



RESEARCH PROGRAM ON  
Climate Change,  
Agriculture and  
Food Security



# Climate-Smart Villages in Haryana, India



CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)  
International Maize and Wheat Improvement Center (CIMMYT)

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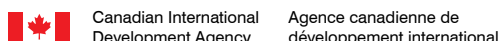
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## Foreword

The State of Haryana has been at the forefront in agricultural development and has played a key role in national food and nutritional security since the dawn of the Green Revolution. The state has already reached plateau in land availability for agriculture but it still plays a critical role in future food security. This warrants a growth model that will conserve and sustain its finite natural resources such as land, water and biodiversity while contributing significantly towards meeting the demands for food not only for Haryana but for the whole country.

The problem is further intensified with the inefficient use and mismanagement of production resources, especially water, energy and agro-chemicals. The sharp rise in the cost of energy, diversion of human capital to non-farm sectors, volatility of food prices and climate change-induced vulnerability, pose major challenges to farmers and our society.

During the past three years, I had an opportunity to have close interaction with farmers and other stakeholders in Haryana State and got acquainted with the complexity of challenges that farmers are facing. These include declining factor productivity, depleting natural resources particularly water and soil health, climate change induced extreme weather conditions, poor market access and less income due to which youth in rural areas are reluctant to take up agriculture as a profession. As the problems in agriculture are complex, the solutions are also not simple. A business as usual approach in terms of 'technology development, refinement and extension' is not likely to result in enhanced production and productivity of food grains and other commodities for sustained livelihood of the people.

Hence, there is great need for greater participation of the farming community, particularly the youth and women. We need everyone's support in technology development, adoption and use of modern tools and techniques. For example, Information Communication Technologies (ICT) such as mobile phones can be used for real-time access to relevant climate and agriculture information and can greatly reduce the climate risks for farmers.

I am happy to learn that the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) and the International Maize and Wheat Improvement Centre (CIMMYT) in close collaboration with national and international research organizations (Indian Council of Agricultural Research, CCS Haryana Agricultural University, other CGIAR institutes), developmental organizations (State Department of Agriculture, Government of Haryana), policy planners

(Haryana Farmers' Commission), private sector and farmers' organizations have initiated the 'Climate Smart Village' program in Haryana. The project calls for community based and local adoption planning to address the challenges of climate change. I had the opportunity to visit some of these project implementation sites and closely interacted with the farmers and other stakeholders. I was pleased to learn that this holistic approach provides opportunity to farmers to participate in technology development and adoption to climate change as well as in creating awareness among the community on the usefulness of climate resilient farming systems.

I congratulate the research team of CIMMYT-CCAFS for documenting the initial evidence on climate smart agriculture in Haryana and bringing out this synthesis report which will be of immense use for researchers, change agents and policy planners for scaling-up of climate smart agriculture through Climate Smart Village program in India and elsewhere in Asia region.



(R.S. Paroda)

Chairman, Haryana Farmers' Commission &  
Chairman, Trust for Advancement of Agricultural Sciences

# Contents

Foreword	iii
<b>1. Climate and Agriculture Challenges in Haryana</b>	<b>01</b>
How climate change impacts major crops and livestock	01
<b>2. Climate-Smart Villages: A Community Based Approach to Sustainable Agriculture</b>	<b>03</b>
Climate-smart villages in Haryana	04
Prioritising and targeting climate-smart agriculture interventions in Haryana	05
<b>3. Farmers' Testimonials from Climate-Smart Villages</b>	<b>08</b>
Nilokheri block	08
Gharaunda block	09
Indri block	10
Nissing block	11
<b>4. Scaling Out Climate-Smart Villages: The Way Forward</b>	<b>12</b>



# Climate and Agriculture Challenges in Haryana

Haryana state in northern India lies in the fertile Indo-Gangetic Plains (IGP). Straddling Pakistan, India, Nepal and Bangladesh, the IGP is a major food basket for South Asia, producing nearly 15 percent of the global wheat. In India, it traverses Punjab, Haryana, Uttar Pradesh, Bihar and West Bengal.

