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OBSERVATION ON SOCIO-ECONOMIC IMPACTS OF DROUGHT TOLERANT AND SHORT DURATION CULTIVARS OF MAIZETO MARGINAL LANDHOLDERS OF RAIN-FED HAMIRPUR REGION IN HIMACHAL PRADESH, INDIA

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ABSTRACT

Small scale farming dominates the agricultural land-scape of India. More than 80 per cent in India are marginal and smallholders having less than two ha farm size. Therefore, marginal and small farmers constitute a key group requiring attention in agriculture to increase their productivity and income for reducing hunger and poverty in India. On the basis of socio-economic impact of climatic resilient drought tolerant and short duration cultivars of Maize, research is to be designed to achieve it by primary and secondary data. Here in the study primary data was collected from structural questionnaire which has been framed with the help of expert suggestions, existing literature and concerned thesis on this topic. Mostly, questionnaire was framed on Likert-Scale, which has 5-point satisfaction level. Potential for adoption of drought tolerant and pest resistant cultivars of Wheat have been assessed on point scales for variables. This data have been collected through interview, observation, pilot survey and questionnaire. The impact assessment was done using both quantitative and qualitative techniques. They also faced a big challenge to cope with vulnerability of local varieties of Maize. The major themes under Climatic resilient Crop production technologies identified were enhanced crop yield and promote drought tolerant and short duration cultivars of Maize. The whole questionnaire was divided into independent variables viz; block, sex, caste, level of education, source of irrigation and land holding particulars. The data was analyzed using descriptive statistics (percentage, correlation, standard deviation, mean). For analysis of data, budgeting techniques and cost concepts (fixed cost, variable cost and total cost) and economic efficiency measures viz., Benefit-Cost Ratio, Net present value were used. Economics to be worked out based upon total cost of production per unit area and not on critical inputs alone. The results on the profile characteristics of the smart and non smart farmers are given in tables at appropriate place. Socio-economic impact of climate change implies the effect of recent changes in the climatic parameter on the livelihood of farmers. Hence, there is an increase in crop sowing area as well as improving economy of smart farmers. Thus, there is an upliftment of socio-economic status of smart farmers rather than non smart farmers of Nadaun and Bhoranj blocks of rain-fed Hamirpur district in Himachal Pradesh.

Keywords: Climate, Cultivars, Hamirpur, Maize, Marginal, Rain-fed, Socio-Economic

Introduction

After the Second World War, Pt. Nehru assumed, "Everything else can wait, but not the agriculture". The foundation of the Indian economy is Agriculture. India is a predominantly an agricultural country. Agriculture represents a core part of the Indian revenue and conclusively the largest livelihood source to the populace (Around 65 per cent). Agriculture is the primary income for an estimated 70% of the world's poor who live in rural areas (WB 2006; Acosta *et al*., 2016). The sector employs about 1.3 billion smallholders and landless workers (WB 2008), and yet the future of the sector is increasingly uncertain (Balisacan 1998). Climate variability and change will negatively impact on food security and agricultural livelihoods of the poorest farmers, fishers and forest-dependent people (Cabaraban, 2015). Coupled with land degradation, increasing energy and food prices, and reduced investment support (Smit *et al*., 1996), climate change will exacerbate poverty and food insecurity for the poorest smallholder farmers (Chandra *et al*., 2016). Added to other non-climatic stresses (e.g. poverty, inequality, and market shocks) climate change will make achieving Sustainable Development Goals on food security, livelihood, poverty reduction, health, and access to clean water more difficult to achieve for vulnerable communities (IPCC 2014). Agriculture can have both climate change adaptation and mitigation functions, while playing a beneficial role in economic growth and livelihoods (Lipper *et al*., 2014). Agriculture releases to the atmosphere significant amounts of CO_2, CH_4 and N_2O (Chhetri *et al*., 2012). Given the complexity of agricultural systems, *planned adaptation* measures or adaptation resulting from deliberate policy decisions and awareness from farm to global level are discussed in literature as key to reducing present and future vulnerability and climate impacts on livelihoods (Rosenberg, 1992). Adaptation on the other hand is recognized as socio-economic priority and concern for the majority of the most vulnerable developing countries (UN, 1992). This divide has also widened the political gap between commitment and action within international processes of the United Nations

Framework Convention on Climate Change (UNFCCC), as the world continues to try and hold the increase in global temperatures to below 2°C (Da Costa Pinheiro 2014; Eakin, 2005). Adaptive capacity (in relation to climate impacts on agriculture) is defined as the he ability of agricultural system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities (e.g. targeted diversification of production systems and livelihoods), or to cope with the consequences (IPCC 2001; Howden *et al*., 2007). Mitigation is identified as interventions to reduce greenhouse gas (GHG) sources and emissions and enhance GHG sinks (IPCC, 2001). CSA is defined by FAO (2010) as agriculture that sustainably increases productivity, resilience (adaptation), reduces/ removes GHGs (mitigation), and enhances achievement of national food security and development goals. Adaptation, mitigation and food security are the three key pillars of CSA (Lipper *et al*., 2014).

