socially, economically and environmentally secure and sustainable.

3 FRAMEWORK FOR A NEW-LOOK AGRICULTURAL EXTENSION SYSTEM

During the first 25-30 years of Green Revolution (GR), the T&V system of extension emphasising input-use-driven productivity growth in alliance with crop area shifts paid dividends. Following that, area transfer for expanding cultivation of these crops ceased and productivity growth rates crashed. Plummeting productivity growth rates of rice–wheat crops (Fig 9) are making it harder to push further the economic advancement of farmers. Post-GR phase is marked with two serious thereto unknown problems: insecticide resistance of cotton and invasion of whet with weed *Phalaris minor.* Also, this period saw the insidious rise of degradation in health and quality of natural resources.

The much touted T&V system lacked innovations like networking and partnerships with farmers. It also ignored blending with other systems of TT like KVKs, NGOs, researchers and policy makers. Undoubtedly, there was a mechanism of participatory research review system through "On farm trials", but their impact was not short-lived due to absence of farmers and researchers participation monitoring and evaluation system. Also, there were no quantifiable indicators measuring outcome and impact, particularly of training. Above all, identification of needs and opportunities hardly matched with the rise of adverse ecological consequences that resulted from exclusive focus on increasing productivity to build food grain production. Overwhelmed by these inadequacies, come mid-1990s, T&V system faded and disappeared. The detailed report on the rise and fall of T&V system in Haryana was presented in the AHRD project (www.icar.org.in/.../09-AGRICULTURAL%20HUMAN%20RESOURCE%20DEVELO...). Despite renaissance in the form of ATMA model that espouses percolation of extension administration down to farmers' participation, AE has not been able to fully revive the already lost effectivity of the technology transfer machinery. The major issue continues to be the old and outdated T&V mind-set on productivity-push without fully reforming and aligning content and context of farm advisories to emerging realities and new developments. As usual, AE machinery persists with 'one-size fits all' generalized advice-giving. The location and situation specificity needs remain disjointed from sustaining health of soils, maintaining quality and quantity of water resources,

dealing with frequent incidents of aberrant weather episodes, induction of crop diversification, curricula for farmers' knowledge and skill upgradation and orienting farm produce quality and kind with changing markets and consumer preferences. Then technological inputs suiting the needs, specifically of marginal farmers (average land holding 0.45 ha), lack wide-scale acceptance because of practical or economic constraints. Above all, benefits of gelling crop based recommendations with interventions on livestock, fisheries and horticulture remain grossly unharnessed. Integration with these sunshine areas is necessary, since these generate maximum potential for income with an additional surge for employability.

In order to contain the adverse impact of above described pack of problems, conventional transfer of know-how in parcels is apparently inadequate. Current activities, approach and apparatus of extension machinery requires a paradigm shift to prepare for a new-look focus of extension advisories and accordingly a revamped work portfolio. It would be a compelling reason to devise an out-of-box thinking on TT strategy that nucleates around rural community needs and aspirations while responding comprehensively to:

- Sustainable growth in productivity, profitability and employability.
- Mitigation of greenhouse gas emissions.
- Soil health building measure that inspire soil carbon sequestration and discourage nutrient mining.
- Resource conservation techniques to prevent entry of pollutants and contaminants into soils, water, air and food.
- Acceptance of diversification, low volume high value agriculture, processing for value addition and demand-linked marketing.
- Extension of productive efficiency, competitive agriculture and safe produce / quality output by integrating native and man-made resources employing a judicious mix of indigenous and modern practices.
- Minimization of losses associated with post-harvest handling, transport and storage.

All said and done, without effective policy support for upskilling and upscaling entire stratagem on refurbishment of existing extension system will go in vain.

Hence, addressing multifaceted problems influencing present & Future agricultural growth, this group trusts and believes that neither single agency extension model, nor a universal technology delivery system adopting a monolithic

approach would be adequate to infuse willing and lasting adoption of requisite interventions. It is so, since targeting sustainable productivity growth, secure income, employability and above all maintenance of socially supportable quality of natural resources is so intricate that it is not just possible to successfully handle it either by a slow, outdated and orthodox public extension machinery or by an active, outcome and profit oriented private technology delivery agencies.

It, thus, appears that a renewed farmers' participated technology transfer machinery constructs around public-private partnerships and networks to reinforce each other's strength transforming individual weaknesses into joint opportunities. Need will also be absolute to fix goals and quantifiable indicators of success that align with Government's social commitments.

Involvement of farmers will be central to these corporate arrangements. It will be Crucial to engage with farmers right in the beginning, since a responsible TT system must respond to socio-economic capabilities and needs of farmers on the one hand and sustain quality of biophysical conditions of their farms on the other. This 'multi-organization' or 'pluralistic extension' has to serve the cause of multifunctional agriculture. It, therefore, implies that futuristic extension has to balance growth of food and fibre output goals in consonance with the containment of non-commodity adverse outputs like poor soil health, greenhouse gas emissions, pollutants, contaminants and biodiversity depletion. Simultaneously, the new system must be up-scalable and out-scalable. In that pursuit, role of ICT would be vital in preparing appropriately skilled human resource. However, training must help developing skills and capacity of both service providers and beneficiary farmers. This approach is seen to inspire good agricultural practices and building up a class of professionals in specific and specialized areas of low volume, labour and input dense and profit maximizing farming plants. This purpose is likely to be served best if the Strategic Agricultural Management and Training Institute (part of ATMA model of AE) is remodelled on the lines of Industrial Training Institutes, where experiential learning is the iconic path of the pedagogy.

Typically, an ex-ante study on social sensitivity and social vulnerability to alternative tech initiatives would provide a sound foundation to capture farmers' needs, aspirations, constraints and opportunities. This farmer-involved kind of SWOT examination will help planning, organizing, financing, monitoring and evaluation cycle of events making an all-inclusive, vibrant, contributing and relevant extension model. A pluralistic innovative extension design is expected to be maintainable and sustainable because all stakeholders are its envisaged trustees. Finally, this Committee holds a firm conviction that TT influences all involved in the

art, science, service and profession of agriculture; hence agricultural extension/education should be business of all – research, development and socio-economic institutions. Without refurbished mandate and work portfolio**,** existing Haryana Agricultural Management and Extension Training Institute **(HAMETI)** may not be adequate.

New Look Extension Model - Recommendations:

Before making a proposal on a New Look Extension Model, the issues and concerns confronting agriculture are reiterated once again. These are:

1. Falling growth in productivity, profitability and income; growing un-employability of agriculture dependent population.
2. Misplaced overdrive on modern technologies and chemical inputs relegating indigenous way of management and use of native sources; thus advocating intensification having little regard for sustainability perspective.
3. Emergence of potassium deficiency and micro-nutrient hidden hunger due to overwhelmed emphasis on heavily subsidized urea.
4. Intense cultivation negating any possible build-up of natively low soil carbon stocks; resulting in non-sustenance of soil health.
5. Less than 50% use efficiency of fertilizers, water and energy inspiring rise in greenhouse gas emissions, climate change and abnormal aberrations in normal weather patterns.
6. Depleting bio-diversity promoted by cereal-cereal farming; rising incidence of biotic and abiotic stresses.
7. Over development of underground water; falling water table, rising energy expenses and environmental pollution.
8. Excess use and misuse of canal water aggravating growth of water logging, salinity and nutrient leaching.
9. Low spread of: precision agricultural practices, protected agriculture and processing; minimization of post-harvest losses and strengthened market links.
10. Fragmented extension apparatus, poorly staffed, heavily individualistic, centralized, top down, supply driven, divided across sectors and subjects, addressesing components of an agri-business and above all feebly appreciates value of farmers' participation while prioritizing research, extension and development agenda.

Model design of future extension services will have, thus, to focus its advisories that respond to above listed 10 stress points of Haryana agriculture. Processes and organization of the proposed extension system draws lessons from the past/existing experiences or recommendations. Keynote outcome of this analysis is summarized below:

Past/existing experiences	Future action
Extension machinery sets its objectives, draws its work plan, implements it and self-assesses the performance, all in isolation of primary stakeholders – the farmers. This goes on despite the fact what 1st Five Year Plan document observed "No Plan can have any chance of success unless the millions of small and marginal farmers in the country accept its objectives, share in its making, regard it as their own and are prepared to make sacrifices necessary for implementing it".	The commentary made in the 1st Five Year Plan document remains relevant to date. People-centric and -participatory extension methodology is a must to garner willing acceptance of new technologies for upscaling application and maximizing impact. Also, enhancing crop productivity, undoubtedly, is as important activity of AE as was ever before, but it requires to sustain profitability, employability and natural resources' quality.
Scientists continue to conduct research without linking to the limitations of the bio-physical resources of a region and/or understanding the needs and aspirations of farmers living there. Also, rarely do they discuss with the extension workers or the NGOs active in the region on problems faced by the farmers and solutions thereof. No wonder; farmers at the most accept only one of the three scientists recommended technologies. The major factor contributing to this debacle is the poor research-extension-farmer interface.	Hereafter, scientists must realize the bonded responsibility they owe to the cultivators in terms of improving their life and living. In that pursuit, they need to move from their laboratories, green-houses and research farms to farmers' fields to validate relevance and practicality of their findings. Before recommending a technology, they need to authenticate its applicability by simple field pilots involving farmers (adaptive research). Also, genuine action is necessary for solidifying research-extension linkage so that productivity is enhanced and antecedent problems are solved.

