Comparison of Organic and Conventional Farmers Based on Integrated Climate Change Adaptive Capacity

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ABSTRACT

Climate change is a major threat to mankind due to its potentially harmful consequences to sustainable development. As the cultivation of crops is highly dependent on climate and water availability, the variations in climate adversely affect the agricultural production to a larger extent. Even though agriculture is a major contributor to cli-mate change, when done sustainably, can also be an option for adaptation and mitigation. There are many reports stating that organic farming has the potential for adapting as well as mitigating to climate change. So a study had been conducted to analyze the Integrated Adaptive Capacity (IAC) Index of the organic farming in comparison with conventional farming. The comparison of the mean scores of IAC Index of organic (81.05) and conventional farmers (46.35) clearly indicated that there exist a significant difference between the two groups and the organic farmers were better adapters. Also the organic farmers were found to be more adaptable with respect to the bio-physical, agricultural, ecological, socio-economic, technological and managerial factors of IAC index over that of the conventional farmers. Thus, the results of the study revealed that compared to conventional farmers, the organic farmers have better adaptive capacity for coping up with climate change.

Key words: *Climate change; Sustainable development; Adaptation; Mitigation; Integrated Adaptive Capacity Index;*

Extreme climatic events and weather abnormalities reporting from all over the world confirm that climate change is a reality. Several studies reported that climate change will have significant impacts on agriculture, natural resources, ecosystem and biodiversity (*Reynolds and Nierenberg, 2012; Vani and Kumar, 2016 and Simpson, 2016*). Even though agriculture is a major contributor to cli-mate change, when done sustainably, it can be helpful to mitigate and adapt with its e effects (*Smith, 2008; Amiraslany, 2010; FAO, 2011 and Semedo, 2016*).

According to *Semedo (2016)* agriculture will play a crucial role in addressing the planet's future challenges and is a key to providing important adaptation-mitigation synergies to climate change, as well as socio-economic and environmental co-benefits. According to *Guar (2016*), organic farming is one of the several approaches found to meet the objectives of sustainable agriculture and is based on various laws and certification programmes, which prohibit the use of almost all synthetic inputs and health of the soil is recognised as the central theme of the method. Several studies are there revealing the potential of organic farming for mitigating climate change and to assist in building resilience and adaptation (*FAO, 2007; IFOAM, 2009; Niggli et al., 2008; Fliessbach, 2007; Scialabba and Müller-Lindenlauf, 2010; Muller et al., 2016*).

In Kerala, recent years have witnessed stagnation in the growth of the agricultural sector due to extreme weather conditions like drought and other climatic variability (*Economic review, 2016*). The State Action Plan on Climate Change (SAPCC) reported that Kerala is severely threatened by climate change. The projected climate change scenario estimates that the atmospheric temperature across Kerala will rise by 2 degrees Celsius by the year 2050. As the state of Kerala has low base in food production and facing serious challenges in retaining the meagre area, proper adaptation strategies need to be developed in the event of projected temperature rise for sustenance of agricultural production (*Gopakumar, 2011*). In this context, a study to analyze the integrated adaptive capacity of the organic farming in comparison with conventional farming was carried out in Kerala.

METHODOLOGY

In the study, '*ex post-facto research design*' also known as '*after the fact*' research, was used which is a systematic inquiry in which the scientist does not have direct control over the variables, as the manifestations already happened. The study had been conducted in the selected agro-ecological units of Kerala, based on maximum and minimum number of certified organic farmers. The climate of Kerala is tropical monsoon with seasonally excessive rainfall and hot summer. The annual precipitation varies between 100 cm to 500 cm, with a state average of about 300 cm. It is the most developed state in India, as it ranks first in human development index, literacy rate and sex ratio. Kerala is categorized as a multi-hazard prone state due to its vulnerability to a multitude of disasters. The threat of global warming and its resultant climatic variations and environmental issues increases the vulnerability of the state (*Gopakumar, 2011; Economic Review, 2016*).

The State has rich bio-diversity and tropical rain forests spread in 13 Agro-Ecological Zones (AEZ) and 23 Agro-Ecological Units (AEU). An AEU is a homogeneous geographical area which has the production environment in terms of agro-climate, resource endowments and homogenous socio-economic conditions where majority of the farmers have similar production constraints and research needs (*Rajasekharan and Bhaskaran, 2016*). The study was conducted from among the organic and conventional farmers of four AE units' namely Southern coastal plain, South central laterites, Northern laterites and Northern foot hills. Total of 150 farmers, in which 75 organic and 75 conventional farmers were selected for the study.

As the direct assessment of adaptive capacity was not possible, an index based frame work is adopted for measuring the adaptive capacity in this study. The index based approach is the one in which the selection of factors/ indicators of adaptive capacity were done, quantified and then the overall index is calculated. To assess the integrated adaptive capacity in a quantitative manner, the first step was to identify the factors contributing to it. For this a set of key factors and the indicators of each factor which reduce the adverse outcomes of climate change, were identified, through extensive review of related studies, discussion with experts and interpretations of the researcher. The same was given for judges rating. The results obtained were scrutinised and the following six factors were selected for measuring the Integrative Adaptive Capacity, viz; bio-physical, agricultural, ecological, socio-economic, technological and managerial. A detailed pre-tested interview schedule had been prepared and the respondents were personally interviewed for data collection. The data collected from the respondents were scored, tabulated and analyzed with different statistical methods like mean, standard deviation, cumulative frequencies and percentage analysis using Excel and Statistical Package for Social Sciences (SPSS).

