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RESEARCH ARTICLE

Technology needs for sustained agriculture and resource use: a case study of Mewat district, Haryana, India

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ABSTRACT

Sustaining agriculture and food security in the face of serious and widespread problems of resource degradation and more ominous climate change related issues has emerged as a major challenge of the present century. In the past most interventions to enhance agriculture have aimed at improving crop yields through the supply of seed improved cultivation and inputs and little consideration has been given to sustainable resource use management. A small study was conducted in the Mewat district of Haryana, India with an objective to examine is as to what extent the past agricultural development efforts and technological interventions has benefitted the region considering the associated impact which these interventions entailed on the state of natural resources. The study has clearly indicated that past agricultural development has significantly impacted natural resource base of the region specifically groundwater and the soils of the region. Thus it has been observed that declining availability and quality of ground water resource, widespread problem of soil degradation, lack of fodder and feed resource for the livestock, and fuel for household would appear the key entry points where the activities of different agencies must complement to yield sustainable gains in livelihood opportunities.

INTRODUCTION

Sustaining agriculture and food security in the face of serious and widespread problems of resource degradation and more ominous climate change related issues has emerged as a major challenge of the present century. Agriculture being the major land use and a source of livelihood for more than 58% of India's population, agricultural scientists' community has a critical role in developing and promoting strategies and agricultural practices aimed at sustained benefits with reversing processes contributing to resource degradation and adapting to climate change. Resource degradation issues exacerbated by uncertain climatic events directly impacts agriculture and the livelihoods of the farmers. Particularly risk prone and adversely impacted are the farming communities in rainfed and resource depleted regions and where the past agricultural development efforts have not yielded the desired gains. It is in this context that the Planning Commission has identified 150 most backward districts in the country with a view to reinforce focused efforts towards improved livelihoods. Mewat district of Haryana forming a part of the dry semi-arid ecoregion spread over the states of Haryana, Rajasthan and western Uttar Pradesh is one of the least developed districts in Haryana (Planning Department, Government of Haryana, 2011). Agriculture being the major land use and farming the main vocation for livelihood for majority of the population in the region, it is thus important to understand the current dynamics of resource use and agriculture related activities such that any interventions aimed at enhancing agriculture productivity ensure sustainable resource use and management while improving livelihood opportunities. Apart from the baseline understandings of the bio-physical and socio-economic characteristics of the region; analyzing past developmental and technological interventions is extremely important in order to assess the accrued benefits of these initiatives and for exploring sustainable developmental and technological options for the current and future. These were the primary objectives of this study.

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Study Area

Mewat-a part of the North Punjab plain, Ganga-Yamuna Doad and Rajasthan upland hot dry semi-arid eco-subregion accounts for an area of 118 million ha representing nearly 36.5 % of the ecoregion and 3.5 % of the total geographical area of the country. The length of growing period in the subregion varies between 90 and 120 days beginning with July and ending with the first fortnight of October (Gajbhiye, and Mandal). Earlier, a part of Gurgaon and Faridabad districts, Mewat was carved out as an independent 20th district of Haryana state in April 2005. The district has two tehsils Nuh and F. P Jhirkha with five development blocks namely Taoru, Nuh, Nagina, F. P Jhirkha, and Punhana (Mewat CDAP, 2007).

METHODOLOGY

The study is a part of World Bank funded, Indian Council of Agricultural Research, National Agricultural Innovation Project, ***'Achieving improved livelihood security through resource conservation and diversified farming system in Mewat'***. Following methodology was adopted for achieving the objectives of this study.

- **Literature Review:** literature review of both the research papers and other documents (publications by NGOs, reports of line departments, reports of other government agencies) has been done to build a sound understanding on major issues impacting sustainability of agriculture in the district and to explore possible options and opportunities available to facilitate actions towards sustainable agriculture.
- **Stakeholder Interactions:** to supplement understanding gained through literature review interactions with key stakeholders (farmers, official of line department, officials of major