Past/existing experiences	Future action
Extension functionaries belonging to the Departments of Agriculture (DOA), Animal Husbandry and Fishery (DOAH&F), Horticulture (DOH)... individually issue advisories in the area of their subject domain. At times, a particular department instead of reinforcing what any other department recommends. Individual support for enabling the adoption of some elements of an advisory multiplies the burden of public funding (in the form of subsidy) and poor use of human resource.	For farmers, agriculture is an integrated enterprise; they need a holistic package of recommendations for crops, livestock and horticulture. For synergy, it becomes incumbent to transfer a combined set of advisories/support via Inter-departmental convergence. Currently, for drawing annual extension work-plans, HAU organizes separate workshops for officers belonging to DOA, DOAH&F, DOH (and Home Science). Hereafter, instead of multiplicity of meetings, it is recommended to organize one combined meeting devising a joint work-plan and common public support enabling its adoption.
By and large, focus of package of practices is on increasing yield. Aftereffects of doing that on soil health, water quality/quantity and climate change are given a goby. Also, training curricula includes lessons on inputs use but not on their efficient use. New management practices on saving inputs without scarifying productivity, even if transferred, are seldom adopted. Major cause of this apathy is that farmers are either ignorant about the benefits or the proposed methods are impractical for them. Another weakness of the existing technology transfer is the 'individual extension', which does not ensure 'last-mile delivery'. This happens because	Undoubtedly, increasing yield remains the top-most priority, but it must not be at the cost of soil, water and environmental health. Input use needs to be holistic, in that its application espouses efficient use targeting a production system, which is known to sustain growth in total economic yield without generating negative outputs. Time is ripe to move educating farmers in groups on alternative practices that enhance efficiency of fertilizers, water, energy etc. In order to garner willing and lasting acceptance, it will be necessary that the new technology and management practices are aligned with all the elements of a production system (or farming system) including farmers' needs and concerns. In this pursuit, farmers have to be sensitised for organizing themselves as a 'producer company', or 'common

Past/existing experiences	Future action
farmers are many and extension agents supporting them are fewer in number.	interest group'. Then their requirements are captured by understanding the approach they adopt in working out a solution suiting their farms and farming practices. Conducting a farmer feedback study will be desirable. Following that it will be necessary to suggest a technology recipe that has group endorsement. Further, not only will it be important to create enabling milieu on adoption of a technology to raise production, but it will also be necessary to produce what is market - demanded.
It is a well-known fact that farmers depend more on other farmers' experience than extension workers when it comes to adopting a new practice (Table 1). Also, for day-to-day advice, they mostly rely on information given by the nearby input dealers. These informal channels, are undoubtedly effective in spreading value of new practices. But at times such exchange suffers from imperfections, typically from the point of holistic management of natural resources and management of inputs that regulate sustainable growth.	Since, technology transfer happens fast and wide via farmer to farmer contacts and input dealers, it becomes necessary to strengthen these individuals and institutions in popularizing new farm practices. Infusing concept of sustainable growth, building knowledge and skill economy of these groups in holistic management of a production system and appropriately devised training program is will seen reinforce success.
A single extension agency (largely public) continues to meet the technology transfer needs of today's agriculture, which are wide ranging and multi-faceted. Apparently, public extension alone is found wanting in delivering advice covering all activities happening from field to fork and beyond i/e., an agri-business value chain.	Irrefutably, a pluralistic system of extension is necessary in meeting the holistic technological needs of today's agri-business value chain model of farming. Multiagency extension is need of the hour, and to make it happen, forging public-private and public-farmer-private partnerships will have to be institutionalized.

Past/existing experiences	Future action
Agriculture is a risky business. But exposure to risk and vulnerability across farmers and farms at time is not uniformly distributed. Hence, site-specific, real time solutions become necessary when virulence of a peril demand immediate treatment. Also, if client farmers are women, they are under social pressure when receiving direct advice from unknown AE men. Being confined to the four walls of their homes, traditional extension methodology is seen to be less effective for women.	Informatics – the art and science of information processing - enabled by information and communication technology (ICT) overcomes the problem of delivery from the point of space, time and volume. Television, mobile phones, computers, digital networks represent tools of ICT. Transfer of community-shared knowledge and skills is facilitated by organizing ICT as: tele-centres, web-portals, call-centres, e-mail, mobile phones, WhatsApp groups, audio-video conferencing... In addition, radio, television and print media continue to be employed for transmitting and sharing information. If the content is situational, simple and easy to practise, interactive ICT offers immense socio-economic potential in strengthening power of advisories in real-time and space. This methodology is also gender-friendly.
Against widely prevalent free advisory, paid extension, like in the USA, is not popular with the Indian farmers. Limited success of agri-business and agri-clinics scheme explains that. It is a known fact that anything given for free is not valued that much as is the paid one.	It is proposed that farmers may continue receiving free extension services relating to yield enhancement via efficient crop/soil/ water management practices. TT on a full value chain development or on preparing a business plan blue-print for converting high-volume agriculture into low-volume high-value commercial enterprise (protected agriculture, processing for value addition) is a new whole ball-game. Since end to end solutions for specialized agriculture require expert services, farmers are expected to pay willingly for such consultation. Also, if farmer sees losing a valuable asset, like animals/poultry, he will unhesitatingly pay for the advice.

Past/existing experiences	Future action
Extension is managed by functionaries, who are either promotees or enter service through direct selection. There is no firm policy on competence and capacity building in specific subject areas dealing with emerging constraints and demands of agriculture. In the recent times, extension workers have been spending relatively more time on distribution of subsidized inputs and less time on their right and efficient use. Director of Agriculture, who is drawn from the IAS cadres, is the over-all in-charge of AE. Being term-post, time taken on getting familiarized with the complex issues and concerns of farming affect sustainable impact creating contribution.	Extension must be managed by highly competent personnel observed Dr Russell in as early as 1937 (Menon, 1987). In pursuance of that there is need for compulsorily imparting special capacity building programs before induction into service followed by continuing refresher courses on regular basis. In addition, time to time services of acknowledged experts in the field may be hired to mentor the staff under real field situations. Government may consider appointment of an agricultural professional for filling post of Director of Agriculture.

Based on the above analysis, **deliverables of a new-look AE system** need to comply with the following:

- While formulating goals and objectives of technology development and execution plans, research and extension must work hand in hand accepting farmers' needs and perception as the nucleus; farmers' participation need to be right at the entry point of conceptualization, planning and validation of developed and transferred information and advice
- Research and extension must disentangle from routine promotion and transfer of compartmentalized knowledge and know-how; package of practices need emphasis on solutions welding all components of a farming system. In this pursuit soliciting input of Development Departments will further fortify the sustainable spread and shelf-life of an introduced technology.
- Extension approach of 'one size fits all' need to be dumped and instead advisories have to nucleate around farmers (holding size and main source of livelihood), farms (bio-physical characteristics of land, irrigation, livestock...) and farming practices (current technology use and need for introduction of a replacement technology suiting emerging needs and scenario).

- Delivery of information and advice, besides being real-time and specific has to be bolstered by a ready to use decision support system. Also, its reach must unwind the bounds of time and space. On this ground, use of ICT for information processing and delivery becomes imperative. Nevertheless, personal contact and consultation with the farmers will always hold a crucial place, setting research/extension priorities. It requires to be pursued by reading the pulse of the farmers on solutions and counselling they perceive and look for. What is being proposed is a fair mix of traditional and technology mediated dissemination of farmer-relevant and scientists-developed innovative solutions.

  IT-enabled AE offers vast possibilities of integrating audio-video messaging in its totality. Setting up of digital library in this regard is seen to facilitate easy access to e-information. Typically, initiative of this kind has potential for integrating a number of advisories ranging from weather forecasting to scientific methods of land and water management. Reach to an audio-video digital library is also seen to assist farmers in decision-making on solving day-to-day crisis faced by their crops and livestock. Above all, ICT is projected to help farmers in managing and marketing their produce by establishing **links with eNAM (electronic National Agricultural Market)**

- Problems faced by today's agriculture are multifarious requiring multi-dimensional answers. On the one hand, solutions ought to be client-centred and on the other, these must emphasize efficient use of resources, competitiveness of farming and market-demand relevance. Apparently, building versatility in advisories responding to complicated issues faced by diverse farm groups and farming situations comes to the fore. Irrefutably, providing varied solutions to difficult problems is beyond the capability of a single agency ploughing a lone furrow. And the information and advice, particularly in the nature of expert consultation, cannot always be for free. What is thus required, is a multi-layered extension system. Firstly, its activities will range from cultivation to consumption and beyond. Secondly, its organization will involve farmer-focused public and private agencies working in partnership, which is founded on goal commonality, clear understanding on responsibility/credit sharing, conflict resolution and funding arrangements. Naturally, from the public extension's view point the partnership will have to be backstopped by a clear policy instrument. And finally, a fair delineation of advisories that are delivered for free and professional consultations that are chargeable will be necessary.

- AE needs to be treated more like a mission and less like a routine public program. Past accomplishments on making Haryana a front running state in food grain production is a witness to that treatment. It was the result of a self-competing committed manpower, who utilized technology transfer as a vehicle of change by inspiring willing acceptance of the new practices among keen and hard-working Haryanvi farmers. Today, when productivity growth has to be balanced by containing onslaught of natural resources decay and climate change, role of science and technology has become more fundamental than ever before. The competence of extension manpower requires continuing up-skilling in the area of this new reality. This up-skilling will make them more proficient and confident in the area of their work while sharpening professional skills of farmers. However, appropriate changes in the State' human development policy for the extension staff by making training a compulsory element of career pathway becomes necessary. Also, for infusing practice of scientific agriculture among farmers, launch of experiential learning courses becomes of paramount significance.

