



# Broadening the Genetic Base of Cultivated Crops for Climate Change Adaptation: A Citizen Science Approach

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RESEARCH PROGRAM ON  
Climate Change,  
Agriculture and  
Food Security



## Background

With climatic uncertainty and extreme events such as floods, droughts, cyclones and heat waves projected to increase, agriculture and food security are more vulnerable than ever. This instability puts productivity, incomes and ecosystems at risk. Poor smallholder farming communities will be hit the hardest. The 'Seeds for Needs' initiative helps farmers cope with these uncertainties by exposing them to more crop varieties and increasing their knowledge about different useful traits. A basket of different crop species/varieties/landraces is the best insurance against the vagaries of the weather and biotic stresses. Crop diversity improves soil fertility, supports pollination, controls pests and diseases, and ensures yield and economic stability while contributing to food and nutritional security.

**'Seeds for Needs' is a global initiative of Bioversity International to reduce farmers' vulnerability in a scenario of climate change and other risks by using existing crop diversity.**

**The performance of the tested varieties under adverse climatic conditions and word-of-mouth have increased farmers' participation from 30 to 40,000 in only 5 years.**

## Our Approach

We encourage farmers to grow diverse crops, however, farmers do not always have access to information on quality planting material to choose different crops and their varieties that suit their conditions.

**Seeds for Needs-India** started in 2011 to:

- Expose farmers to more crops and varieties to enhance their first-hand knowledge about different traits and options available
- Ensure farmers have always access to quality planting material that fits their changing needs.

Cropping patterns are diversified by providing seeds of legumes, cereals, oilseeds and vegetables. To share information and capture feedback in a dynamic environment, digital technology is integrated into the programme. We strengthen their seed systems and seed-saving capacity through on-farm training.

**Selection of varieties:** Different sets of varieties are selected for different agroecological systems. The selection is done from a broad pool and major selection criteria include: varieties released for the region, past

Top image: A woman farmer from Chitrakoot, Uttar Pradesh

Credit: Bioversity International/  
S. Dsouza

performance of varieties in the region, those performing better in similar agroclimatic conditions, trait-based selection, etc.

**Citizen Science approach:** Two types of trials are conducted to assess the suitability of different varieties in a particular region.

**1. Crowdsourcing approach:**

Each farmer in the network is given three randomly-assigned varieties, out of a broader selection, to compare with their own varieties. As ‘citizen scientists’, farmers directly take part in the evaluation and selection of crop varieties on their own field and provide feedback on their preferred traits.

**2. Participatory Varietal Selection (PVS):**

These replicated trials of all the varieties are for quantitative evaluation. Feedback from non-participating farmers is also collected. The collected scientific data is statistically analyzed, which helps in selecting the varieties for crowdsourcing trials. Due to the strict scientific nature of data evaluation, the number of these trials is somewhat restricted.