Agriculture is mainly practices in rainy season in Indian sinario (Hackman, 1985). Although, sixty per cent total cropped area is at a standstill rain-fed. There is a considerable expansion of food demand (IAASTD, 2009). In India, average food consumption is 550 gm per capita per day while the consequent figures in China and USA are 980 gm and 2580 gm, respectively (IPCC, 1990). Since, additional trauma on natural resources, decline in soil health, alteration in water table, salinity, ruin of irrigation water quality, pesticide resistance, altering situation of world agriculture trade and also the prospective changes in the global climate (Jakob *et al*., 2014; Kalfagianni and Duyck, 2015). Agriculture ensures livelihood security to more than 85 per cent of the rural populace in India (Ma *et al*., 2009). Nevertheless, with the massive escalation in human populace last fifty years, per capita allocate of natural resources has reduced radically (Lara and Champain, 2009). Miserably, the yield as well as productivity as well is not consequently hopeful in favor of transformation towards prosperity (Naess *et al*., 2005). The low yield can be endorsed to multiple factors resembling lessening of land and water resources, soil health dedradation, poor broadcasting of technology extension and awareness, insufficient venture in agriculture, unproductive input delivery system, and fragile information services (OCD, 2013). In India, there is tremendous decline in land holding as a result of 85 per cent small and marginal farmers turn out to be vulnerable (Paavola, 2008). The allocation of prosperity is also declining as the cost of cultivation is on the rise. That is why; there is a universal migration phenomenon of masses in search of livilihood from village to city (Dokken, 2014). In this context, the climate change could be a supplementary stressor to reach the objective of food and nutritional security. Thus, climate change could significantly hinder the pace of poverty reduction in India (Shiva, 2005). The implication is that climate change will play an important role in determining the food and livelihood security of farming community as well as equilibrium in mass and energy of agro-ecosystem globally (UNFCCC, 2008; Sultana, 2013).

Materials and Methods

The major theme drought tolerant and short duration cultivars of Maize is useful to enhance crop yield. The whole questionnaire was divided into independent variables viz.; block, sex, caste, level of education, source of irrigation and land holding particulars. The data was analyzed using descriptive statistics (percentage, correlation, standard deviation, mean). The results on the profile characteristics of the smart and non smart farmers are given in tables at appropriate place. Most families are dependent on agriculture for livelihood. All these were target to enhance the crop yield and livelihood status of marginal and smallholder farmer's resilience to climate stresses. In this paper, we present the analysis based on questions and plot harvest Method.

Study Area: The comprehensive study has been conducted in the Nadaun and Bhoranj blocks of rain-fed Hamirpur district, North Western Himalaya and is based on the primary data. To select the sample households, random sampling and plot harvest procedure was followed. To begin with, 10 villages, namely Badeher, Ghumaharata, Kutheraha, Jahu, Jangloo, Lag-Manwin, Ludder, Mann, Tal and Tareti were selected to represent different micro agro-climatic niches. A sample of households was selected randomly from these villages through proportional allocation method. On the basis of socio-economic impact of climatic resilient drought tolerant and short duration cultivars of Maize, research is to be designed to achieve it by primary data during 2018 to 2019 (Fig. 1).

Source: www.mapsofindia

Fig. 1: Map of Hamirpur district, Himachal Pradesh

Total 300 farmers were selected randomly and categorized into two categories viz., smart (KVK beneficiaries) and non smart farmers (KVK non-beneficiaries). For analysis of data, budgeting techniques and cost concepts (fixed cost, variable cost and total cost) and economic efficiency measures viz., Benefit-Cost Ratio, Net Present Value were used. Economics to be worked out based upon total cost of production per unit area and not on critical inputs alone. This data have been collected through interview, observation, pilot survey and questionnaire. The data was analyzed using descriptive statistics (percentage, correlation, standard deviation and mean). Socio-economic factors governing farmer's adoption behavior have been identified based on square-root of Average Square of deviation, when the deviations from the value of individual item in the series are obtained from arithmetic mean. The

primary data were collected from the respondents through personal interview method on pre-tested well structured questionnaire. Various methods have been developed for quantifying production and productivity of agricultural systems at research plot level and also for agricultural statistics at regional level. The sum of fixed costs and variable costs forms the 'total cost', when the total expenditure is deducted from the total returns (income), one gets the 'net profit'.