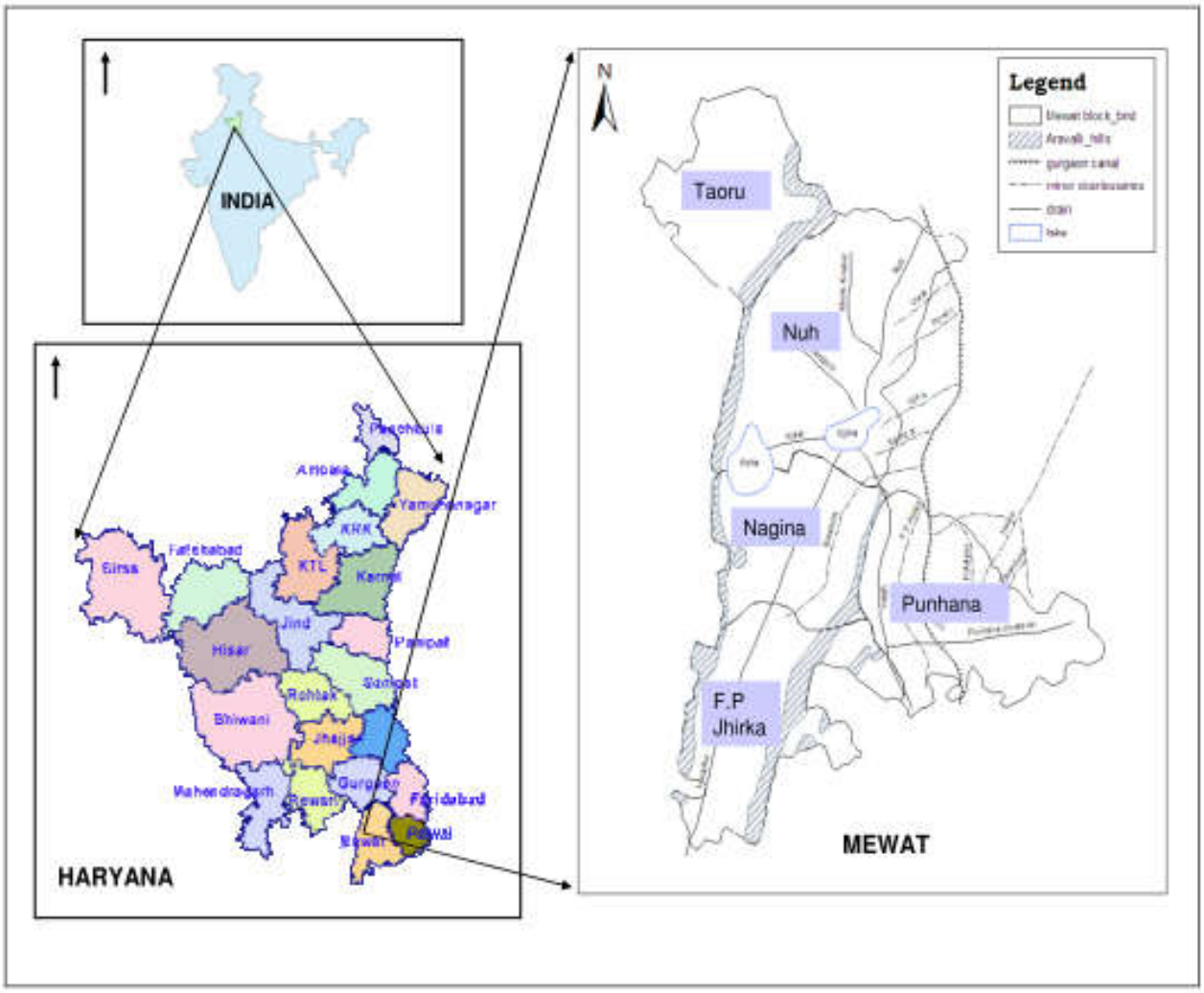

Fig. 1. Location of Mewat

organizations working in the district, officials of Central Groundwater Board (CGWB), officials of Haryana Agricultural University, and Haryana Space Applications Centre) have been done. The understanding was further crystalized by the information gained through various stakeholder consultations/ meetings carried out by various agencies (Annexure I).

RESULTS AND DISCUSSIONS

Current dynamics of resource use and agriculture related activities in the district

The factors governing the dynamics of resource use and agriculture are both bio-physical and socio-economic in nature. Thus both the factors were analyzed separately; the details are listed in Table (1) and Table (2).