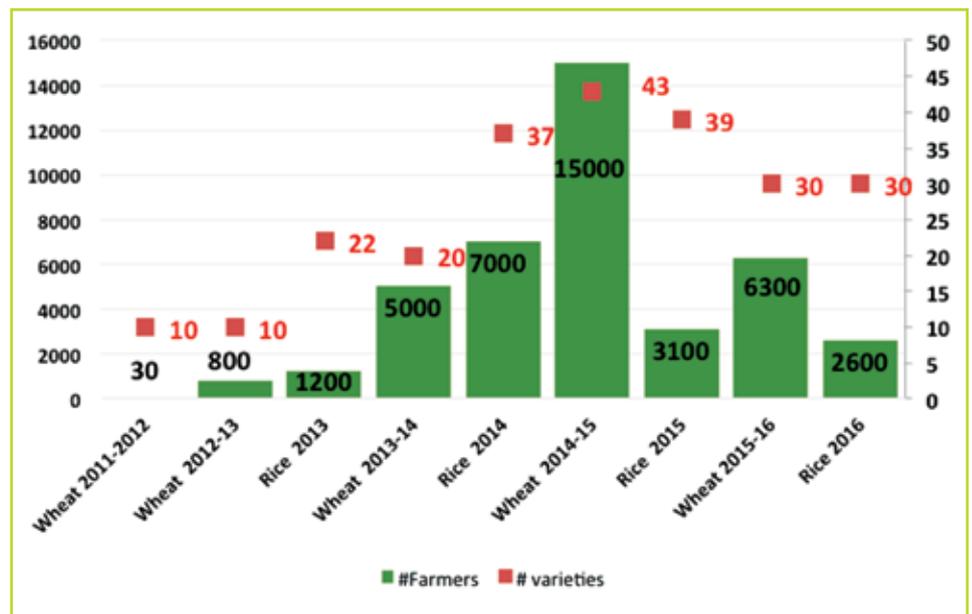
**Using Digital Tools**

Micro weather-recording devices known as iButtons, are installed at the trial locations to record temperature and humidity. This data is then correlated with farmers’ feedback. Bioversity International has also developed an online platform and app – ClimMob – that allows scientists to analyze the collected data and generate individual and collective preferences for the region. Field staff regularly records observations by using Android devices and upload the data directly from the farmers’ fields to the Open Data Kit (ODK) aggregate server, thus reducing the time taken between data collection and its availability to the scientists.

**Locations in India**

The programme started in 2011 in Vaishali district of Bihar, the site selected for climate-smart agriculture under the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). A large section of farmers in the area are resource-poor with poor land holdings. To gain faith and create a network of farmers, trials started with major crops in the area, i.e. wheat and rice. Though initially hesitant, farmers started participating and soon the initiative became popular. The activity was further expanded in the areas where climatic shocks are regular and farmers lack resources. Farmers from eastern and western Uttar Pradesh, Odisha, Madhya Pradesh and Chhattisgarh have participated. The biotic and abiotic stresses of these areas vary, and most of the farmers do not have access to the latest technologies.

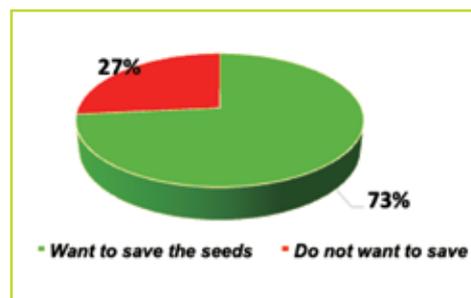
**Fig.1: Farmers’ participation in varietal diversification for wheat and rice.**



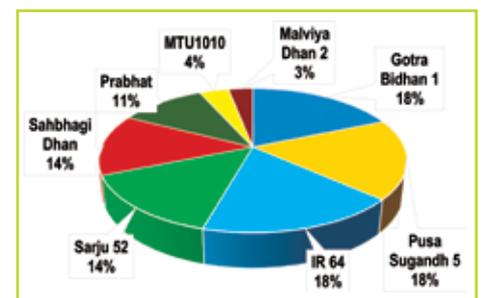
We began the experimentation with 30 farmers who were quite skeptical about growing so many varieties of wheat in Bihar. The results were so overwhelming that in the next 2 years, the number of farmers increased exponentially to 5,000. We even had 15,000 farmers participating at one point in the experiments.

Under this plan of action, approximately 2,500 farmers were trained in on-farm seed production. Based on these trainings, farmers produced their own seeds for 7 rice varieties and 13 wheat varieties in Bihar. These seeds were used in the trials in the subsequent year.

**Acceptance by Farmers in Bihar**



**Fig. 2: Farmers’ response to saving seeds in Vaishali district.**



**Fig. 3: Percentage of farmers who prefer different varieties**

A survey conducted in Bihar after 3 years of the initiative indicated that 96% farmers in Samastipur, 90% in Muzaffarpur and 73% in Vaishali districts (Fig 2) who participated in the trials, agreed on the concept of crop diversification. In other words, they wanted to grow the varieties which were evaluated in crowdsourcing and PVS trials. In the same survey, we also assessed the ranking of varieties based on farmers' preference (Fig. 3). Trainings on quality seed production of wheat and rice have helped farmers to retain their own seed of preferred varieties from this experimentation.