Net Profit/ Return = Total returns/income – Total cost/ expenditure

Benefit-Cost Ratio

This criterion indicates the rate of return per rupee invested in agro-technology enterprises. It was worked out by taking the net present value of expected future cash flows from investment and dividing by the investment's original cost (Rymbai *et al*., 2012). A ratio above one indicates that the investment will be profitable while a ratio below one means that it will not. A cost benefit ratio is also called a profitability index.

$$\text{BC Ratio} = \frac{\text{Present worth of Gross Returns}}{\text{Present worth of Growth Cost}}$$

Results and Discussion

Drought and pest infestation is one of the major limiting factors in obtaining high yield in wheat crops under rain-fed conditions of district Hamirpur. Maize cultivars viz.; Plant gene (2465); Girja; Proline (3440); 4640; Pologoldare best substitute to enhance crop yield. Smart marginal farmers were able to enhance their economy more by sowing cultivars of Maize as compared to local varieties.

Cost and Returns of climate drought tolerant and short duration cultivars of Maize

Plant gene (2465); Girja; Proline (3440); 4640; Pologold): The inception agro-technology implementation by smart farmers generates positive returns during the initial two year (2018-19 and 2019-20) onwards. The gross returns of agro-technology implemented were studied higher as compared to farmer practices under rainfed agro-ecosystem. The productivity of improved varieties of maize *viz.,* Vyas, Plant gene (2465), Girija, Proline (3440), 4640 and Pologold was found to be 22.2 Q/ha, 29.2Q/ha, 22.3Q/ha, 19.2Q/ha, 25.1Q/ha and 23.1Q/ha respectively. Net returns of improved varieties of maize were found to be Rs 9200, Rs 9300, Rs 9200, Rs 10700, Rs 14600 and Rs 11500 respectively (Table 4.1.3). It indicates that the net returns of improved varieties of maize increases with the increase of adoption behavior of smart farmers under rainfed conditions and it entails the principle of economies of scale.

Maize (High yielding, drought tolerant and pest resistance varieties: Plant gene (2465); Girja; Proline (3440); 4640; Pologold): The economic feasibility indicators of improved varieties of maize were presented in Table 4. The B-C ratio was estimated as 1.53:1 for Vyas, 1.54:1 for Plant gene, 1.53:1 for Girija, 1.51:1 for Proline (3440), 1.89:1 for 4640 and 1.52:1 for Pologold with an average ratio of 1.58:1. The benefit cost ratio was found to be more in the smart farmer's farms because of increase productivity of these farms. The B-C ratio analysis indicates that the investment in improved varieties of maize is economically viable and on an average Rs 1 investment brings Rs 1.58 returns. Maize cultivation is capital intensive. It was found to be economically feasible in the district.

Blocks: It is found from the table 2 that out of 168 respondents in Nadaun block, 100 per cent have strongly agreed opinion and out of 132 respondents in Bhoranj block, 56.8 per cent have neutral opinion followed by 22.7 per cent have disagree opinion, 18.9 per cent have strongly disagreed opinion, 1.5 per cent have strongly agreed opinion respectively. The per cent of block shows integrated nutrient and water management on soil test basis, recommended hybrids were cultivated and also had more plant height, cob size as well as grain yield and less disease susceptible.

Therefore, the calculated the value of Correlation is – 0.916. It shows negative relationship between recommended hybrids of Maize and Paddy as Kharif crop and Nadaun and Bhoranj block respectively. The reason behind that there is difference in demography, geography, edaphic characteristics, climate as well as adoption behavior of Maize recommended hybrids were cultivated and also had more plant height, cob size as well as grain yield and less disease susceptible among smart and non smart farmers of two blocks respectively.

Sex: It is found from the table 2 that out of 227 male respondents, 54.2 per cent have strongly agree followed by 26.9 per cent have neutral opinion, 10.1 per cent have disagreed opinion, 8.8 per cent have strongly disagreed opinion and out of 73 female respondents, 64.4 per cent have strongly agree followed by 19.2 per cent have neutral opinion, 9.6 per cent have disagreed opinion, 6.8 per cent have strongly disagreed opinion respectively.

Therefore, the calculated the value of Correlation is 0.076. It shows positive relationship between male and female smart and non smart farmers of both blocks. The reason behind that there is no difference in adoption behavior of shows integrated nutrient and water management on soil test basis, Maize recommended hybrids were cultivated and also had more plant height, cob size as well as grain yield and less disease susceptible under crop production system among opposite sexes of two blocks respectively.