Past Agriculture Development Efforts

Over the recent past considerable efforts has been made at the state level to improve agriculture productivity of the region. Development efforts of the region are being coordinated by Mewat Development Agency (MDA), while different line departments of the government are the executing agencies. From 1995-2005, MDA executed a major project funded jointly by International Fund for Agricultural Development (IFAD) 67% and Govt. of Haryana 29% with the objective of improving the social and economic well being through omoting activities which aimed at greater self resilience on a sustained basis while broadening the range of economic opportunities available to the communities. Although the project come to an end in 2005 at which time Mewat was also carved out as a new district of Haryana many of the activities have since been pursued by different line departments through Central and State government funded projects. Table (3) above provides a brief summary of the broad activities that have been or are being pursued towards agricultural and related developments. The key question that we wish to examine is as to what extent the benefits of past agricultural development efforts, and the technological elements which formed a basis, can be sustained considering the associated impact which these interventions entailed on the state of natural resources and if the agricultural practices promote during the project phase can be pursued on a sustained basis by the farmers in the absence of specific project based interventions in the post project phase.

Major Findings

Efforts to address issues of soil and water conservation: These efforts have been pursued through two separate approaches one adopted by division of Soil and Water Conservation, Department of Agriculture focusing mainly on engineering approaches while the other being a part of the crop production strategy and being pursued by the agriculture department. Establishment of water harvesting structure/percolation tanks along periphery of Aravalli fort hills together with construction of field bunds check dams gully plugs, diversion bunds to check erosion etc being the main activities. There are serious question on sustainable benefits

Table 1. Biophysical Features of Mewat

Parameter	Features	Major Issues	Source
Topography	• Bowl shaped with undulating Aravalli hillocks on the two sides and almost plain topography in the central part	• Influencing Groundwater and soils of the region resulting in different homogenous units in the district	• Digital Elevation Map of Mewat • Planning Department, Government of Haryana, 2011
Rainfall	• Average rainfall of 372 mm received primarily in monsoon • 21-22 average number of rainy days	• Less rainfall • Monsoonal Rainfall (maximum rain only in 2-3 months) • Uneven rainfall in different blocks of Mewat	• Strategic Report, 2008 • CDAP report, 2007
Temperature	• Mean temperature ranging from 30° to 48° C (summer) and 4° to 25° C (winter) • May and June are the hottest months	• High evapotranspiration • Increase in mean winter temperature over last decade resulting: ▪ Poor germination of winter crops ▪ Shortening of germination period leading to forced maturity ▪ Increased irrigation demand (one irrigation in the month of March) prior to harvesting	• CDAP report, 2007 • Stakeholder Interactions
Groundwater	• Major source of drinking and irrigation in the district (Except 20-30 villages (which are entirely rainfed and where piped drinking water supply is available) out of 443 villages) • *Variability in groundwater quality* • Fresh Groundwater Zone ▪ Region along the Aravalli foothills and Taoru Block ▪ EC = 0-2 millimohs/cm^2 ▪ Groundwater Depth = 10-30m • Medium to High Salinity Zone ▪ Region next to fresh groundwater zone approximately 1-2 km away from the Aravalli foothills (have access to fresh groundwater; withdrawing groundwater from Fresh Zone through underground pipelines) ▪ EC = 2-4 millimohs/cm^2 ▪ Groundwater Depth = 3-10m • Highly Saline Zone ▪ Region next to medium to high salinity zone where access to fresh ground water is not available (20-30 villages which are totally rainfed and where piped drinking water supply is available) ▪ EC = More than 4 millimohs/cm^2 ▪ Groundwater Depth = 0-3m	• Rapid decline in groundwater depth in Fresh Groundwater Zone because of the following factors ▪ Shift from cereal based cropping system to vegetables in the Fresh Zone ▪ Expansion in agricultural area ▪ Shift to hybrid varieties ▪ Pressure from Medium to High salinity Zone ▪ Decline in average annual rainfall ▪ Deforestation in Aravalli ranges ▪ Intrusion of saline water towards the Fresh Zone • Groundwater contamination in the canal irrigated areas (canal water is highly contaminated with industrial wastes of adjacent areas mainly Faridabad Industrial Area)	• CGWB, 2011 • Department of Agriculture (DoA), Mewat, 2009 Data • Field visits, Interactions with farming community, Line department officials, NGO officials • Haryana State Remote Sensing Application Centre (HARSAC), Technical report 25, 1999 • Kaur et al 2007 • Mehra et al, 2012
Canal Water	• 68% of the total cultivated area in the district is under irrigation, out of which 75% is under tube well and remaining 25% is under canal irrigation • Currently some 24.23% area in Kharif (mainly Paddy) and 11.77 % area in rabi are irrigated with these canals	• Industrial pollution in canal water • Waterlogging problems in the areas irrigated with canal water • Increase in Paddy cultivation with the introduction of canal water	• Strategic Report, 2008 • Kaur et al 2007 • Stakeholder interactions
Soils	• Soil Type: Largely Sandy Loam (66%) to Sandy (32%) • Soil pH: 7.0 to 8.5 • Soil Organic Matter: low • Soil NPK Status: except P, both N & K status ranges from low to very low in the district • Soil Micronutrient Status: Low • Soil Salinity: nearly 40% of the region is facing medium to severe soil salinity issues (especially Nuh, Nagina & Punhana blocks)	• Low soil fertility • Increasing soil salinity • Soil degradation because of the following factors: • Water and wind erosion • In-efficient use of chemical fertilizers and pesticides • Increasing Brick Kiln industries in the district • Waterlogging due to canal water seepage	• DoA, Mewat • Strategic Report, 2008 • CDAP report, 2007 • Stakeholder interactions • Haryana State Remote Sensing Application Centre (HARSAC), Technical report 25, 1999