### Seeds for Needs: Chitrakoot (Uttar Pradesh) and Satna (Madhya Pradesh)

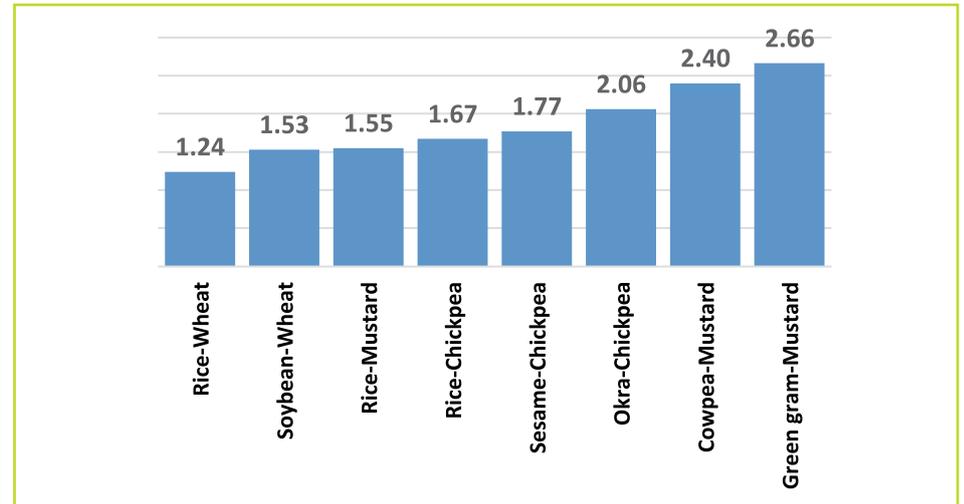
With the development of high-yielding varieties of cereals during the Green Revolution, crop diversity in both districts is shrinking. Vegetables, pulses and oilseeds have been replaced with rice and wheat. In collaboration with KVKs of Deendayal Research Institute, the seeds of 77 varieties of 22 crops have been distributed through the Seeds for Needs initiative.

The majority of farming is carried out under rainfed conditions. Satna has 27% irrigated land while Chitrakoot has 26%. In rice, both short- and long-duration varieties are tested. Most of the farmers prefer short-duration varieties since they require less water. Farmers who have sufficient water availability in their field, particularly in lowland areas, prefer long-duration varieties. Vegetables were provided in the areas where soil has high fertility and irrigation facilities are available. Other crops included in the programme are chickpea, soy bean, cowpea, green gram etc.

During 2015-16 *rabi*<sup>1</sup> season, 9 varieties of mustard were distributed to 1100 farmers in Satna. Mustard is not a prevalent crop but its successful cultivation in drought-affected region brought the smile back on farmers' faces. Mustard seems to fit well in the existing wheat-dominated cropping system due to its higher productivity under fewer irrigations and ability to tolerate frost.