The recent report from the Intergovernmental Panel on Climate Change (IPCC) highlights that as one of the most densely populated regions in the world, South Asia is among the most vulnerable to climate change and climate variability. In the absence of adaptation and mitigation, climate change can have major consequences on food security and development in the decades to come.

## Climate Change Projections for Haryana\*

### Temperature change projections under different climate scenarios (RCPs)

In the short-term (2030s), annual temperature is likely to rise by 1.5 to 2.5°C

In the medium-term (2060s), this rise is likely to be between 2 to 4°C

In the long-term (2080s), it is projected to rise between 2 to 6.5°C

### Precipitation change projections under different climate scenarios (RCPs)

Projections shows increase in annual precipitation in Haryana

This increase will be approximately up to 10 percent in the short-term,

5 to 15 percent in the medium-term, and 5-30 percent in the long-term

*\*Multi-model ensemble mean of 18 GCMs (CMIP5); Changes relative to pre-industrial base period (1880s: 1861-1900). Source: Chaturvedi et al., 2012*

The lack of perennial rivers in Haryana has made water an acutely scarce resource. The *Ghaggar* is the only seasonal river, which flows in the north of the state. The state has a well-developed canal network. The net sown area is 85 percent of the total geographic area, as compared to the national average of 46 percent making it one of the major contributors to national food production. However, farmers here are contending with several challenges – declining water tables and low water use efficiency, multi-nutrient deficiencies and soil health deterioration and plateauing crop yields. The practice of residue burning is still widely prevalent. Apart from destroying soil organic matter, it affects air quality and contributes to greenhouse gas emissions. The shortage of labour and energy has increased production costs. Climatic variability led biotic and abiotic stresses add another dimension to these existing challenges.

## How climate change impacts major crops and livestock

**Wheat:** It is the major rabi (winter) crop of the state. Wheat is highly vulnerable to heat stress and requires optimal temperatures at different stages of its growth. It grows best where the temperature is between 20-25°C. Rising temperatures could have significant impacts on wheat yields and

productivity across the plains. Studies project that climate change will reduce wheat yield in India in the range of 6 to 23 percent by 2050 and 15 to 25 percent by 2080s.

**Rice:** Conventional tillage-based, irrigated rice consumes more than 50 percent of water used for irrigation in Asia. Rice requires 3-4 times more water per unit grain produced than crops such as wheat and maize. In a water-scarce region, a move towards adaptation practices that conserve water while increasing yields is critical. In Haryana, rice is sown in the summer months which consumes 150-200 cm water in each crop cycle and is leading to depletion of ground water tables. The government is also encouraging farmers to replace water-guzzling rice varieties and diversify their crops to include maize, pulses, and short-duration rice varieties.

**Livestock:** Climate change has direct and indirect effect on animal production, reproduction and emergence of many animal diseases. It has been estimated that the annual loss in total milk production due to heat stress on livestock is around two percent in the country's total milk production.



**Moving towards conservation agriculture:**

Residue burning (top left) is still a widely prevalent practice among farmers in Haryana. It destroys soil organic matter, affects the air quality and adds to greenhouse gas emissions. But with growing awareness of conservation agriculture practices, farmers are increasingly seeing the benefits of residue recycling in no-till-which means direct sowing of seeds through the residues without tilling the land (bottom left).



# Climate-Smart Villages: A Community Based Approach to Sustainable Agriculture

The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) together with the International Maize and Wheat Improvement Center (CIMMYT) and National Agricultural Research and Extension System (NARES), CGIAR centres and farmer organisations are implementing the Climate-Smart Village program. Apart from South Asia, the program is being piloted with a diverse range of partners in all CCAFS regions, that is, East and West Africa, Southeast Asia and Latin America.

***Climate-Smart Villages are sites where researchers from national and international organisations, farmers' cooperatives, local government leaders, private sector organisations and key policy planners come together to identify which climate-smart agriculture interventions are most appropriate to tackle the climate and agriculture challenges in the village.*** The idea is to integrate climate-smart agriculture into village development plans, using local knowledge and expertise and supported by local institutions.