Caste: It is found from the table 2 that out of 86 General Category respondents, 55.8 per cent have strongly agree followed by 20.9 per cent have neutral opinion, 14.0 per cent have disagreed opinion, 5.8 per cent have strongly disagreed opinion and out of 124 Other Backward Caste, 54.0 per cent have strongly agree followed by 28.2 per cent have neutral opinion, 8.9 per cent have disagreed and strongly disagree opinions each respectively. Out of 4 Schedule Tribe respondents, 100 per cent have strongly agreed opinion. The per cent of castes indicated adoption integrated nutrient and water management on soil test basis, Maize recommended hybrids were cultivated and also had more plant height, cob size as well as grain yield and less disease susceptible of Nadaun and Bhoranj respectively.

However, the calculated value of Correlation is 0.017. It shows positive relationship between Maize recommended hybrids as Kharif crop were cultivatedand castes of smart and non smart farmers of both blocks. The reason behind that Caste had no difference in adoption behavior of Maize recommended hybrids were cultivated under crop production system which was useful in rain-fed farming.

Average Annual Income: It is found from the table 2 that out of 40 (50,000-1,00,000 Rs) respondents, 55.0 per cent have neutral opinion followed by 20.0 per cent disagreed and strongly disagree opinions each, 5.0 per cent have strongly agreed opinion respectively. Out of 40 (1,00,001-1,50,000 Rs) respondents, 41.2 per cent have neutral opinion followed by 27.8 per cent have strongly agreed opinion, 18.6 per cent have disagreed opinion, 12.4 per cent have strongly disagreed opinion respectively. Out of 122 (1,50,001-2,00,000 Rs) respondents, 83.6 per cent have strongly agree opinion followed by 10.7 per cent have neutral opinion, 3.3 per cent have neutral opinion, 2.5 per cent have disagreed opinion respectively. Out of41 (>2,00,000 Rs) respondents, 95.1 per cent have strongly agree followed by 2.4 per cent have disagreed and strongly disagree opinions each respectively.

The per cent of annual income indicated the recommended hybrids were cultivatedas well as enhanced revenue of smart farmers as compared to non smart farmers in both blocks respectively.

However, the calculated the value of Correlation is 0.594. It indicates positive relationship between average annual income and Maize recommended hybrids crops of smart and non smart farmers of both blocks. The reason behind that integrated nutrient and water management on soil test basis, Maize recommended hybrids were cultivated and also had more plant height, cob size as well as grain yield and less disease susceptible.

Level of education: It is found from the table 2 that out of 5 primary respondents, 40.0 per cent have and neutral opinion and disagree opinions each followed by 20.0 per cent have strongly disagreed opinion respectively. Out of 73 primary respondents, 39.7 per cent have neutral opinion followed by 35.6 per cent have strongly agreed opinion, 15.1 per cent have disagreed opinion, 9.6 per cent have strongly disagreed opinion respectively. Out of 135 matriculate respondents, 63.0 per cent have strongly agreed opinion followed by 20.7 per cent have neutral opinion, 8.1 per cent have disagreed and strongly disagree opinions each respectively. Out of 87 Graduate/Postgraduate respondents, 67.8 per cent have strongly agree followed by 18.4 per cent have neutral opinion, 6.9 per cent have disagreed and strongly disagreed opinions each respectively. The per cent of level of education revealed the higher adoption behavior of Maize recommended hybrids by smart farmers rather than non smart farmers in both blocks respectively.

However, the calculated the value of Correlation is 0.239. It shows positive relationship between level of education and recommended hybrids of Kharif crop of smart and non smart farmers of both blocks. The reason behind that adoption behavior of integrated nutrient and water management on soil test basis, Maize recommended hybrids were cultivated and also had more plant height, cob size as well as grain yield and less disease susceptible adopted by matriculate, graduate or post graduate smart farmers under crop production system than illiterate non smart farmers of Nadaun and Bhoranj blocks respectively.

Source of Irrigation: It is found from the table 4.2.22 that out of 25 Poly-lined tanks respondents, 100 per cent have strongly agreed opinion respectively. Out of 106 RCC tanks respondents, 71.7 per cent have strongly agree followed by 17.0 per cent have neutral opinion, 6.6 per cent have disagreed opinion, 4.7 per cent have strongly disagreed opinion respectively. Out of 9 bore well respondents, 88.9 per cent have strongly agree opinion followed by 11.1 per cent have neutral opinion respectively. Out of 160 these source of irrigation respondents, 38.1 per cent have strongly agree opinion followed by 35.0 per cent have neutral opinion, 14.4 per cent have disagreed opinion, 12.5 per cent have strongly disagreed opinion respectively. The per cent of source of irrigation indicates the higher adoption behavior of recommended hybrids as Kharif crops by smart farmers as compared to non smart farmers in Nadaun and Bhoranj blocks respectively.