Deliverables of a New-look AE System - Essentials

- Farmers participation right at the entry point of conceptualization/ planning/validation
- Multi-dimensional: Package of practices combining all elements of a farming enterprise
- Specific and real time advisory suiting location and situation
- Advice need to be real-time; backstopped by an appropriate decision support system; ICT use for linking farmers with e-NAM
- Technology transfer requires to be a combine of public and private agencies; will have to be paid if in the form of consultancy for development
- AE a mission to infuse a holistic change not just a program to increase productivity

Proposed AE System

Fundamentals and Processes:

a. The proposed AE system ensures participation of farmers right at the entry point of conceptualization, planning, development, deployment and validation of transferred information and advice by joint involvement and contribution of research and extension. It does not allow routine transfer of compartmentalized knowledge and know-how on different aspects of agriculture. Instead, it emphasizes professional advice and solutions on all

components of a farming system. In other words, the need is for **a farmers' demand driven, broad-based and a single window extension system.**

b. The proposed system will focuses more on community based organizations like 'farmer producer groups', 'farmer producer companies' or 'farmer interest groups' (farmer includes both men and women farmers) when it comes to training and skill development activities and technology transfer, refinement, testing, monitoring for mid-course corrections and evaluation of the final outcome before dissemination as a package of practice. **Focus of technology transfer will have to tilt more towards 'community based groups/organizations method of delivery'**.

c. AE system will cover wide range and perspective of tech recommendations by: stressing growth in productivity, income and employability through specific entrepreneurship development avenues; containing development of adversaries like natural resources degradation and climate change and linking farmers to government schemes/institutions for maintaining resilience of agriculture as a profession. **'Extension need to organize itself as a multifunctional activity with its emphasis widening beyond efficient production-technology to income and employment generating value adding pro-nature enterprise,** arrangements for competitively priced quality inputs, right education and training, safe produce management and links to markets and financial institutions (credit and agricultural insurance)**'.**

d. Organization-wise, with farmers based institutions as the nucleus, **multifunctional extension follows a consortia approach** for covering improvement of farms, farmers and farming in all their aspects. On the one hand, it **ensures convergence of programs run by diverse government departments and on the other it inspires participation of public-private establishments**.

e. The proposed system disseminates new knowledge even to the most unreached point and delivers real time advisory facilitating immediate action for reducing damage from a sudden natural risk. In either case, induction of ICT or mass-media channels (cosmopolite channels) come to the fore. In contrast, social (localite) channels are preferred when it comes to influencing adoption of an alternative technology. Hence, **creating awareness and knowledge on a new innovation and initiating decision process on its acceptance, rejection and continued adoption, respective use of mutually-complimenting cosmopolitan (ICT) and localite (social) channels is necessary**.

f. **It places great value on continuing human resources development**. In pursuing its goals, the proposed AE, formulates specific and specialized training capsules for extension personnel. Inter alia, the curricula, besides sharpening knowledge in diverse technical subjects, focuses to **upskilling in areas like organizational skills, situation management, analytical capabilities, effective communication, listening and learning, inspiring motivation, team building and working with colleagues and farmers**. In the final run, **the investment on HRD is investment for the future**. It is seen as creating human resource enriched with missionary zeal to impact growth of public goals and commitments on sustainable farms, livelihood- and income-secure farmers and flourishing agriculture as an industry. Simultaneously, thus accomplished extension functionaries endeavor to accommodate farmers' views, sensitivity and relevance on an introduced technological invention. This feedback they communicate to the inventor scientists for refining and, if necessary, reinventing technological recipes before dissemination. Farmers' perceptions and situation-appropriate skill and practical needs form the core of training course curricula. The trainers should be the persons from the development departments, has also architects of technology.

g. **The proposed AE, gets necessary policy backing and administrative support for effecting changes leading to a truly decentralized extension system**, **which is demand driven, single window and managed professionally**. Simultaneously, it is funded adequately for wiping out input and knowledge deficit on the one hand and creating uncertainty-proofing and income-enhancing infrastructure (human resource, protected agriculture, efficient tools and tackles, roads and communication, quality and safety, market links, agricultural insurance....) on the other. **The growth in agriculture in Haryana is also contingent to private sector involvement because the resolution of second generation problems requires pluralistic AE system.**

h. **Besides productivity enhancement, AE also focuses on building nutritional security and food quality.**

Fundamentals of Proposed AE System

- Technology identification and development involves farmers' participation and addresses needs of a total farming system

- Knowledge and skill delivery: (i) focuses more on community based organizations, (ii) helps linking production activities to emerging markets and (iii) makes the group part of developing value-adding chains
- Transmits real-time advice even to the most vulnerable and un-reached farmers' groups
- Adopts a multifunctional portfolio with emphasis on productivity increase, income enhancement, employment generation and nutritional security with quality and without impacting health of natural resources
- Ensures convergence of programs run by diverse government departments for infusing diversification and making AE a single-window activity
- Inspires partnerships of public institutions with progressive farmers, small input dealers and large private agri-business houses
- Places great value on regularly updating knowledge and skills of extension staff
- Strengthens lifelong learning of farmers, both by formal and informal means of education
- Provides space for periodic impact assessment of a new method/practice by farmers' representatives together with technology transfer partners

3.1 ATMA Model of Extension,

ATMA model of extension, introduced first in 1998 and modified from time to time since then, fulfils several of the above requirements. Yet infusion of some additional fine tuning in governance, organizational structure, finance management and process parameters is seen to be helpful. **Necessary recommendations on each of these areas of ATMA Model are enlisted below**.

ATMA Governance

I. **Inter-Departmental Working Group** (IDWG) is the highest body mandated to ensure effective coordination of extension activities undertaken by different departments like, Agriculture, Animal Husbandry and Fisheries, Horticulture… (Figure 2). In order to make working of the group more effective, **it is proposed that the senior-most Secretary of the line-department chairs the IDWG meetings instead of the existing arrangement of Principal Secretary Agriculture being the Chairman**.

II. At the **State level**, Director of Agriculture is the Nodal Officer. He is drawn from the IAS cadre in Haryana. As in several other states, for maintaining functional continuity/contribution and making technology transfer more

and more science-driven, **it is recommended that an outstanding scientist replaces the IAS cadre person as Director of Agriculture**. Also, currently the State Coordinator position is filled with persons appointed on deputation. In order to maintain stability and sustainability of output, it is **proposed to make this appointment on a regular basis.**

III. **At the** District level, District Magistrate/Collector acts as the Chairman of the ATMA Governing Board (GB). Since DM is loaded with wide-ranging duties, as such he may hardly find quality time for analysing complex issues concerning art and science of agriculture. In order to maintain efficacy of functioning, right-tracking the program based on monitoring and evaluation reports and add professionalism to the agency work, **it is recommended that the position of the Chairman of the ATMA GB should be entrusted to the Divisional Commissioner.**

IV. At the **Block level**, two bodies Block Technology Team (BTT) - a team comprising officers of agriculture and all line departments within the block, and a Farmers Advisory Committee (FAC) - constituted exclusively of farmers, provide feedback and input on preparation of action plans and prioritization of technologies and extension activities. In order to facilitate feedback study and analysis of its findings for inclusion in the action plan, it is recommended that a **Scientist Mentor** from the KVK be nominated for the job. His involvement is seen to provide platform for marrying farmers-needed practices with the new innovations in agriculture.

V. At the **Village level**, Block FAC is mandated to facilitate organizing cultivators into Farmers Producer Companies (FPC), Framers Interest Groups (FIG) or Farmers Field Schools (FFS). In pursuance, farmers are guided to self-create an organization structure on the lines of a company that produces and markets its own goods. It is suggested that those of the farmers pursuing a common farm enterprise or a production system preferably constitute a FPC/ FIG/ FFS. A KVK subject matter specialist (scientist), as outlined above, is assigned to the FAC to facilitate group building. He will also assist in its professional functioning.

To be coordinated by the group elected leader and backstopped technically by the KVK scientist, the FFS need to articulate and identify biotic, abiotic and socio-economic constraints obstructing sustainable growth in productivity and profitability of their enterprise. Based on this analysis, the FFS members identify necessary physical (inputs, machinery, knowledge and skills, field demonstrations, credit, farm insurance etc.), academic

(training, exposure visits etc.) and infrastructural (irrigation, storage, safe transport, value addition, market links etc.) needs. The constrains thus identified and mitigating solutions so worked out by FFS members across villages of a Block should be synthesized into a report. The KVK scientist, deputed as block facilitator, should help in consolidation of reports of different FFSs. This document should form the basis for preparation of Block Action Plans and prioritization of the extension activities by the FAC. It is recommended that farm scientists belonging to the nearby SAU/ICAR institute are recommended to may utilize the production-constraints recognized by a FFS while designing new research or refining their ongoing research activities.

The State-level Extension Training Institute should be strengthened adequately for infusing life- long learning among the farming community. In pursuance of this, it is recommended that existing Haryana Agriculture Management and Extension Training Institute (HAMETI) be headed by an HRD specialist.