## What are climate-smart agriculture practices?

A laser-leveller (top left) produces an exceptionally flat surface. This helps distribute water evenly across the field. Most farmers in Haryana rent the equipment on an hourly basis. Farmers pay between 600-700 rupees an hour to use the machine. Emergence of wheat crop on a no-till farm in Haryana (bottom left). No-till farming is a way of growing crops without disturbing the soil through tillage or ploughing. The seeds are sown using a zero-till machine. No-till farming increases water infiltration into the soil, enhances retention of soil organic matter as well as help in adapting to climatic extreme.

**Climate-smart agriculture strives to sustainably increase productivity and incomes, build resilience and adaptive capacity, and where possible reduce greenhouse gas emissions. It works to enhance the achievement of national food security and development goals.**

Climate-smart agriculture is location specific and tailored to fit the agro-ecological and socioeconomic conditions of a location. Interventions that work in one area may not be applicable in another.

The Climate-Smart Village adopts a portfolio of interventions that cover the full spectrum of farm activities. These include **water smart** practices (rainwater harvesting, laser land levelling, micro-irrigation, raised bed planting, crop diversification, alternate wetting and drying in rice, direct seeded rice), **weather smart** activities (ICT-based agromet services, index-based insurance, stress tolerant crops and varieties), **nutrient smart** practices (precision fertilizer application using Nutrient Expert decision support tools, GreenSeeker and Leaf Color Chart, residue management, legume catch-cropping), **carbon and energy smart** (zero tillage, residue management, legumes) and **knowledge smart** activities (farmer-farmer learning, capacity enhancement on climate-smart agriculture, community seed banks and cooperatives). These interventions work together to increase a community’s resilience to climatic stresses while ensuring household food and livelihood security.

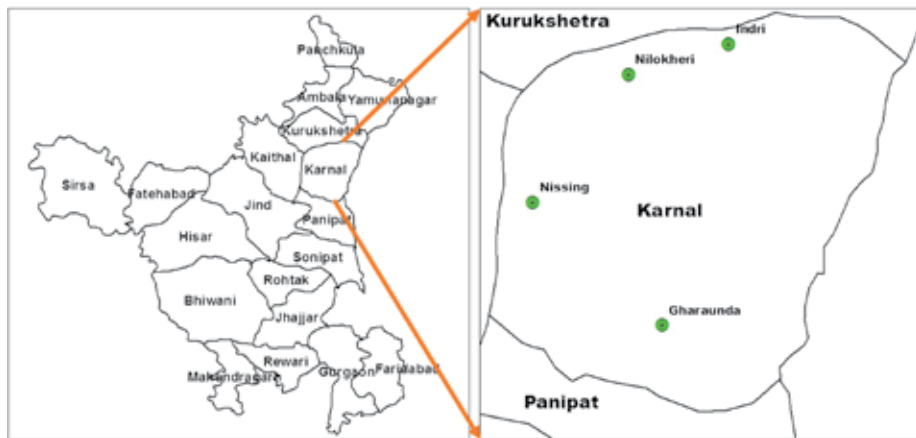
In South Asia, Climate-Smart Villages were initiated in 2011, first in Haryana and Bihar in India and Rupandehi in Nepal. In this report, we outline the status of Climate-Smart Villages in Haryana.

## Climate-smart villages in Haryana

Haryana is an intensively cultivated semi-arid irrigated region with irrigation intensity exceeding 175 percent. It receives about 700 mm of rainfall annually. Rice-wheat is the predominant cropping system. The livestock and dairy industry is also an integral part of the rural economy of Haryana.

Karnal district is the site of several pilot programmes by the government. It hosts important national research bodies such as the Central Soil Salinity Research

Institute (CSSRI), the National Dairy Research Institute (NDRI), Directorate of Wheat Research (DWR),



### Expansion of Climate-Smart Villages in Karnal, Haryana

In 2012: 4 villages

In 2014: 27 villages in 4 blocks

#### Demography

Average village population: 5357

Sex ratio: 1.05

Large farm households: 15 percent

Small farm households: 85 percent

(farm size based on average land holding size in Haryana)

the Regional Station of CCS Haryana Agricultural University. Under the aegis of National Initiative on Climate Resilient Agriculture (NICRA), a close partner of CCAFS-CIMMYT, these institutes are also implementing the Climate Smart Village program.