Therefore, the calculated the value of Correlation is –0.388. It indicates negative relationship between source of irrigation and recommended hybrids as Kharif crops of smart and non smart farmers of both blocks. The reason behind that cultivation recommended hybrids as Kharif crops were drought tolerant and disease resistant varieties which require less water for irrigation.

Land Holding Particulars (ha): It is found from the table 2that out of 213 Marginal (0.1-1.0 ha) respondents, 57.3 per cent have strongly agree opinion followed by 26.8 per cent have neutral opinion, 8.0 per cent have disagreed and strongly disagreed opinions each respectively. Out of Small 57 (1.1-2.0 ha) respondents, 50.9 per cent have strongly agreed opinion followed by 24.6 per cent have neutral opinion, 17.5 per cent have disagreed opinion, 7.0 per cent have strongly disagreed opinion respectively. Out of 18 Medium (2.1-4.0 ha) respondents, 72.2 per cent have strongly agree opinion followed by 16.7 per cent have agreed opinion, 5.6 per cent have disagreed and strongly disagreed opinions each respectively. Out of 12 Large (>4.0 ha) of respondents, 50.0 per cent have strongly agree opinion followed by 25.0 per cent have strongly disagreed opinion, 16.7 per cent have disagreed opinion, 8.3 per cent have neutral opinion respectively. The per cent of land holding particulars (ha) indicated the higher adoption behavior of oil yielding crops by smart farmers as compared to non smart farmers in Nadaun and Bhoranj blocks respectively.

Therefore, the calculated value of Correlation is –0.042. It shows negetive relationship between land holding particulars (ha) and oil yielding crops of smart and non smart farmers of both blocks. The reason behind that adoption of Maize recommended hybrids under crop production system in rain-fed area by marginal and small land holders over conventional local varieties of maize has strengthen economy of farmers of Nadaun and Bhoranj block respectively.

Table 1: Evaluation of economic aspects of drought tolerant and short duration cultivars of Maize

Varieties	Area under cultivation (ha)	Smart Farmer's Yield	Non Smart Farmer's Yield	% change in yield	Gross Cost	Gross Return	Net Return	BCR
Vyas	2.5	22.2	18.9	17.5	17300	26500	9200	1.53
Plant gene (2465)	3.0	29.2	18.4	58.7	17300	26600	9300	1.54
Girja	2.0	22.3	18.7	19.3	17400	26600	9200	1.53
Proline (3440)	3.0	19.2	17.1	12.3	20800	31500	10700	1.51

4640	3.5	25.1	18.5	35.7	16500	31100	14600	1.88
Pologold	3.0	23.1	18.8	22.9	22000	33500	11500	1.52

Table 2: Classification of respondents on the basis of different independent variables has their responses regarding integrated nutrient management (inm) on soil test basis, maize; Plant gene (2465); Girja; Proline (3440); 4640; Pologold or recommended hybrids were cultivated and also had more plant height and cob size