ATMA Model of Extension – Suggestions on Governance

I. Senior-most secretary of the participating departments chairs the IDWG meetings.

II. State-level Nodal Officer preferably be an outstanding scientist.

III. District level Chairman of the ATMA GB should be the Divisional Commissioner.

IV. Involve a senior scientist from the nearby KVK to mentor and backstop activities of BTT. At the village level, he also serves the technological needs of the FPC/FIG.

V. The Haryana Agriculture Management and Extension Training Institute (HAMETI)

Institutional Arrangements - ATMA

Agriculture is a multi-layered activity – it ranges from crop diversification to horticulture; from livestock rearing to fishery and from produce management to safe storage and value addition. In either case, the goal is to transform agriculture leading it to become a small-scale industry. It, however, need to be recognized that diverse farm activities have unique technological demands. Despite varying needs for scientific input, farmers want unified assistance and professional advice, since for them agriculture is a single enterprise. Contrary to this call, services supporting modern farming, horticulture, livestock and fishery in Haryana are being offered by Three different departments; each promoting its own subject area. With the result,

a farmer has to shuttle from place to place, if he is in need of help for solving problems faced by his crops, horticulture, livestock... Because of physical distance and logistic hurdles, apparently farmers face constraints in receiving total solutions integrating crops-horticulture-livestock continuum. Dispersed delivery of advice on improved practices - constituting a technological package, is a key impediment to the desired effectiveness of the extension system.

In order to minimize the problems arising out of individual functioning of different programs, ATMA model envisages convergence of extension related agenda of government's 4 flagship initiatives on development of agriculture in all its aspects. These projects are: Rashtriya Krishi Vikas Yojna (RKVY), National Horticultural Mission (NHM), National Livestock Mission (NLM) and National Food Security Mission. Notwithstanding this commandment, working of diverse schemes remains disjointed, since funds are allocated for discreet and not for unified activities of a program. Likewise, importance of farmer-focused research and extension linkage is talked of more and realized less. Some examples from the past programs and requisite organizational arrangements are recommended for adoption.

i. Revive spirit of Community Development Program (CDP) launched in 1952. Holistic-nature of CDP is as relevant today, as it was during the early years of India's independence. It sought rural reconstruction by extending comprehensive advisories on improvement in farm employment and economy. In pursuance of that goal, CDP mandated crop diversification by harmonizing it with dairying, horticulture and growth of village-based agro-processing industry.

ii. For strengthening farmers' relevant research, SAUs and ICAR Institutes organize meetings with joint participation of extension officers belonging to agriculture, animal husbandry/ fishery, horticulture and even home science departments. Determining suitability of new practices and launch of new research activities need to be, respectively based on assessment and feedback of field functionaries and grass roots level organizations like Kisan Clubs/FIGs.

iii. A system involving a representative of the farmers' group (Kisan clubs), extension functionary and SAU (KVK) may be put in place for effective coordination, monitoring and concurrent evaluation of the outcome of the technology transfer programs. The proposed set-up will suggest corrective measure to re-bundle the package of practices, if deemed necessary.

iv. Development and institutionalization of appropriate guidelines and procedures be developed and introduced to provide space for participation of private and paid extension programs.

v. For enhancing responsible use of funds being transferred directly to farmers for the conduct of field demonstrations, infusing a system of monitoring is necessary. involvement of extension functionaries as observers is seen to help in strengthening the use of funds for the right conduct of field demonstrations. However, for the purpose of progressive program monitoring and evaluation, it is recommended to be performed jointly by representative of the farmers, an extension department functionary and a KVK subject matter specialist.

ATMA Model of Extension – Suggestions on Functioning and Organization

- Revive spirit of Community Development Program by creating awareness on public-funded initiatives and in tandem with formulation and extention advisories on blending crop diversification, dairying, horticulture, input support and mechanization for building primary village-based agro-processing industry
- Evolve farmers' relevant research and development goals based on feedback of FPCs/FIGs and field functionaries; in fulfilment, scientific programs and extension activities of officers of agriculture, animal husbandry, fishery and horticulture departments need to be mutually complimenting
- Set up a coordinated monitoring and evaluation mechanism for timely review of the outcome of the transferred technology
- Develop guidelines on involving private sector in AE
- For proper use of funds transferred directly to farmers for field demonstrations, progressive monitoring is required to be conducted jointly by beneficiaries and AE officers/KVK scientists

3.2 Process of Setting Extension Agenda – Need Assessment

Extension should not be looked as a single intervention – a monolithic activity in it-self. Instead, it ought to be treated as a process constituting a series of interventions moving agriculture towards sustainable growth in all its aspects. For instance, agriculture extension, as narrated earlier in this Report, has to involve itself in:

- Transferring information/knowledge/skills on new farming methods/ practices pertaining to a farming/production system with the aim of enhancing productivity, income, employability and nutritional quotient by simultaneously containing rise in adversaries like natural resources' degradation, water depletion, biodiversity loss, greenhouse gas emissions.

- Nurturing technology adoption enabling environment (inculcating knowledge and skills on precision agriculture by assuring availability of requisite inputs and resources to practise that).
- Educating farmers on loss free harvests, zero-loss storage/transport and value addition.
- Facilitating closer links with markets and trade.
- Bridging distance between farmers and R&D institutions – both public and private.

Hence, before setting the extension agenda, it is essential to collate data on various elements of a technology package influencing performance of a production system – the unit described for setting group based technology transfer agenda (details in an earlier section). Response of a production system to a technological intervention is known to vary with the land attributes, climatic variables (typically those contributing to incidence of drought and flood) and capability and capacity of farmers to adopt it. This is what is known as location and situation specificity of applicability and response to a technology. So that acceptance residence-time and income gains from technologies are up-scalable, it is essential to assemble requisite data that clearly outline near uniform sites having comparable agriculturally important land uses (say a common production system), analogous climatic patterns, socio-economic and infrastructural services (markets, input support, extension backing, crop insurance, roads and communication). In order to map homogenous sites, necessary information (soil, water, rainfall, incidence of drought floods, vegetation) is gathered from existing public sources and records. It is supplemented by primary information given by the farmers belonging to a FFS or those practising a common production system. A typical focus of farmers' feedback is placed on their perception of the constraints, synopsis of suggested solutions and techniques and need for the kind of assistance. A structured questionnaire on household survey (Social Sensitivity Analysis in tandem with Social Uncertainty Analysis) is of general help to construct primary information. The chief object of the entire data gathering exercise is to prepare area based (block, district, state) constraint/stress profile to script and apply extension work plans on reduction, mitigation and adaptation interventions. The response could be in the nature of technology, capacity building, advisory, pecuniary (subsidized crop/livestock insurance), community based mutual arrangements and infrastructural backstopping. The production-system compliant information on capabilities and constraints thus collated is utilized to quantitatively model vulnerability to physical

risks and socio-economic limitations of a production system. A minimum data set is necessary for modelling technology design corresponding to a location- and situation-compatible interventions. With district/taluk as the unit, the data needs will be as follows:

- **Basic Information on Agriculture**: key production systems both crop and livestock based; crops, yields, technologies and their adoption level, yield gap analysis, input support system, machinery use; livestock status; agricultural training institutes, KVKs, development programs etc. Assessment of extension gap (difference between productivity in field demonstrations and farmers' fields) will help in highlighting the weaknesses in the adoption of a technology package on the one hand and in the on-going TT methodology on the other.
- **Bio-physical Resources**: annual and seasonal precipitation, distribution pattern, inter- and intra-season variations; daily maximum and minimum temperatures, variability analysis (a data-set of last 30 years is necessary to capture climatic nuances); land use pattern; health of soils, water resources including irrigation by source, land forms (topography), vegetation and livestock resource.
- **Demographic Information**: population (male and female) engaged in agriculture, literacy level, farm and off-farm sources of livelihoods, economic situation of farmers following the identified production system and other enterprises.
- **Public Services**: extension personnel both sanctioned and in-position and duties assigned and performed by them, agro-met advisories, presence of credit landing institutions, communication and market links and after harvest storage/processing industry.
- **R & D Institutions**: research outfits and main programs; development departments, public welfare programs for farms, farmers and farming: agencies (public and private) committed to rural development in general and agriculture in particular and services they offer.
- **Funding**: budgetary provisions (Centre and State) for agricultural R&D vis a vis GDP

Above information is synthesized to arrive at the health of overall agriculture of a district/taluk falling within the bounds of an agro-ecozone. The outcome is utilized to conduct SWOT analysis for formulating district level research and extension plans. In order to strengthen planning at the micro-level (village/production

system/Kisan Clubs), farmer perceived feedback on the state of agriculture and related activities is assessed as described above and briefly reiterated as follows:

- **Farmers:** Catalogue of farmers identified economic activities and state of individual and community economy, list of technologies and practices (indigenous, modern and progressive farmers invented), perceptions on constraints and aspirations and approach on solutions (house hold baseline survey through a structured questionnaire).

Participation of the rural community right at the early planning stage offers a unique opportunity to scientists and development agents to explain the value of location- and situation-specific technologies. More specifically, researcher-farmer interaction is expected to right-track scientific investigations enhancing adoption levels and residence-time of a technology. By placing farmers' interest in the centre, participation of private service providers in public programs catalyses the economic benefits by turning a technology into an innovation. Farmers' participation also fosters community action on a village basis. Above all, it empowers them to execute different aspects of the work plan by being member of a FFS/producer group. Each group takes responsibility for ensuring effective implementation of the agreed upon aspects of the program (say introduction of soil and water conservation agriculture practices) and its timely conduct, monitoring, evaluation and dissemination of success stories for extrapolation.