At present, 27 Climate-Smart Villages are being piloted in Karnal. The villages are in Nilokheri, Indri, Gharaunda and Nissing blocks.

## Prioritising and targeting climate-smart agriculture interventions in Haryana

In intensive cereal based systems, the success of alternative, efficient and climate resilient cropping systems depends on the resource endowments of the region and the full range of activities carried out by farm households.

The selection of climate-smart agriculture practices and technologies was based on the CCAFS Baseline Household Level Survey conducted in eight randomly selected villages (20 household per village) in Karnal district. The data gathered from this exercise was used to develop the farmer typology for developing the portfolio of climate-smart practices and technologies for each block and village. From this survey, variables that were applicable to all farm households (i.e. where all farm households surveyed had an answer, either binary (yes/no) or continuous) were selected based on their resources available, their livelihood activities and cropping practices.

Village committees comprising of farmers, researchers and local planners were formed in consultation with local community for prioritising and implementing key climate-smart interventions relevant for the community as different farmer typologies. Farmers' prioritisation and willingness to pay for climate smart agriculture technologies was also carried out through a choice experiment by the International Food Policy Research Institute (IFPRI) and CIMMYT.

The practices below are rated based on their *Food Security (FS)*, *Climate Risk Management (CR)*, *Adaptation (A)* and *Mitigation (M)* potential.

Climate-smart agriculture practice/technologies	FS	CR	A	M
<b>Direct seeded rice:</b> Traditional rice cultivation involves sprouting rice in a nursery and then transplanting the seedlings into an intensively tilled field with standing water. With direct seeded rice, the rice seeds are sown directly in dry seedbed just like any other upland crop. This eliminates the laborious process of manually transplanting seedlings, significantly reduces the crop's water requirements and improves the soil's physical conditions.	x	xx	xxx	xx
<b>Alternate wetting and drying in rice:</b> In alternate wetting and drying, rice fields are alternately flooded and drained. The use of a monitoring instrument like a tensiometer can help farmers decide when to irrigate their fields. Alternate wet and drying reduces methane emissions by an average of 48 percent compared to continuous flooding. Combining this with precision fertilizer tools can further reduce greenhouse gas emissions.	xx	x	xxx	xxx

contd...