INDEPENDENT VARIABLES		SA	A	N	D	SDA	TOTAL	Correlations
Block	**Nadaun**	168 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	168 (100%)	–0.916
	Bhoranj	2 (1.5%)	0 (0.0%)	75 (56.8%)	30 (22.7%)	25 (18.9%)	132 (100%)	
	Total Respondents	170 (56.7%)	0 (0.0%)	75 (25.0%)	30 (10.0%)	25 (8.3%)	300 (100%)	
Sex	**Male**	123 (54.2%)	0 (0.0%)	61 (26.9%)	23 (10.1%)	20 (8.8%)	227 (100%)	0.076
	Female	47 (64.4%)	0 (0.0%)	14 (19.2%)	7 (9.6%)	5 (6.8%)	73 (100%)	
	Total Respondents	170 (56.7%)	0 (0.0%)	75 (25.0%)	30 (10.0%)	25 (8.3%)	300 (100%)	
Caste	**GC**	48 (55.8%)	0 (0.0%)	22 (25.6%)	7 (8.1%)	9 (10.5%)	86 (100%)	0.017
	OBC	51 (59.3%)	0 (0.0%)	18 (20.9%)	12 (14.0%)	5 (5.8%)	86 (100%)	
	SC	67 (54.0%)	0 (0.0%)	35 (28.2%)	11 (8.9%)	11 (8.9%)	124 (100%)	
	ST	4 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4 (100%)	
	Total Respondents	170 (56.7%)	0 (0.0%)	75 (25.0%)	30 (10.0%)	25 (8.3%)	300 (100%)	
Average Annual Income (Rs)	**50,000-1,00,000**	2 (5.0%)	0 (0.0%)	22 (55.0%)	8 (20.0%)	8 (20.0%)	40 (100%)	0.594
	1,00,001-1,50,000	27 (27.8%)	0 (0.0%)	40 (41.2%)	18 (18.6%)	12 (12.4%)	47 (100%)	
	1,50,001-2,00,000	102 (83.6%)	0 (0.0%)	13 (10.7%)	3 (2.5%)	4 (3.3%)	122 (100%)	
	>2,00,000	39 (95.1%)	0 (0.0%)	0 (0.0%)	1 (2.4%)	1 (2.4%)	41 (100%)	
	Total Respondents	170 (56.7%)	0 (0.0%)	75 (25.0%)	30 (10.0%)	25 (8.3%)	300 (100%)	
Level of education	**Primary**	0 (0.0%)	0 (0.0%)	2 (40.0%)	2 (40.0%)	1 (20.0%)	5 (100%)	0.239
	Middle	26 (35.6%)	0 (0.0%)	29 (39.7%)	11 (15.1%)	7 (9.6%)	73 (100%)	
	Matriculate	85 (63.0%)	0 (0.0%)	28 (20.7%)	11 (8.1%)	11 (8.1%)	135 (100%)	
	Graduate/Postgraduate	59 (67.8%)	0 (0.0%)	16 (18.4%)	6 (6.9%)	6 (6.9%)	87 (100%)	
	Total Respondents	170 (56.7%)	0 (0.0%)	75 (25.0%)	30 (10.0%)	25 (8.3%)	300 (100%)	
Source of Irrigation	**Poly-lined Tanks**	25 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	25 (100%)	–0.388
	RCC Tank	76 (71.7%)	0 (0.0%)	18 (17.0%)	7 (6.6%)	5 (4.7%)	106 (100%)	
	Bore Well	8 (88.9%)	0 (0.0%)	1 (11.1%)	0 (0.0%)	0 (0.0%)	9 (100%)	
	None of these	61 (38.1%)	0 (0.0%)	56 (35.0%)	23 (14.4%)	20 (12.5%)	160 (100%)	
	Total Respondents	170 (56.7%)	0 (0.0%)	75 (25.0%)	30 (10.0%)	25 (8.3%)	300 (100%)	
Land Holding Particulars (ha)	**Marginal (0.1-1.0 ha)**	122 (57.3%)	0 (0.0%)	57 (26.8%)	17 (8.0%)	17 (8.0%)	213 (100%)	–0.042
	Small (1.1-2.0 ha)	29 (50.9%)	0 (0.0%)	14 (24.6%)	10 (17.5%)	4 (7.0%)	57 (100%)	
	Medium (2.1-4.0 ha)	13 (72.2%)	0 (0.0%)	3 (16.7%)	1 (5.6%)	1 (5.6%)	18 (100%)	
	Large (>4.0 ha)	6 (50.0%)	0 (0.0%)	1 (8.3%)	2 (16.7%)	3 (25.0%)	12 (100%)	
	Total Respondents	170 (56.7%)	0 (0.0%)	75 (25.0%)	30 (10.0%)	25 (8.3%)	300 (100%)	

Abbreviations: SA - Strongly Agree; A - Agree; N - Neutral; D - Disagree; SDA - Strongly Disagree; GC - General Category; OBC - Other Backward Classes; SC - Schedule Caste; ST - Schedule Tribe

Note: Figures in parenthesis are percentage of row total; Rs - Indian Rupees; ha - hectare; **Source:** Primary Data Years, 2018-20

Table 3: Calculated results of mean $(\overline{X})$, standard deviation (σ) and chi-square (χ^2) for integrated nutrient management (inm) on soil test basis, maize**;** Plant gene (2465); Girja; Proline (3440); 4640; Pologold or recommended hybrids were cultivated and also had more plant height and cob size

Predictor	MEAN $(\overline{X})$	Standard Deviation (σ)	Chi-Square (χ^2)
Block	1.4400	0.49722	291.979 (d.f. 3)
Sex	1.2433	0.42981	2.593 (d.f. 3)
Caste	2.1533	0.85572	7.392 (d.f. 9)
Average Annual Income (Rs)	2.5467	0.88908	138.582 (d.f. 9)
Level of education	3.0133	0.77578	29.529 (d.f. 9)
Source of Irrigation	3.0133	1.10630	55.453 (d.f. 9)
Land Holding Particulars (ha)	1.4300	0.77918	12.633 (d.f. 9)

Note: Figures in parenthesis are degree of freedom; Rs - Indian Rupees; ha - hectare
Source: Primary Data Years, 2018-20

Block: on the basis of table 3, it is observed that the mean value is 1.4400 which shows higher side of mean score 3 on a five point continuum. The standard deviation is 0.49722, it is scattered more toward higher side. Therefore, the calculated value of chi-square is 291.979 at 5 per cent significance level and table value is 7.815, then difference is significant. Therefore, Null hypothesis is rejected.