The step-wise procedure on setting up of farmers-driven technology and transfer agenda is outlined below:

a. The first and foremost step is to **engage with the village community**. The entry point on initiating farmers need assessment study could be through the Panchayat or Kisan Clubs. Block FAC will oversee this study to be conducted by a Social Scientist/Statistician drawn from the SAU or ICAR Institute.

b. The second step is to make a **household survey** (Social Sensitivity Analysis jointly with Social Uncertainty Analysis) to collate base-line information on economic health and employability, general agriculture with description of supporting sectors, dominant production system, observed natural resources quality and climate shifts, productivity levels and time series dynamics, production constraints, native solutions vis a vis technical know-how & knowledge and their viewpoint on its utility, extension services and quality, input arrangements, credit institutions and market links. This information is gathered through a structured questionnaire designed by a

Social Scientist/Statistician. The process on filling the questionnaire can be outsourced to some local facilitators/farmer-friend/NGO.

c. In the third step, **the farmer perceived and provided information is used to realign native farming practices with modern knowhow for defining, refining, evolving and finalizing new technologies.** The common points of baseline information, typically on constraints, are useful in monitoring and measuring the outcome and also to decide on capacity building needs and strengthening input supply. The capacity building needs will comprise of up-skilling through training and visits to sites of action. Haryana Agriculture Management and Training Institute (HAMETI) will be roped in for conducting farmers' capacity building programs. The input support will be consolidated by way of initial hand holding. This will be in the form of some freebies like seed mini-kits, planting material, a critical implement, improved livestock and shared financial support for building produce and water harvesting structure. In order to minimize farmers' distress on production losses caused by a severe drought/flood, access to subsidized crop and livestock insurance will be facilitated. In this exercise, as suggested above, it will be necessary to involve researchers and technology transfer agents along with FFS leader.

d. The fourth step will be **micro-planning and organization of resources and partners**. While the farmers' view point will be central to preparing a roadmap of activities, it will be the Block FAC and Block TT backstopped by the Social Scientist/Statistician who will be responsible for developing a doable Work Plan. At this stage, involvement of a KVK scientist and representative of the private service provider active in the area is seen to enrich in prioritizing the list of pro-farmer, science-based holistic interventions and underlining the enabling resources and conditions necessary for successful outcome therefrom.

e. The fifth step will involve District FAC in designing the **technology transfer implementation plan** including setting up of time-bound targets and indicators of measuring the success, formalizing responsibilities and resource sharing arrangements. Since a work plan comprises of several sub-programs, block FAC will give responsibility for executing each to an appropriate FFS/producer group. So that members of a FFS have better coordination in undertaking unified action (like input purchase and produce marketing) and to learn from each other's experience, it is proposed to help

them organize into WhatsApp groups. As highlighted earlier, a scientist from the nearby KVK mentors team building and working.

At the district level, the technology transfer and implementation plan finalized above will have to be utilized while preparing Strategic Research and Extension Plan (SREP). It is the ATMA Management Committee that must ensure active participation of research and technology transfer professionals while finalizing SREP. Once approved by the ATMA Governing Board, the work plan will be operationalized with a bottoms-up approach i.e. the farmers being responsible for its execution. Also, SREPs of each district will be consolidated to formulate State Extension Work Plan (SEWP).

f. The sixth step involves **establishing a creditable implementing and monitoring mechanism**. While the ATMA Management Committee is in charge of finalizing the SREP, it should also be mandated for getting the progress monitored by a third-party evaluation team. Findings of this review are crucial in right-tracking output of a program or in introducing mid-course correction, if necessary. On completion of an activity, the same group will **evaluate** the program against the targets and goals set initially. The data on findings of the evaluation will be put to scientific scrutiny by involving scientists of SAUs/ICAR institutes. At the micro-level, say FFS, the progress needs to be self-monitored against self-conceived and approved targets

g. The seventh and the final step involves **collation of lessons learnt, detailing of success stories and their dissemination for extrapolation of findings to analogous sites**. In order to prepare a holistic extension and a cohesive implementation plan, yearly convergence meeting of all line departments and SAU will be helpful. Combined power of print, ICT and field demonstrations will need to be harnessed in spreading the relevance and utility of instituting agriculture as an enterprise, which is not only productivity and income enhancing, but is also efficient and competitive enough to reduce cost of inputs, contain rise of negative environmental factors and inspire painless produce marketability at economically attractive prices, while maintaining system resilience and farmers' adaptability.

Funding/Staffing:

The State needs to ensure adequate funding (State + Centre) for successful

implementation of all aspects of the approved SEWP. It is also important to allocate envisaged share of all activities and partners as detailed below:

i. Genuinely allocate 30% of the resources for women-specific programs. Typically, increase the number of women extension workers and women related extension activities and programs.

ii. Funds provided for participation of KVK and other SAU scientists for facilitating working of BTT/FCC and for forging research-extension linkages need to be reimbursed in performance of duties assigned in this regard.

iii. Small scale input dealers play significant role in creating awareness and extending advice on management of inputs, there is need to provide funds for their capacity building training program (Diploma in Agricultural Services for Input Dealers) conducted at MANAGE, Hyderabad.

iv. Vacant positions of extension staff (~30% of the total sanctioned) need to be filled up on urgent basis for sustaining contribution necessary for enhancing visibility of output. Also, providing descent office and proper logistic support for mobility is essential. It is seen to catalyse the productivity of the extension functionaries.

v. Public subsidy focus need to shift from increasing input use to improving efficient input use or in other words centring subsidy on use of a technology package in place of a single input.

vi. In order to attract willing staff-commitment in remote areas, it is recommended to launch an incentive and reward scheme in terms of special financial package like grant of remote area allowance and advance increments

ATMA Model of Extension – Funding and Staffing

- Allocate 30% of funds for women specific programs
- Reimburse genuinely funds for KVK and SAU participation
- Partially support small input dealer training at MANAGE
- Urgently fill vacant staff positions (currently 30%)
- Provide subsidy for a package of practices and not for one practice Grant remote area allowance for State-identified disadvantaged districts

3.3 Key Technologies: Needing Focused Attention

Introduction of technologies listed below are important components of the package of knowledge, know-how and skills to be transferred through the above proposed system of extension. It may, however, be kept in mind that successful application of these technologies requires that with farmers as the nucleus: (i) scientists and development department work hand-in-hand and (ii) activities and programs being pursued by different departments are implemented as unified project. Above all, for attaining technology-driven goal of sustainable growth of Haryana agriculture, it will be necessary that the interventions proposed below are implemented for a targeted area for which FIGs are formed, feedback study done; farmers' needs assessed, constraints scripted, solutions in the form of knowledge, skills and inputs listed and market links established. It is further stressed that the achievement of output must be realistic, time bound and measurable by a set of quantifiable indicators.

I. Soil management: Laser land levelling; resource conservation agriculture (minimum tillage + legume intercrop + mulch); bed farming for maximum sunlight energy utilization

II. Fertiliser management: multi-nutrient/complex (soil test based/site-specific formulations) and micronutrient-fortified fertilizers placed as basal; top-dress N scheduling before irrigation but application rate adjustment as per colour chart index; integrated nutrient management

III. Water management: water productivity and energy use enhancing technologies (tension-meters guided irrigation scheduling, precision water management techniques); direct seeded rice; waste-water utilization; solar energy run energy efficient pumps

IV. Crop management: seed treatment combined with priming and timely seeding; relay cropping, intercropping, vertical farming; integrated pest management, loss-free harvest, transport and storage; diversification with competitive alternatives are pro-livestock and have market relevance; protected agriculture

V. Livestock: clean environment; breed, feed and disease management; primary processing, packaging; apiary; fishery; animal waste management. High-value fodder production raised hydroponically (e.g., wheat/maize grass) is an emerging area of improving livestock-nutrition and productivity. In all, special focus is necessary on development of appropriate competitive integrated farming systems.

VI. Horticulture: market supported fruit, vegetable and flower production in open and protected conditions; Waste management: post bio-remediated use of waste water, professional crop and livestock waste management for generation of feed, enriched compost and fuel

VII. Mechanization: integrated machines for straw chopping and spreading combined with zero-till sowing; machinery banks run by a producer's company and/or custom hiring service provider

VIII. Entrepreneurship development – HRD not only for developing knowledge and skills of farmers for income and employment generation with market links, but for inspiring youth to launch start-up companies in agriculture

Finally, delivery of right technology with related knowledge and skills to apply is only one feature of a responsible and responsive extension apparatus. For extended technical advice to be sustainably productive, creating adoption enabling environment like: (i) accessibility to requisite inputs at affordable prices and real-time advice on efficiency enhancing tools and tackles (like use of ICT); (ii) supporting risk-mitigating and moderating infrastructure (e.g., diversification and agricultural insurance) and (iii) assured minimum price and demand-driven marketing arrangements are necessary. Above all, an umbrella policy instrument committing government resolve to strengthen a pro-farmer, unified but research interfaced extension machinery with men, material and money is fundamental to application of science and technology for sustaining farm productivity and income with conservation of natural resources' quality is irrefutably necessary.