Climate-smart agriculture practice/technologies	FS	CR	A	M
<b>ICT services to access weather and agro advisories:</b> <i>M-Solution</i> is CCAFS supported ICT-based climate and agro advisory project being piloted in Climate-Smart Villages by CIMMYT, together with Kisan Sanchar as the implementation partner and IFFCO Kisan Sanchar Limited (IKSL) as a content partner. Farmers get voice and text messages that inform them of weather forecasts, new seed varieties, climate smart farming practices and tips on conservation agriculture. The project aims to document farmers' perceptions on increasingly erratic weather events and to understand if the information they receive helps in overall behaviour change towards adapting to climate change and in the uptake of new practices and technology. The project ensured the inclusion of women farmers right from the onset. Many have said it is a vital source of information for them on climate change and agriculture.	xx	xxx	x	
<b>Zero-tillage:</b> Zero-till or no-till farming is a way of growing crops without disturbing the soil through tillage. It increases the amount of water that infiltrates into the soil and increases organic matter retention and the cycling of nutrients in the soil. Zero-tillage improves soil properties, making it more resilient. <b>A CCAFS-CIMMYT study</b> comparing zero-tillage and conventional tillage in Haryana showed that zero-tillage provided both economic and climate gains. Results show that farmers can save approximately USD79 per hectare in terms of total production costs and increase net revenue of about USD 97.5 per hectare under zero-tillage land compared to conventional tillage. The study shows that shifting from conventional tillage to zero-tillage based wheat production reduces greenhouse gas emissions by 1.5 Mg CO <sub>2</sub> -eq per hectare per season (Aryal et al, 2014). Zero-tillage also helps in buffering the terminal heat effects which is one of the key climate change related constraints in wheat production in Haryana.	xx	xx	xxx	xx
<b>Laser land levelling:</b> A laser-leveller is a tractor-towed, laser-controlled device that achieves an exceptionally flat surface. Levelling the field ensures equitable reach and distribution of water and increases crop productivity. It also increases energy efficiency as less water means less need to run electric pumps. Most farmers in Haryana rent the equipment on an hourly basis. Farmers pay between 600-700 Rupees an hour to use the machinery. The practice of laser-land levelling has increased exponentially in the state. In Haryana, at the current adoption scale, the estimated amount of irrigation water saving is 933 million cubic meters per year. The estimated greenhouse gas mitigation is 163,600 MT of CO <sub>2</sub> -eq per year (CIMMYT-CCAFS, 2014).	xx	xx	xx	xxx
<b>Residue management/mulching:</b> Crop residue mulching is a system of maintaining a protective cover of vegetative residues and stubble on the soil surface. It adds to soil organic matter, which improves the quality of the seedbed and increases the water infiltration and retention capacity of the soil. Rice crop residue burning is one of the major issues in Haryana. Using innovative planting machinery like Turbo Happy Seeder, crops can be directly drilled without tillage while residue on surface acts as mulch.	xx	xx	xx	xxx

contd...

Climate-smart agriculture practice/technologies	FS	CR	A	M
<b>Crop diversification:</b> The aim of crop diversification is to increase farmers' crop portfolio so they are not dependent on a single crop for an income. This also diversifies a farmer's climate risk and contributes to increased household food security. Also, the innovative crop portfolio and system optimisation based diversification options help in sustainable intensification. Introducing legumes in the crop rotation cycle helps fix Nitrogen in the soil.	xxx	xxx	x	x
<b>Agroforestry:</b> Planting trees with crops or vegetables helps sequester carbon in the soil and prevent soil erosion. Trees provide shade to crops and are a source of timber, fruit, fodder and fuel-wood for farmers. They enhance biodiversity by providing habitats to varied species of birds, insects and animals and contribute to a healthy ecological landscape.	x		xxx	xxx
<b>Precision nutrient management:</b> Tools such as Nutrient Expert Decision Support Tool, Leaf Colour Chart and GreenSeeker sensors are used by farmers to determine optimum fertilizer dosage for crops and assess crop vitality. Overuse of fertilizers increase production costs, damage the soil, contaminate groundwater and add to greenhouse gas emissions.	xxx		x	xxx
<ul style="list-style-type: none"> <li>• <b>Nutrient Expert-decision support tool</b> helps farmers decide location-specific use of correct fertilizers in the hands of individual farmers. This site-specific nutrient management tool adds value to soil testing and guide farmers for precision prescriptions even in absence of farmer access to soil testing. The Nutrient Expert is interactive software and is available for free use on websites.</li> </ul>	xxx		x	xxx
<ul style="list-style-type: none"> <li>• <b>GreenSeeker</b> is a handheld, easy to use crop sensor that is easily calibrated locally. When held above the crop canopy, it calculates the Normalised Difference Vegetation Index (NDVI) which suggests the crop health and nitrogen requirement for a particular plot/field. Using GreenSeeker, farmers optimise the fertilizer N use increase crop yield and profits as well as reduce environmental foot prints.</li> </ul>	xxx		x	xxx
<ul style="list-style-type: none"> <li>• <b>Leaf color chart</b> is a visual chart used for measuring the greenness of the leaves to quantify the nitrogen to be applied to rice fields to get a maximum productivity. It is also suitable for maize and wheat and provides farmers with a good diagnostic tool for detecting nitrogen deficiency.</li> </ul>	xxx		x	xxx