Sex: on the basis of table 3, it is observed that the mean value is 1.2433 which shows higher side of mean score 3 on a five point continuum. The standard deviation is 0.42981, it is scattered more toward higher side. Therefore, the calculated value of chi-square is 2.593 at 5 per cent significance level and table value is 7.815, then difference is not significant. Therefore, Null hypothesis is accepted.

Caste: On the basis of table 3, it is observed that the mean value is 2.1533 which shows higher side of mean score 3 on a five point continuum. The standard deviation is 0.85572, it is scattered more toward higher side. Therefore, the calculated value of chi-square is 7.392 at 5 per cent significance level and table value is 16.919, then difference is not significant. Therefore, Null hypothesis is accepted.

Average annual income: On the basis of table 3, it is observed that the mean value is 2.5467 which shows higher side of mean score 3 on a five point continuum. The standard deviation is 0.88908, it is scattered more toward higher side. Therefore, the calculated value of chi-square is 138.582 at 5 per cent significance level and table value is 16.919, then difference is not significant. Therefore, Null hypothesis is accepted.

Level of education: On the basis of table 3, it is observed that the mean value is 3.0133 which shows higher side of mean score 3 on a five point continuum. The standard deviation is 0.77578, it is scattered more toward higher side. Therefore, the calculated value of chi-square is 29.529 at 5 per cent significance level and table value is 16.919, then difference is not significant. Therefore, Null hypothesis is accepted.

Source of irrigation: On the basis of table 3, it is observed that the mean value is 3.0133 which shows higher side of mean score 3 on a five point continuum. The standard deviation is 1.10630, it is scattered more toward higher side.

Therefore, the calculated value of chi-square is 55.453 at 5 per cent significance level and table value is 16.919, then difference is significant. Therefore, Null hypothesis is rejected.

Land holding particulars (ha): On the basis of table 3, it is observed that the mean value is 1.4300 which shows higher side of mean score 3 on a five point continuum. The standard deviation is 0.77918, it is scattered more toward higher side. Therefore, the calculated value of chi-square is 12.633 at 5 per cent significance level and table value is 16.919, then difference is not significant. Therefore, Null hypothesis is accepted.

Table 4: ANOVA

Model	SS	d.f.	MS	F	Significant
Regression	290.582	1	290.582	665.262	.000
Residual	130.165	298	0.437		
Total	420.747	299			

Abbreviations: SS **-** Sum of Squares; d.f. **-**Degrees of Freedom; MS**-**Mean Square; F**-**Friedman Test

The calculated value of F is compared with the table value. The calculated value of F is 290.582whichis greater than table value which is 161.4 at pre-assigned level of significance, the Null hypothesis is rejected (Table 4). Hence, the two samples drawn from population have not same variance. Analysis of Variance (ANOVA) depicted that Integrated Nutrient Management (INM) on soil test basis, recommended drought tolerant hybrids of Maize exposed to variability in rain-fed agro-ecosystem significantly. In response to these sensitivities, smart farmers were adapting ICAR-IARI recommended hybrid varieties of cereal crops to cope up with climatic vulnerabilities (uneven rainfall and fluctuation in temperature) and less susceptible to disease infestation as well as to enhance crop yield in rain-fed areas.

Conclusion

The findings of present study concluded that an instrument for inducing resilience to agro-ecosystem, drought tolerant and short duration cultivars of Maize had managed to imprint its positive and intended consequences on various dimensions affecting socio-economic and cultural aspects of farmers. The agro-technologies were able to make smart farmers to stand a step forward towards achieving climate resilience. Apart from this, hybrid cultivars of wheat under crop production over local varieties put in enhancement in social, economic and cultural sectors. Through a network of institutions operating in each locality, the agro-technology as drought tolerant and short duration cultivars of Maize gained acceleration in their adoption and production. Constraints in adoption added a pinch of salt to their achievement, as in any case constraints were interwoven in this case also. It can be simplified and deal with adequate strategies and proper design. These agro-technologies can be up-scaled and out-scaled in the similar agro-ecosystem to address the climate variability. The strategy suggested for up-scaling and out-scaling of such agro-technologies will help the researchers and policy makers in devising suitable policy framework.

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References

Acosta, L.A.; Eugenio, E.A.; Macandog, P.B.M.; Magcale-Macandog, D.B. and Lin, E.K. (2016). Loss and damage from typhoon-induced floods and landslides in the Philippines: Community Perceptions on climate impacts and adaptation options. International Journal of Global Warming 9(1):33-65.