Technological and Other Elements Assuring Success of ATMA System of Extension System

- ✓ Technology which represents an integrated package of farming methods that sustain productivity growth, maintain profitability, contain land degradation and greenhouse gas emissions and builds resilience; is developed by research backstopped by extension
- ✓ Introduced technology – a mix of indigenous practices and modern methods, fulfils farmers' needs and perceptions
- ✓ A farmers' centric technology is not fixed, but needs orientation with soil and climatic conditions of a location and competence and capability of beneficiary farmers
- ✓ Advisories on use of a technology package are real-time and delivery covers all elements relating to a production system

- ✓ Accessibility to requisite inputs is at affordable prices and advice on use and farmers' queries is given from a common window
- ✓ Creation of risk moderating (irrigation, agricultural insurance…) and resilience building (farmers' training and farm diversification) interventions is necessary
- ✓ Community-based farm diversification is linked to market-demand, consumer-preferred and competitively-assured produce price
- ✓ Partnerships and networks of public-private extension apparatus aggregating all elements of a value chain e.g., knowledge dissemination, skill building, input supply, value adding processing and marketing help sustain productivity growth and profitability

All said and done, an umbrella policy instrument committing government resolve to strengthen a farmer-centred, unified but research-interfaced extension apparatus with men, machines, money and adaptive innovations is absolutely necessary for growth of science and technology based agriculture assuring and sustaining farm productivity, income and employment with conservation of natural resources' quality.

4 AGRICULTURAL EXTENSION GROUP REPORT AT A GLANCE

AE Concept and Definition

- Traditionally, AE is defined as transfer of knowledge and skills to farmers on improved techniques of crop management for increasing productivity/ profitability.
- In the present context, information and know-how extended to farmers also need to cover diverse farm enterprises, like management of horticulture / plantation crops, livestock and fishery. Loss-free handling of produce and its value adding processing are also on the agenda of modern AE. The quest for raising productivity/profitability has not to lose sight of sustaining health and quality of natural resources and containing rise in greenhouse gas emissions.
- AE is no more a monolithic activity, but a stakeholder-centric process. Its technical content, context and coverage area have to evolve with the participation of farmer interest groups in coordination with the AE field functionaries.
- The purpose of new technological interventions will be to strengthen sustainable growth of all elements of a farming system. Since farm enterprises vary across locations, so does the relevance, development and dissemination of technical knowledge and knowhow.
- On the whole, AE process must protect, develop and sustain growth of agricultural industry in all its aspects.

In this report, emphasis is on the following elements constituting the AE process:

- Induct integrated technologies serving all facets of a production system common to a well-defined agro-eco zone; for development of new technologies scientists must be guided by the needs and perceptions of farmer' producer groups and developing market demand.

- Transfer location- and situation-right information and impart skills on application of new set of technologies by utilizing formal (public AE) and non-formal (progressive farmers, input dealers) channels; further refinements are possible by participatory testing involving scientists and farmers in the form of adaptive research and farmer managed front-line demonstrations.
- Nurture technology adoption enabling environment. i.e., need-based supply of inputs and capacity building training to apply the same in a balanced and efficient way.
- Focus technology application for sustainable rise in productivity, income, and employment by supporting on- and off-farm capacity building.
- Inform and educate on cautions and precautions arising as the aftermath of using new inputs and practices on health/quality of natural resources.
- Support formation of farmers' producer groups by forging backward and forward linkage to maintain market links (sustained by consumer preferred production), value addition and post-harvest management.
- Above all, along with crop-based technology transfer, give genuine thrust to farm diversification by harmonizing crop based agriculture with horticulture, fisheries, veterinary and animal husbandry extension.

Highs and Lows of Haryana Agriculture

- Performance of Haryana agriculture has been remarkably spectacular; from a food deficit region it has turned out to be a big builder of the national food security.
- Contribution of AE in hoisting productivity and production of food grains in Haryana is undoubtedly impressive, but at the cost of declining soil health and dwindling quality and quantity of water resources.
- Steep rise in use of chemical inputs in the company of high yielding varieties and irrigation made the happening of Green Revolution possible; lack of awareness on their need-based application, right management and unbalanced use spurred soil health problems like rise of K deficiency, deepening of aquifers, greenhouse gas emissions and above all inflation in cost of cultivation at the expense of fall in farm income.
- Farm intensification - a boon for up-surge in agricultural production without introduction of conservation agricultural practices, is proving more of an adversary to sustain growth of farm productivity; CAGR of food production has fallen from ~3% in 1980s to <1.5% thereafter.

- Livestock an integral part of otherwise crop dominated agriculture receives non-commensurate investment for improvement in breed, feed and as a distinct farm industry.
- Diversification - a big opportunity for Haryana agriculture, remains largely a wasted opportunity because of no recommendations on competitive and market-driven alternatives.
- Protected agriculture, suiting specifically the economic growth and employability of small and marginal farmers continues to be poorly exploited because of fragmented efforts on spreading and supporting it as an industry.
- Organic resources – both of livestock and crop origin, in plenty, but plundered due to off-farm diversion and on-farm burning.
- Continued focus on raising rice and wheat productivity by emphasizing exclusive use of subsidized inputs made extension personal complacent on campaigning for their efficient use or educating cultivators on consequences of doing that without integrating with organic manures; result is widening hunger for micronutrients and physical health of soils.
- AE machinery is neither adequately trained nor shows genuine appreciation for value of inducting conservation agricultural practices and its role in saving input use, protecting soil health, professional management of water and mitigating greenhouse gas emissions.
- Haryana farmers are progressive and quick to adopt innovative ideas, if trained in art and science of countering adverse developments like declining soil health or converting the traditional agriculture as high value low volume industry; crucial role of private agencies and actors supporting AE with public sector extension remains poorly harnessed.

Focus of New-look AE System

From the above analysis of Haryana Agriculture, unsustainable intensification causing loss of farm efficiency due to rising degradation of soil quality and depletion of water resources is not possible to reverse by routine transfer of compartmentalized knowledge and know-how and without infusing multi-functional extension and integrating role of other organizations and private sector extension. Therefore, current activities, approach and apparatus of extension machinery requires paradigm shift to prepare for a new-look AE model, which needs to focus on:

- Sustainable growth in productivity, profitability, employability.

- ✦ Mitigation of GHG emissions and containment of land degradation and water depletion.
- ✦ Risk management, capacity building and resources conservation.
- ✦ All shades of integrated farming, diversification, low volume high value agriculture (protected agriculture) and village-based primary processing for value addition with market links.
- ✦ Sustenance of productive efficiency of inputs favouring cost-reducing competitive agriculture.
- ✦ Generation of safe produce/quality output by harmonizing native and man-made resources and a judicious mix of indigenous and modern practices.
- ✦ Minimization of post-harvest handling, transport and storage losses and introduction of preliminary and primary value adding processing, e.g., grading and packaging.
- ✦ Developing public-private partnerships and mainstreaming role of KVKS, progressive farmers, input dealers and AB&AC entrepreneurs.
- ✦ Capacity building of farmers in groups (FPC) on raising productivity and income and conserving health of natural resources in all aspects.
- ✦ Delivery of real-time advisories to FPC strengthening anticipatory decision taking on solving instant problems and making informed choices on market-relevant crop kinds and quality.
- ✦ Need based but progressive training of extension staff.

Thus to summarize, current TT machinery for solving multitude of problems is neither possible by a single agency ploughing its lone furrow nor by exclusively focusing on productivity enhancement, but the new look extension has to be multifunctional in content and multi-agency in organization.

National Mission on Agricultural Extension and Technology (NMAET) strengthened ATMA model of extension fulfils several requirements of multi-functional and multi-agency extension. In order to make its contribution vibrant and visible, the Extension Group has recommended following modifications in its governance, functioning, organization, funding and staffing:

ATMA Model of Extension – Suggestions on Governance

I. Senior-most Secretary of the participating Departments Chairs the IDWG meetings.

II. State-level Nodal Officer preferably be an outstanding scientist.

III. District level Chairman of the ATMA GB should be the Divisional Commissioner

IV. Involve a senior scientist from the nearby KVK to mentor and backstop activities of BTT. At the village level, he also serves the technological needs of the FPC/FIG.

V. The Haryana Agriculture Management and Extension Training Institute (HAMETI) be headed by an HRD specialist.

ATMA Model of Extension – Suggestions on Functioning and Organization

- ✦ Revive spirit of Community Development Program by creating awareness on public-funded initiatives and in tandem with formulation and extension of advisories on blending crop diversification, dairying, horticulture, input support and mechanization for building primary village-based agro-processing industry.
- ✦ Evolve farmers' relevant research and development goals based on feedback of FPCs/FIGs and field functionaries; in fulfilment, scientific programs and extension activities of officers of agriculture, animal husbandry, fishery and horticulture departments need to be mutually complimenting.
- ✦ Set up a coordinated monitoring and evaluation mechanism for timely review of the outcome of the transferred technology by an outside agency.
- ✦ Develop guidelines on involving private sector in AE.
- ✦ For proper use of funds transferred directly to farmers for field demonstrations, progressive monitoring is required to be conducted jointly by beneficiaries and AE officers/KVK scientists.

ATMA Model of Extension – Funding and Staffing

- ✦ Allocate 30% of funds for women specific programs.
- ✦ Reimburse genuinely funds for KVK and SAU participation.
- ✦ Partially support small input dealer training at MANAGE.
- ✦ Urgently fill vacant staff positions (currently 30%).
- ✦ Provide subsidy for a package of practices and not for one practice.
- ✦ Grant remote area allowance for State-identified disadvantaged districts .