*xxx-high potential; xx-medium potential; x-reasonable potential*

# Farmers' Testimonials from Climate-Smart Villages

## Climate-Smart Villages in Nilokheri

Moodi, Sagga, Narayana, Galib Kheri, Birnarayana, Ganger, Pakhana, Sandhir, Taraori, Barana, Pujaam, Anjanthali

## Nilokheri is a municipal town in Karnal district

Population: 16,400 (52 percent males and 48 percent females)

Average literacy rate: 73 percent

CSA practice/technologies in Nilokheri	No. of households	Area (Ha)
Laser land levelling	3840	4106
Changes in crop variety and stress tolerant varieties	840	1561
Zero-tillage	454	1361
Crop diversification with legume integration	395	751
ICT services to access weather forecasts	146	-
Site specific nutrient management	78	30
Direct seeded rice	65	85
Nutrient expert decision support tool for maize and wheat	50	25
Alternate wetting and drying	15	40
Residue mulching	15	50
GreenSeeker	13	56

36-year-old Harpreet Singh (right) from Birnarayana village is an early adopter of the alternate wetting and drying method. He uses a tensiometer to determine when he needs to irrigate rice fields.

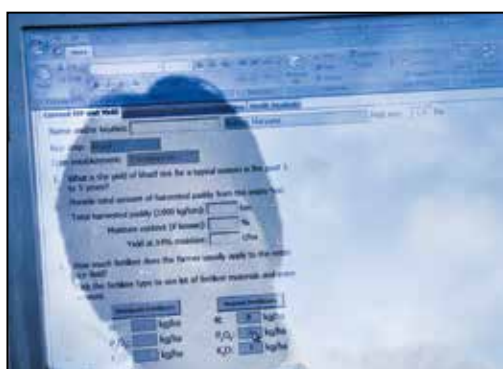
“This year the temperatures have been high and rain has been scarce. Direct-seeded rice and alternate wetting and drying methods help me save on water by almost 30 percent. The Climate-Smart Village programme has linked me to scientists and researchers to understand how climate-smart interventions can help increase yields while using resources sustainably.”





Ruby Mehla and her husband Vinod Kumar (right) practice climate-smart agriculture on their farm in Anjanthali village in Karnal, Haryana.

“ I don't work on the fields myself but through the voice and text messages I receive through the ICT agromet service on my mobile phone, I learn about good farm practices, rain forecasts and what new seed varieties are available. I can now discuss these things with my husband and I feel more informed. I think it's important for women to be able to access these services, says Ruby. ”



Nutrient Expert-Decision support tool (computer screen on left) is a site-specific nutrient management tool. It adds value to soil testing and guides farmers on precision prescriptions even in absence of farmers being able to access soil testing. The Nutrient Expert is an interactive software developed and validated by IPNI and CIMMYT together with NARES and is available for free use.

### Climate Smart Villages in Gharaunda

Unchasamana, Kutail, Dahaa, Bastada

Gharaunda is a municipal committee in Karnal district. Population: 30,179 (males 54 percent and females 46 percent) Average literacy rate: 67 percent

CSA practices/technologies in Gharaunda	No. of households	Area (Ha)
Laser land levelling	2170	3500
Zero-tillage	307	835
Integrated nutrient management	159	768
ICT services to access weather forecasts	90	-
Crop diversification with legume integration	70	92
Alternate wetting and drying	45	32
Crop insurance	44	116
Nutrient expert decision support tool	9	9
GreenSeeker	9	18
Changes in crop varieties and stress tolerant varieties	6	4
Site specific nutrient management	4	2
Direct seeded rice	4	10
Residue mulching	2	4

The GreenSeeker (right) is a handheld, easy to use, crop sensor that is easily calibrated locally for precision nitrogen prescriptions. When held above the crop canopy, it calculates the Normalised Difference Vegetation Index (NDVI) which suggests the crop health and nitrogen requirement for a particular field. Using this device, farmers can optimise their nitrogen fertilizer use. Through efficient fertilizer use, farmers can save costs, but also reduce the greenhouse gas emissions from their fields.