Cabaraban, M.C. (2015). Strengthening resiliency and adaptation to climate change- an endline assessment. Quezon City, the Philippines: Oxfam in the Philippines.

Chandra, A.; McNamara, K.E.; Dargusch, P.; Damen, B.; Rioux, J.; Dallinger, J. and Bacudo, I. (2016). Resolving the UNFCCC divide on climate-smart agriculture. Carbon Management 7(5-6):295-299.

Chhetri, N.; Chaudhary, P.; Tiwari, P.R. and Yadaw, R.B. (2012). Institutional and technological innovation: Understanding agricultural adaptation to climate change in Nepal. Applied Geography 33: 142–150.

Da Costa Pinheiro, M.F. (2014). Timor-Leste's road to ASEAN. San Francisco, CA: The Asia Foundation. Available: http://asiafoundation.org/in-asia/2014/02/12/timor-lestes-road-to-asean/ (accessed 22/05/2014).

Eakin, H. (2005). Institutional change, climate risk, and rural vulnerability: cases from central Mexico. World Development 33(11): 1923–1938.

Dokken, V.R.; Mach, K.J.; Mastrandrea, M.D.; Bilir, T.E.; Chatterjee, M.; Ebi, K.L.; Estrada, Y.O.; Genova, R.C.; Girma, B.; Kissel, E.S.; Levy, A.N.; MacCracken, S.; Mastrandrea, P.R. and White, L.L. (eds.), Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK and New York, NY, USA: Cambridge University Press. pp. 485-533.

Eakin, H. (2005). Institutional change, climate risk, and rural vulnerability: cases from central Mexico. World Development 33(11): 1923–1938.

Hackman, J.R. (1985). Doing research that makes a difference. In: Lawler, E. E. (ed.). Doing research that is useful for theory and practice. New York: Lexington Books. pp.: 126 –149

IPCC (1990). Climate Change. The IPCC Scientific Assessment. Cambridge, UK and New York, USA: Cambridge University Press.

IPCC (2001): Climate Change 2001: Impacts and Adaptation. O. Canziani, O.; McCarthy, J.; Leary, N.; Dokken, D. and White, K. (eds.). Cambridge, MA and New York, NY: Cambridge UniversityPress.

IPCC (2014). Chapter 7: Food Security and Food Production Systems. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. IPCC Working Group II Contribution to AR5. Geneva: IPCC Secretariat, World Meteorological Organisation. Available: http://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Chap7_FGDall.pdf (accessed 19/04/2014).

IAASTD (2009). Agriculture at a crossroads. The global report of the International Assessment of Agricultural Knowledge, Science, and Technology. Washington, DC: Island Press.

Jakob, M.; Steckel, J.C.; Klasen, S.; Lay, J.; Grunewald, N.; Martínez-Zarzoso, I.; Renner, S. and Edenhofer, O. (2014). Feasible mitigation actions in developing countries. Nature Climate Change 4: 961–968.

Kalfagianni, A. and Duyck, S. (2015). The evolving role of agriculture in climate change negotiations: Progress and players. CCAFS Info Note. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark: CGIAR Research Programme on Climate Change, Agriculture and Food Security (CCAFS).

Lara Jr.; F.J. and Champain, P. (2009). Inclusive Peace in Muslim Mindanao: Revisiting the dynamics of conflict and exclusion. Davao, Philippines: International Alert.

Lipper, L.; Thornton, P.; Campbell, B.M.; Baedeker, T.; Braimoh, A.; Bwalya, M.; Torquebiau, E.F. (2014). Climate-smart agriculture for food security. Nature Climate Change 4: 1068–1072.

Ma X.; Xu, J.; Luo, Y.; Agrawal, S.P. and Li, J. (2009). Response of hydrological processes to land-cover and climate changes in Kejie watershed, South-west China. Hydrological Processes 23(8): 1179–1191.

Naess, L.O.; Bang, G.; Eriksen, S. and Vevatne, J. (2005). Institutional adaptation to climate change: Flood responses at the municipal level in Norway. Global Environmental Change 15: 125–138.

OCD (2013). Caraga Disaster Risk Reduction and Management Plan 2013-2017. Butuan, Philippines: Office of Civil Defence.

Paavola, J. (2008). Livelihoods, vulnerability and adaptation to climate change in Morogoro, Tanzania. Environmental Science & Policy 11(7): 642–654.

Rymbai, D.; Singh, R.; Feroze, S.M. and Bardoloi, R. (2012). Benefit-Cost Ratio Analysis of Pineapple Orchard in Meghalaya, Indian Journal of Hill Farming, 25(1): 9-12.