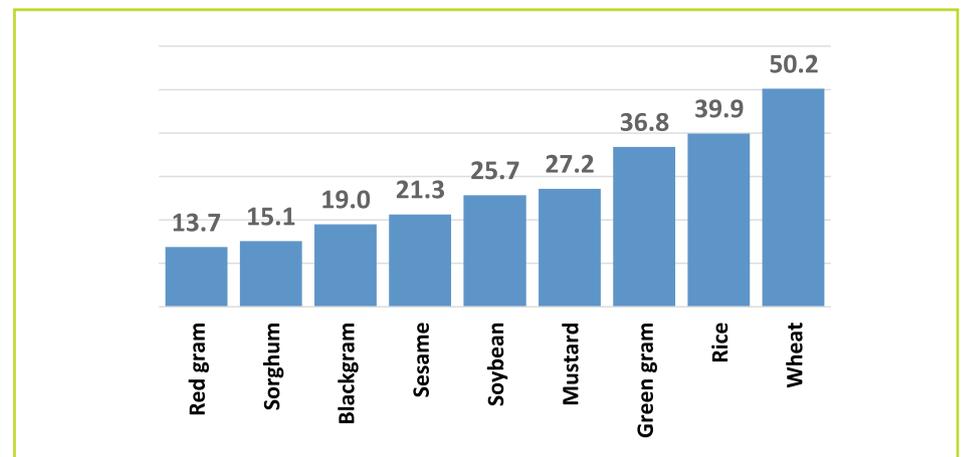
### Previous Studies and their Findings

Fig.4: Benefit-Cost Ratio



Under a national project, the National Initiative on Climate Resilient Agriculture (NICRA), KVK Satna found that inclusion of short-duration pulses, oilseeds and vegetables in crop sequence improved the economic return in comparison to the current dominating long-duration rice-wheat cropping sequence.

Fig.5: Increase in yield (%) replaced with the selected varieties



Another study revealed that replacing regular varieties with those selected based on specific requirements, increased yield in all the major crops. The study was conducted by including short-duration varieties in kharif<sup>1</sup> and drought tolerant in rabi season.

<sup>1</sup> The Indian cropping season is classified into two main seasons: kharif and rabi, based on the monsoon. The kharif cropping season is from July-October during the south-west monsoon and the rabi cropping season is from October-March (winter). The crops grown between March and June are summer crops. The terms originate from Arabic language where kharif means autumn and rabi means spring.

## Success Stories

**Horel Singh** of Vaishali district in Bihar has been farming for 30 years and has witnessed a lot of changes in the climate. Like many farmers in the area he mainly grows wheat and rice but also vegetables like bitter gourd, brinjal, jackfruit, cucumber, tomato, etc.



Credit: Bioversity International / S. Dsouza

He has been part of the Seeds for Needs initiative since 2011. Horel says “Bioversity International provided me with Rajendra Bhagwati and Pusa Sugandha – 5 varieties of rice which performed so well that I grew them for 3 years in a row. I have learnt that it is imperative to grow more varieties as even if one of the varieties fails, all is not lost. This programme has helped me to minimize my losses.”

**Jagdish Singh** of Mukundpur village, Vaishali district, Bihar, has been part



Credit: Bioversity International / N. Sharma

of the Seeds for Needs initiative since 2011. About the trials in his fields he says: “I assess all the varieties and then select the better varieties for use in the subsequent years.” Earlier he used to get the seeds from the market where often he could not find high-quality seeds. According to him, “It is imperative to try new varieties to counter the climate change we are experiencing in our area.” Due to dearth of labour in the area, he has also diversified to growing mango trees. He shares that over the years, crops like Sama (barnyard millet), Marua (finger millet), Kodo (millet), Arhar (lentils) have been lost and are not grown in the area anymore.

**Sunita Devi** of Ganiwan, Chitrakoot, a farmer for 20 years, joined Seeds for Needs in 2015. Referring to the three varieties of wheat that she received, she says “I particularly liked GW 273 and HD 2967 and would like to save seeds of these varieties for use in the next year.” She feels that



Credit: Bioversity International / S. Dsouza

the Community Seed Banks will be a boon for the farmers as they will be able to store seeds for a longer time. She is also cultivating vegetables to take care of the dietary requirements of her family.

**Sumitra** of Ganiwan, Chitrakoot received three varieties of wheat under crowdsourcing trials in 2015. She would like to store seeds of HI 1531 and MP 3173 varieties but shares that she is unable to store seeds for a longer time due to infestation. She would like to receive seeds for mustard, red lentils and chickpeas.



Credit: Bioversity International / P. Quek

## Looking ahead

The survey conducted in Bihar to validate the acceptability of diversification has reflected one side of the coin. We will also conduct an analysis to assess the initiative’s impact in terms of economic returns.

To take the initiative further and involve new farmers and sites, Bioversity International is exploring a business model with diverse stakeholders to create an e-platform. This platform will improve the services and value-addition and enhance the trust between seed suppliers and users.

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