28-year-old Kuldeep Kharangar (bottom left) from Kutail village in Gharaunda, Karnal uses a Leaf-Color Chart (top left). By matching the shade of green of the leaf to the chart, he can gauge how much nitrogen fertilizer needs to be applied on the crop. Efficient nitrogen fertilizer use is critical to maintain soil health and also reduce resulting greenhouse gas emissions. Kharangar also practices direct-seeded rice and subscribes to the ICT-based agromet services. For him, the biggest gains from direct-seeded rice are the costs he saves on labour and water.

**Climate-Smart Villages in Indri**  
Ghidee, Chandsamnd, Kartarpur,  
Dabkoli, Musipuer, Badarpur,  
Chorpura, Kalsaura, Sayedchakra

**Indri is a municipal committee in Karnal, Haryana.**  
Population: 14,515 (males 53 percent and females 47 percent)  
Average literacy rate: 63 percent



Livestock and dairy are an integral part of the rural economy in Haryana. The State is home to the National Dairy Research Institute and the Central Institute for Research on Buffaloes. Farm animals are also vulnerable to climate change. Heat stress can exacerbate disease and lower milk production.



CSA practices/technologies in Indri	No. of households	Area (Ha)
Laser land levelling	2265	3832
ICT services to access weather forecasts	140	-
GreenSeeker	106	43
Zero-tillage	87	128
Integrated nutrient management	73	100
Change in crop variety and stress tolerant varieties	65	72
Crop diversification and legume integration	28	46
Direct seeded rice	23	27
Residue mulching	21	10

**Climate Smart Villages in Nissing**  
Sambhali, Balu

**Nissing is a municipal committee in Karnal district of Haryana.**

Population: 17,438 (male 54 percent, female 46 percent).

Average literacy rate: 74 percent

CSA practices/technologies in Nissing	No. of households	Area (Ha)
Changes in crop varieties and stress tolerant varieties	650	3000
Laser land levelling	520	1740
Integrated nutrient management	460	1800
Crop diversification with legume integration	400	760
ICT services to access weather forecasts	55	-
Zero-tillage	50	168
Crop diversification	15	180
Residue mulching	15	22
Direct seeded rice	10	10



48-year-old Ishwar Dayal (left) from Sambhali village in Karnal, grows trees on his vegetable garden. The practice of agroforestry has multiple benefits for farmers. Trees enrich the soil and help retain moisture. They sequester carbon in the soil and provide shade, fruit, fodder and timber.

# Scaling Out Climate-Smart Villages: The Way Forward

Initial testimonials from farmers and policymakers indicate promising opportunities to scale out the Climate-Smart Village model and to mainstream climate-smart agriculture into policies and development plans.

By documenting the evidence on the synergies and trade-offs of a portfolio of climate-smart agriculture interventions for a specific region, it is hoped that climate-smart agriculture can prepare farmers to respond to the uncertainty that comes with climate change and its impacts on food security and livelihoods.

Climate-Smart Agriculture Practices (CSAPs) are already prioritised and included in the agricultural plans of the state for scaling-out these interventions with the aim of increasing agricultural productivity and farmers' incomes, while safeguarding the natural resource base from exploitation and protecting biodiversity.

Dr. Bhoopendra Singh Hooda, Chief Minister, Haryana; Dr. R.S. Paroda, Chairman, Haryana Farmer's Commission; Dr. S. Ayyappan, Director General, ICAR and other officers visited and discussed Conservation Agriculture Research and mechanisation priorities with CIMMYT-CCAFS and ICAR-scientists at NDRI, Karnal, Haryana



Deputy Director General, Natural Resource Management, ICAR, Dr. A.K. Sikka visits Climate-Smart Villages in Karnal





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CCAFS and CIMMYT work with a wide range of partners in Climate-Smart Villages in Haryana



*From left to right:* Indian Council of Agricultural Research (ICAR); Department of Agriculture Government of Haryana; Haryana Farmers' Commission; CCS Haryana Agricultural University; International Plant Nutrition Institute; IFFCO Kisan Sanchar Ltd; Kisan Sanchar and Farmers' Cooperative