Table 2. Socio-Economic Features of Mewat

(Mewat the most backward district of Haryana)

Parameter	Features	Major Issues	Source
Landuse	• Geographical area: 148963 hectare • Cultivatable area: 81% of total geographical area • Cultivated are: 73% of total geographical area • Current fallow: 7% of total geographical area • Forest = 1% of total geographical area • Land under non-agricultural use: 2% of total geographical area	• Less forest area • Increasing wasteland area in past decades	• DoA, Mewat • CDAP Report, 2007 • Haryana State Remote Sensing Application Centre (HARSAC), Technical report 25, 1999
Source of Livelihood	• Primary: Agriculture • Secondary: Animal husbandry	• Limited livelihood diversification (little focus on other sources of livelihood for eg; bee keeping, mushroom cultivation, horticulture etc.)	• Strategic Report, 2008 • CDAP report, 2007
Agriculture	• Cropping Intensity: 137% • Cropping pattern: • <u>Rainy season</u> ▪ Pearmillet = 18% of total cultivated area ▪ Paddy = 4% of total cultivated area • <u>Post rainy season</u> ▪ Wheat = 52% of total cultivated area ▪ Oilseed = 25% of total cultivated area ▪ Barley = 1% of total cultivated area • Irrigation: ▪ Irrigated area = 87% of total cultivated area ▪ Rainfed area = 13% of total cultivated area	• Declining crop productivity • Increasing area under vegetables in areas having fresh groundwater • Increased application of fertilizers and pesticides • Increasing area under paddy cultivation • Limited crop diversification • Major focus on irrigated areas in comparison with rainfed areas • Increasing vulnerability to climate associated variability in rainfall and temperature	• Strategic Report, 2008 • DoA, Mewat • CDAP report, 2007 • Ahuja, U.R. and Nanwani, N, 2011 • NCAP Report, 2010
Livestock	• Mewat possesses nearly 47955 cows, 296137 buffalo, 22878 sheep, 83907 goats and 46182 poultry bird	• With only 18% area devoted to fodder crops sustaining livestock productivity is becoming a big challenge for the farmers • Unavailability of sufficient quantity and quality of animal nutrition (both green and dry fodder) is leading to increased incidences of malnutrition and diseases in the livestock	• Strategic Report, 2008
Livelihood Status	• Small Farmers1: 43% • Marginal farmers: 46% • Medium farmers: 6% • Large farmers: 5%	• Low socio-economic status	• Strategic Report, 2008
Literacy Rate	• Literacy of the district: 44% ▪ Male literacy: 60.5% ▪ Female literacy: 24.2%	• Less awareness • Less access to government schemes • Less adoption of sustainable technologies	• Strategic Report, 2008
Population Density	• 556 @ per sq .K.M	• Resource scarcity • Mewat being meo dominated area have large average family size (7 members in a family)	• Strategic Report, 2008