Technological and Other Elements Assuring Success of ATMA System of Extension System

- ✦ Technology represents an integrated package of farming methods that sustain productivity growth, maintain profitability, contain land degradation and greenhouse gas emissions and builds resilience; is developed by research backstopped by extension.
- ✦ Introduced technology – a mix of indigenous practices and modern methods, fulfils farmers' needs and perceptions.
- ✦ A farmers' centric technology is not fixed, but needs orientation with soil and climatic conditions of a location and competence and capability of beneficiary farmers.
- ✦ Advisories on use of a technology package are real-time and delivery covers all elements relating to a production system.
- ✦ Accessibility to requisite inputs is at affordable prices and advice on use and farmers' queries is given from a common window.
- ✦ Creation of risk moderating (irrigation, agricultural insurance…) and resilience building (farmers' training and farm diversification) interventions is necessary.
- ✦ Community-based farm diversification is linked to market-demand, consumer-preferred and competitively-assured produce price.
- ✦ Partnerships and networks of public-private extension apparatus aggregating all elements of a value chain e.g., knowledge dissemination, skill building, input supply, value adding processing and marketing which help sustain productivity growth and profitability.

Finally, the Committee recommends that an umbrella policy instrument committing government resolve to strengthen a farmer-centred, unified but research-interfaced extension apparatus with men, machines, money and adaptive innovations is absolutely necessary for growth of science and technology based agriculture assuring and sustaining farm productivity, income and employment with conservation of natural resources' quality.

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ACRONYMS

AB & AC	:	Agri-business and agri-clinic Scheme
ACZ	:	Agro-climatic Zone
AE	:	Agricultural Extension
AI	:	Aridity Index
ATICs	:	Agricultural Technology Information Cells
ATMA	:	Agriculture Technology Management Agency
BTT	:	Block Technology Team
CA	:	Conservation Agriculture
CAGR	:	Compound Annual Growth Rate
CDP	:	Community Development Program
CI	:	Cropping Intensity
CIG	:	Community Interest Group
DOA	:	Department of Agriculture
DOAC	:	Department of Agriculture and Cooperation
DOAH & F	:	Department of Animal Husbandry and Fisheries
DOH	:	Department of Home Science
DoH	:	Department of Horticulture
ECZ	:	Eastern Climatic Zone
eNAM	:	Electronic National Agriculture Market
EPI	:	Environment Performance Index
F2F	:	Farmer to Farmer
FAC	:	Farmers' Advisory Committee
FFS	:	Farmers' Field School
FIG	:	Farmers' Interest Group
FPC	:	Farmers' Producer Company
FPG	:	Farmers' Producer Group
GOI	:	Government of India
GR	:	Green Revolution
HAMETI	:	Haryana Agricultural Management and Extension Training Institute

HRD	:	Human Resources Development
HYVs	:	High Yielding Varieties
IAAP	:	Intensive Area Agricultural Program
IADP	:	Intensive Agricultural District Program
ICAR	:	Indian Council of Agricultural Research
ICT	:	Information and Communication Technology
IDWG	:	Inter-departmental Working Group
In-situ	:	On site
IPM	:	Integrated Pest Management
KVK	:	Krishi Vigyan Kendra
M&S	:	Marginal and Small
MA NAGE	:	National Institute of Agricultural Management and Extension
MOA	:	Ministry of Agriculture (now Ministry of Agriculture and Farmers' Welfare)
MSAM	:	Submission on Agricultural Mechanization
MSP	:	Minimum Support Price
NAIP	:	National Agricultural Innovation Project
NARS	:	National Agricultural Research System
NATP	:	National Agricultural Technology Project
ND	:	National Demonstrations
NES	:	National Extension Service
NGO	:	Non Governmental Organization
NHM	:	National Horticulture Mission
NLM	:	National Livestock Mission
NMAET	:	National Mission on Agriculture Extension & Technology
NSSO	:	National Sample Survey Organization
R&D	:	Research and Development
RKVY	:	Rashtriya Krishi Vikas Yojana
SAME	:	Submission on Agriculture Extension
SAMET	:	State Agricultural Management and Extension

SAMETI	:	State Agricultural Management and Extension Training Institute
SAU	:	State Agricultural University
SDR	:	State Development Report
SEWP	:	Strategic Extension Work Plan
SGDP	:	State Gross Domestic Products
SMPP	:	Submission on Plant Protection & Plant Quarantine
SMSP	:	Submission on Seed and Planting Material
SOC	:	Soil Organic Carbon
SREP	:	Strategic Research and Extension Plan
SWOT	:	Strengths Weaknesses Opportunities and Threats
T & V	:	Training & Visit
TAR-IVLP	:	Technology Assessment & Refinement Through Institution Village Linkage Program
TT	:	Technology Transfer
TTS	:	Technology Transfer Service
VERCON	:	Virtual Extension, Research and Communication Network
VICU	:	Vegetable Initiative for Urban Clusters
VLO	:	Village Level Officer
VLW	:	Village Level Worker
WCZ	:	Western Climatic Zone

Annexure-I

Meetings Organized

Sr. No.	Date	Venue	Remarks
1.	13 August, 2014	CCSHAU, Hisar	Brain Storming Workshop on "Agricultural Extension in Haryana"
2.	15 October, 2015	Haryana Kisan Ayog, Panchkula	Meeting of the Working Group
3.	18 November, 2015	CCSHAU,Hisar	Meeting with Presidents of District Kisan Club
4.	19 November, 2015	CCSHAU, Hisar	Meeting with officers of State Department of Agriculture
5.	10 December, 2015	Nidana, Jind	Meeting with Progressive Farmers
6.	14-15 January, 2016	CCSHAU, Hisar	Meeting For Preparation of Draft Report
7.	01-02 February, 2016	CCSHAU, Hisar	Meeting For Preparation of Draft Report
8.	14-18 March, 2016	CCSHAU, Hisar	Discussion on the Draft Report
9.	08-09 June, 2016	Gurugram	Meeting of Working Group on Agricultural Extension
10.	22 June, 2016	CCSHAU, Hisar	Meeting with DEE CCSHAU, Hisar
11.	23 June, 2016	LUVAS, Hisar	Meeting with DEE LUVAS, Hisar
12.	08 August, 2016	CCSHAU, Hisar	Brain storming Workshop on Agricultural Extension in Haryana
13.	22 April, 2017	DEE LUVAS, Hisar	Meeting of the Working Group for finalization of report
14.	12 July, 2017	Gurugram	Finalization of the Report
15.	12 August, 2017	HKA, Panchkula	Finalization and Submission of the Report

HARYANA KISAN AYOG
Government of Haryana
Anaj Mandi, Sector – 20, Panchkula-134116

NOTIFICATION

No. HKA/14/ 119-22 **Dated, Panchkula, the 14th May, 2014**

The Chairman, Haryana Kisan Ayog is pleased to constitute the following working group on **Agricultural Extension in Haryana** :

1. Dr. J.C.Katyal, Ex- Vice-chancellor, CCSHAU, Hisar - Chairman
2. Dr.R.K.Malik, Ex-Director, Extension, CCSHAU, Hisar - Member
3. Dr. B.S.Duggal, Managing Director, HSDC, Panchkula - Member
4. Sh. Ajay Vir Jakhar, Chairman, Bharat Krishak Samaj - Member

Terms of Reference:

- To analyse the strength and weaknesses of present system of technology dissemination, and identify specific gaps.
- To identify, analyse and establish specific causes for not scaling out of innovations.
- To examine the level of private sector involvements in technology transfer and propose ways to encourage their effective participation.
- To suggest the role of farmers associations, NGOs, SHGs, women's groups and specifically the youth and propose their future role in strengthening transfer of technology mechanisms.
- To suggest measures for capacity building to ensure more effective technology transfer.
- To recommend 'Way Forward' and mechanisms for both knowledge and technology dissemination and to have more effective involvement of all stakeholders.

Other Terms and Conditions:

1. On submission of report, the members will be entitled for a lumpsum honorarium of Rs. 25000/- each, whereas the chairman will be paid an honorarium of Rs.50000/-.
2. Members of working group will be paid TA for attending meetings on actual basis and an honorarium of Rs. 2000/- for each meeting.

Contd.-2

3. The working group may invite one or more special invitees to seek their views in specific meetings. Such special invitees will also be paid honorarium and other expenses by the Ayog, as per norms for other members, for their participation and contribution, only for that particular meeting.

4. The Commission will bear the cost on typing, printing etc. and for conducting the meetings. In case if any meeting is to be held by the group elsewhere, the expenses will be paid on actual basis.

5. The working group should submit its report preferably in six months from the date of this notification.

Note: From Commission side, Dr. R.B.Srivastava, Consultant will be the nodal person providing needed Technical backstopping, whereas Dr. R.S. Dalal, Member-Secretary will extend required administrative support.