Table 3. Past Developmental Initiatives (Based on IFAD Project Report)

Approaches	Main Activities/Technological Intervention	Benefit/Assumed Benefit
• Enhanced water availability in the region for irrigation	• Construction, rehabilitation and lining of approximately 78 km length of distributary canals including Nuh subbranch (9.39 Km). • Banarsi distributary (17 Km). • Urma minor canal (11.97 Km). • Gangwani minor canal (14.40 Km). • Sadipur minor canal (8.9 Km). • Dabalu minor canal (11.5 Km). • Hinganpur drain (4.5 Km).	• An increase in net irrigated area covered by canals by 4,500 ha. • Increased employment during rehabilitation and for maintenance works. • Improved crop productivity.
• To conserve soil and water resources by arresting loss of top fertile soils and through enhanced recharge of aquifer	• Laser Land leveling. • Construction of field bunds (1,071 ha), check dams (1,048), gully plugs (361), diversion bunds (396), percolation ponds (248), village ponds (249). • Soil reclamation with supply of amendments to retain alkali affected soils. • Development of panchayat wastelands (834 ha).	• Improved groundwater level in project area and reduced erosion. • An increase in area under rainfed agriculture by 9,500 ha. • Improved productivity of retained soils
• Increased awareness and know-how about improved crop production and efficient input-use technologies	• Organize crop (wheat, mustard, millet etc.) demonstration plots to demonstrate potentials of new cultivars and total package of technologies. • Demonstration of farming techniques in relation to crop production (double/ multiple cropping opportunities, pest control equipment, benefits of green manuring. • Training, on farm research trials, study visits etc.	• Enhanced crop productivity through the adoption of improved cultivars, crop management practices and crop diversification.
• Livestock Improvement	• Infrastructure developing facilities by way of livestock development complexes (16), establishment of mini dairies (36), milk booth (8), mil chilling centre (2). • Facilitating establishment of dairy cooperative societies. • Supply of mineral supplements and organizing deworming of livestock for improved health.	• Increased milk yield and income of farmers. • Reduced causalities and incidence of diseases.

accruing from these efforts. While enhanced percolation of harvested water aiding in recharge of groundwater has been the main plunk to justify the investments, there have been no serious evaluation studies particularly in term of temporal changes in percolation rates in relations to silting of the tanks, maintenance longevity and upkeep of the structure etc. It is also little appreciated that activities like field bunding, check dams are cost intensive, do not in any way reduces or help water erosion and in any case there has never been a doubt that their maintenance is always a casualty. There have been very little if any efforts aimed at promoting such simple practices as vegetative barriers, wind breaks, and mulch etc. which farmers can themselves pursue with relatively little advisory back up.

- **Crop production programs:** (a) these programs have long recognized declining soil health and quality as critical to sustained productivity. It is also recognized that how organic matter content of the soil is most critical to overall health of soils including its physical, chemical, and biological properties yet the major focus of efforts to address soil related constrains has been on meeting the needs through chemical fertilizers which are needed in over increasing quantities and to include an increasing range of macro, secondary, and micro nutrient to maintain crop yields incurring higher input costs. Very little efforts has made to develop and promote practices which might have the potential of improving carbon status of soils-the key determinant of soil quality over the past decades or so growing of sesbania for green manuring has been promoted by providing seeds etc at subsidized rate and this practice is being adopted widely. Again the main reason for its wide acceptations is its ability to contribute a significant amount of nitrogen needs. Gypsum as a soil corrective (amendment) to restore soils' loss of productivity on accounts of adverse effects of use of poor quality groundwater for irrigation is yet another intervention being promoted to maintain soil quality. (b)The singular focus of crop production related interventions (improved cultivars, alternate crops) has been to raise crop yields with increased use of inputs (water, fertilizer, pest control chemicals etc.) with little emphasis on cost consideration, use efficiency of inputs and quality of the resource base. As a result productivity increase has been achieved at a cost in term of resource degradation limiting sustained gains. It is thus apparent that perusal of resource conservation and crop production strategies in isolation has brought us face to face with a situation where achieving further gains is ridden with unimagined challenges.

- **Livestock improvement programs:** This is another major opportunity to improve livelihoods of the people of the region. Again challenges of livestock improvement are linked closely to cropping activities and to available adequate nutrient fodder. While crop production strategies have little focus on availability of fodder, livestock activities have largely focused on issues of genetic improvement through artificial insemination, control of diseases, and milk processing etc. Thus what is needed is to put in place more integrated approaches which can take into account the strong linking's which exist between the crop and livestock sections on the one and productivity and resource conservations concerns on the other.

Conclusion

An overarching requirement in the generation and promotion of technologies to achieve the somewhat elusive sustainability goal in the high degree of spatial variability in resource endowments superimposed by high spatial and temporal variability in seasonal climatic episodes which makes technological needs highly specific to a location, thus developing, adapting and promoting technologies to match the natural resource variability (groundwater quantity, quality, soil characteristics) and climatic episodes which simultaneously address issue of cost reduction, productivity increase while making efficient use of input and maintaining or enhancing the quality of resource base is an imperative which can no longer be ignored if sustainable productivity gains are to be achieved. This will also call for a shift in focus from evaluating gains from technologies purely in terms of individual yield increases to evaluation that consider total biomass, including livestock and household fuel needs. This will also then call for a shift in focus of technologies needs, of not only what the farmers themselves can do at their own fields but on the community action needs which extends to beyond there own fields to the needs of what needs to be done in relation to community lands and watershed/landscapes as a while. In short the need to increasingly build up a system perspective in defining and seeking technologies option for improving the livelihood opportunities for people in the region.

An important imperative in this regard is the opportunity to build upon the strong accumulated knowledge base of the farmers and farming communities of local resource issues and their dynamic understanding over spatial and temporal dimensions. It is in this context that identifying interventions and adapting them under specific farming situations working together with farmers provides an opportunity for greater likelihood of uptake of technological interventions. This is in contrast to the conventional approach whereby standardized technologies packages are recommended for adoption. This calls for a strong component of adaptive research which can serve to bridge the existing large divide between the scientific community and farmers on the one and with development agencies on the other. This also brings to the fore the need for ensuring a strong complementarity between the efforts of the line development departments in achieving objectives. Thus if improving livelihoods while enhancing resource use efficiency and resource quality are the key objectives there has to be a strong complimentarity between the activities of departments. This will happen when the prioritizations of interventions of different departments are derived from the same common objectives eg. improved livelihoods while ensuring long-term sustainability of resource use and quality. In the case of Mewat the resource base, limitation of declining availability and quality of available ground water resource, widespread problem of soil degradation through erosion, soil salinization and waterlogging and depleted soil fertility and the lack of fodder and feed resource for the livestock and fuel for household would appear the key entry points areas where the activities of different agencies must complement to yield sustainable gains in livelihood opportunities.

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Annexure I

S.No	Event	Organizer	Date
1	Stakeholder Consultation Meeting	National Centre for Agricultural Economics and Policy Research	15/07/2009 and 10-11/09/2009
2	Meeting with Krishi Vigyan Kendra Scientists, Mewat District,	Centre for Advancement of Sustainable Agriculture	01/10/2009
3	Indian Council of Agricultural Research, National Innovation Agricultural Project-Mewat Project Launch Workshop	Haryana Agricultural University, Hisar, Haryana	15/10/2009
4	Meetings with the farming community of Mewat	Centre for Advancement of Sustainable Agriculture	11/12/2009
5	Meeting with Groundwater Department	Centre for Advancement of Sustainable Agriculture	07/01/2010
6	Stakeholder Consultations on, "Resource Use Dynamics and Farming Technology" in Mewat.	Centre for Advancement of Sustainable Agriculture	16/03/2011
7	Stakeholder Workshop on, "Water Resources Situation Analysis to Promote Sustainable Groundwater Development of Mewat District, Haryana, India".	TERI University	25/03/2011
8	Stakeholder Workshop on, "Understanding Farmers' Perspective on Climate Variability Implications on Agricultural Production and Natural Resource Base in the Mewat District of Haryana".	Centre for Advancement of Sustainable Agriculture	24/10/2011
9	National Symposium on "Soil Health, Conservation Agriculture and Climate Change".	Centre for Advancement of Sustainable Agriculture	12/02/2012

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