RSDalal

Member-Secretary
Haryana Kisan Ayog

Endst. No./ HKA/14/123-27 **Dated, Panchkula, the 14th May, 2014**

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5. The Financial Commissioner and Principal Secretary, Govt. of Haryana, Agriculture Department, Chandigarh.
6. Vice-Chancellor, CCSHAU, Hisar
7. Dr.R.B.Srivastava, Consultant, HKA
8. PS to Chairman, Haryana Kisan Ayog
9. Accounts Officer, HKA

RSDalal

Member-Secretary
Haryana Kisan Ayog

HARYANA KISAN AYOG
Government of Haryana
Anaj Mandi, Sector – 20, Panchkula-134116

NOTIFICATION

No. HKA/14/ 310 - 319 **Dated, Panchkula, the 4th June, 2014**

In pursuance of the decision taken in the 13th meeting of Haryana Kisan Ayog, held on 28 May, 2014, under the chairmanship of Dr. R.S.Paroda, Chairman, Haryana Kisan Ayog, the working group on **Agricultural Extension in Haryana** is reconstituted as under:

1. Dr. J.C.Katyal, Ex- Vice-chancellor, CCSHAU, Hisar - Chairman
2. Dr.R.K.Malik, Ex-Director, Extension, CCSHAU, Hisar - Member
3. Dr. B.S.Duggal, Managing Director, HSDC, Panchkula - Member
4. Sh. Ajay Vir Jakhar, Chairman, Bharat Krishak Samaj - Member
5. Dr. A.M.Narula, Ex-ZPD, ICAR - Member

Terms of Reference:

- To analyse the strength and weaknesses of present system of technology dissemination, and identify specific gaps.
- To identify, analyse and establish specific causes for not scaling out of innovations.
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- To suggest measures for capacity building to ensure more effective technology transfer.
- To recommend 'Way Forward' and mechanisms for both knowledge and technology dissemination and to have more effective involvement of all stakeholders.

Other Terms and Conditions:

1. On submission of report, the members will be entitled for a lumpsum honorarium of Rs. 25000/- each, whereas the chairman will be paid an honorarium of Rs.50000/-.
2. Members of working group will be paid TA for attending meetings on actual basis and an honorarium of Rs. 2000/- for each meeting.

3. The working group may invite one or more special invitees to seek their views in specific meetings. Such special invitees will also be paid honorarium and other expenses by the Ayog, as per norms for other members, for their participation and contribution, only for that particular meeting.
4. The Commission will bear the cost on typing, printing etc. and for conducting the meetings. In case if any meeting is to be held by the group elsewhere, the expenses will be paid on actual basis.
5. The working group should submit its report preferably in six months from the date of this notification.

Note: From Commission side, Dr. R.B.Srivastava, Consultant will be the nodal person providing needed Technical backstopping, whereas Dr. R.S. Dalal, Member-Secretary will extend required administrative support.

R.S.Dalal 04.06.14

Member-Secretary
Haryana Kisan Ayog

Endst. No./ HKA/14/ 310-319 Dated, Panchkula, the 4th June, 2014

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6. The Financial Commissioner and Principal Secretary, Govt. of Haryana, Agriculture Department, Chandigarh.
7. Vice-Chancellor, CCSHAU, Hisar
8. Dr.R.B.Srivastava, Consultant, HKA
9. PS to Chairman, Haryana Kisan Ayog
10. Accounts Officer, HKA

R.S.Dalal 04.06.14.

Member-Secretary
Haryana Kisan Ayog

HARYANA KISAN AYOG
Government of Haryana
Anaj Mandi, Sector – 20, Panchkula-134116

NOTIFICATION

No. HKA/15/5795-5805 **Dated, Panchkula, the 21st August, 2015**

In continuation of notification issued vide No. HKA/14/310-319 Dated, Panchkula, the 4th June, 2014, the working group on **Agricultural Extension in Haryana** is reconstituted as under:

1.	Dr. J.C.Katyal, Ex- Vice-chancellor, CCSHAU, Hisar	-	Chairman
2.	Dr.R.K.Malik, Ex-Director, Extension, CCSHAU, Hisar	-	Member
3.	Dr. B.S.Duggal, Managing Director, HSDC, Panchkula	-	Member
4.	Sh. Ajay Vir Jakhar, Chairman, Bharat Krishak Samaj	-	Member
5.	Dr. A.M.Narula, Ex-ZPD, ICAR	-	Member
6.	Dr. R.B.Srivastava, Ex- Consultant, HKA		Member

Terms of Reference:

- To analyse the strength and weaknesses of present system of technology dissemination, and identify specific gaps.
- To identify, analyse and establish specific causes for not scaling out of innovations.
- To examine the level of private sector involvements in technology transfer and propose ways to encourage their effective participation.
- To suggest the role of farmers associations, NGOs, SHGs, women's groups and specifically the youth and propose their future role in strengthening transfer of technology mechanisms.
- To suggest measures for capacity building to ensure more effective technology transfer.
- To recommend 'Way Forward' and mechanisms for both knowledge and technology dissemination and to have more effective involvement of all stakeholders.

Other Terms and Conditions:

1. On submission of report, the members will be entitled for a lumpsum honorarium of Rs. 25000/- each, whereas the chairman will be paid an honorarium of Rs.50000/-.
2. Members of working group will be paid TA for attending meetings on actual basis and an honorarium of Rs. 2000/- for each meeting.
3. The working group may invite one or more special invitees to seek their views in specific meetings. Such special invitees will also be paid honorarium and other expenses by the Ayog, as per norms for other members, for their participation and contribution, only for that particular meeting.

4. The Commission will bear the cost on typing, printing etc. and for conducting the meetings. In case if any meeting is to be held by the group elsewhere, the expenses will be paid on actual basis.
5. The working group should submit its report preferably in six months from the date of this notification.

Note: From Commission side, Dr. Sandeep Kumar, Research Fellow will be the nodal person providing needed Technical backstopping, whereas Dr. R.S. Dalal, Member-Secretary will extend required administrative support.

Member-Secretary
Haryana Kisan Ayog

Endst. No./ HKA/15/5795-5805 **Dated, Panchkula, the 21st August, 2015**

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7. The Additional Chief Secretary, Govt. of Haryana, Agriculture Department, Chandigarh.
8. Vice-Chancellor, CCSHAU, Hisar
9. Dr.Sandeep Kumar, Research Fellow, HKA
10. PS to Chairman, Haryana Kisan Ayog
11. Accounts Officer, HKA

Member-Secretary
Haryana Kisan Ayog

HARYANA KISAN AYOG
GOVERNMENT OF HARYANA
ANAJ MANDI, SECTOR — 20, PANCHKULA-134116

NOTIFICATION

No. HKA/PKL/WG-13/2016/3317-28 **Dated, Panchkula, the 1st September, 2016**

In Continuation of notification issued vide No. HKA/15/5795-5805 dated 21th August 2015, the working group on **Agricultural Extension in Haryana** is reconstituted as under:

1.	Dr. J. C. Katyal, Ex- Vice-chancellor, CCSHAU, Hisar	-	Chairman
2.	Dr. R. K. Malik, Ex-Director, Extension, CCSHAU, Hisar	-	Member
3.	Dr. B.S. Duggal, Ex-Managing Director, HSDC, Panchkula	-	Member
4.	Dr. A.M. Narula, Ex-ZPD, ICAR	-	Member
5.	Dr. R. B. Sirvastava, Ex-Consultant, HKA	-	Member
6.	Dr. S. R. Garg, Director of Extension, LUVAS	-	Member

Terms of Reference:

- To analyse the strength and weaknesses of present system of technology dissemination, and identify specific gaps.
- To identify, analyse and establish specific causes for not scaling out of innovations.
- To examine the level of private sector involvements in technology transfer and propose ways to encourage their effective participation.
- To suggest the role of farmers associations, NGOs, SHGs, women's groups and specifically the youth and propose their future role in strengthening transfer of technology mechanisms.
- To suggest measures for capacity building to ensure more effective technology transfer.
- To recommend 'Way Forward' and mechanisms for both knowledge and technology dissemination and to have more effective involvement of all stakeholders.

Other Terms and Conditions:

1. On submission of report, the members will be entitled for a lumpsum honorarium of Rs. 25,000/- each, whereas the chairman will be paid an honorarium of Rs.50,000/-
2. Members of working group will be paid TA for attending meetings on actual basis and an honorarium of Rs. 2,000/- for each meeting.
3. The working group may invite one or more special invitees to seek their views in specific meetings. Such special invitees will also be paid honorarium and other

expenses by the Ayog, as per norms for other members, for their participation and contribution, only for that particular meeting.

4. The Commission will bear the cost on typing, printing etc. and for conducting the meetings. In case if any meeting is to be held by the group elsewhere, the expenses will be paid on actual basis.
5. The working group should submit its report preferably in six months from the date of this notification.

Note: From Commission side, Dr. Sandeep Kumar, Research Fellow will be the nodal person providing needed Technical backstopping, whereas Dr. R.S. Dalal, Member Secretary will extend required administrative support.

R S Dalal

MEMBER SECRETARY
HARYANA KISAN AYOG

Endst No. HKA/PKL/WG-13/2016/3317-28 Dated, Panchkula, the 1st September, 2016

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5. Dr.A.M. Narula, Ex-ZPD, Zone-1, ICAR C/0 Ms. Anita Narula, Principal, Central School for Tibetans, Happy Valley, Mussoorie, District Dehradun (Uttarakhand) E-mail: narula512002@yahoo.co.in M: 08146549889
6. Dr. R.B. Srivastava, H. No. 2147, Sector-2, Ballabgarh, Faridabad
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8. The Financial Commissioner and Principal Secretary, Govt. of Haryana, Agriculture Department, Chandigarh.
9. Vice-Chancellor, CCSHAU, Hisar
10. Vice-Chancellor, LUVAS, Hisar
11. PS to Chairman, Haryana Kisan Ayog
12. Accounts Officer, HKA

R S Dalal

MEMBER SECRETARY
HARYANA KISAN AYOG

AGRICULTURAL
MOBILE APPs

Crop Insurance

Kisan Suvidha

eNAM

AGRI MARKET

M-KISAN

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