The factors and indicators of Integrative Adaptive Capacity Index selected are presented below:

Table 1. The factors and indicators of Integrative Adaptive Capacity Index

Factors	Indicators
Bio-Physical	*Vulnerability of the location*
	Sustainable water resources
	Water holding capacity
	Crop suitability
	Sustainable soil fertility
	Crop production potential
	Availability of inputs
	Pest and disease incidents
	Ownership of farm implements/machines
	Fallowing due to climatic stresses
Agricultural	*Climate friendly agricultural practices*
Ecological	*Conservation of biodiversity*
	Integration of agro-forestry
	Farming with minimum pollution
	Presence of beneficial organisms
	Avoiding the use of chemicals
	Sustainable waste management
	Recycling and reuse of resources
	Local resource utilization
	Effective utilization of solar energy
	Conservation of natural vegetation
Socio-Econnomics	*Access to basic services*
	Sustainable income generation
	Diversified sources of income
	Knowledge sharing with fellow farmers

	Opportunity for lifelong learning		Preservation of genetic resources
	Credit access		Utilization of trainings, seminars, internet, etc
	Crop insurance		Keeping a record of
	Utilization of family labor	Managerial	*Planning*
	Marketing of farm produces		Timely decision making
	Financial improvement through farming		Financial management
Technological	*Utilization of weather information*		Labour management
	Awareness about climate change		Farm supervision
	Use of micro irrigation		Preparing calendar of operations
	Adoption of innovative technologies		Crop surveillance
	Use of water harvesting / recharging structures		Information management
	Farm mechanization		Marketing management
	ITK related to climate change adaptation		*Integrating agri-business opportunities*

AGRICULTURAL

Climate-friendly agricultural practices

Crop production practices	Crop protection practices	Crop management practices
Crop rotation	Use of bio-control agents like: pseudomonas, trichoderma etc.	Changing cropping pattern according to climate change/ variability
Application of organic manures/ bio-fertilizers	Conservation of natural enemies	Diversified land use
Intercropping/ Mixed farming	Use of traps/ repellents	Selection of healthy planting material
Mulching	Hand/mechanical weeding	Use of climate resilient crops/ varieties
Legume integration	Use of farmer made preparations from natural ingredients	Soil testing based nutrient management
Integrated soil and water conservation measures	Field sanitation	Integration of live stock component
Timely Irrigation/ drainage	Soil sterilization / solarisation	Selection of crops according to market demand
Soil acidity /pH management-application of soil amendments	Live fencing/ protection wall	Use of alternate means of marketing
Raising and incorporation of green manure leaves/ crops	Protected cultivation/ rain shelter	Management of harvest & post harvest handling
Summer ploughing	Cover cropping	Processing and value addition

Each of the selected factors was measured by adding the scores obtained for the corresponding indicators. For the measurement of bio-physical, ecological, socio-economic, technological and managerial factors, a four point continuum is used namely most often, often, sometimes and never with scores of 3,2,1 and 0 respectively for positive statements and the reverse scoring pattern for the negative statements. The scores obtained for each statement were summed up to obtain the individual respondent's overall score. For agricultural factor, a total of 30 climate - friendly crop production, protection and management practices were given to the respondents and a score of 1 is given for adoption of each practice and 0 for no adoption. The score range for each factor aws 0-30 was and the total score range for all the six factors together was, 0-180. Thus the Integrated Adaptive Capacity (IAC) index was calculated as the composite measure of these six factors. For each dimension, the maximum possible score was 30, so the total maximum possible score was 306 = 180.

$$\text{IAC Index} = \left\{ \frac{(BP) + (AG) + (EC) + (SE) + (TC) + (MG)}{180} \right\} \times 100$$

Where as -

BP- Bio-Physical score, AG- Agricultural score,
EC- Ecological score, SE- Socio- Economic score,
TC- Technological score and MG- Managerial score

RESULTS AND DISCUSSION

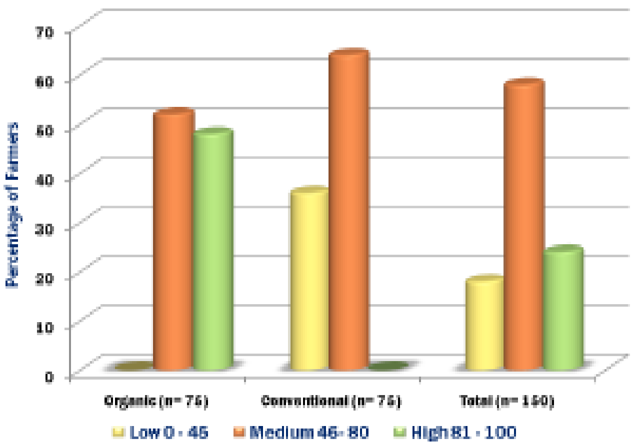
The farmers were categorised into three groups viz. Less Adaptable, Moderately Adaptable and Highly Adaptable, according to the Integrated Adaptive Capacity Index and the distribution is furnished in Table 3.

Table 3. Integrated Adaptive Capacity Index

Category	Range	Organic (n = 75)		Conventional (n = 75)		Total (n = 150)	
		No.	%	No.	%	No.	%
Less	0 - 45	0	0	27	36	27	18.0
Moderately Adaptable	46 - 80	39	52	48	64	87	58.0
Highly Adaptable	81- 100	36	48	0	0	36	24.0
Total	Q1=45 Q3=80	75	100	75	100	75	100

From the Table 3, it was evident that majority of the farmers (58%) were moderately adaptable, 24 percent of the farmers were highly adaptable and 18 percent were less adaptable. While analysing the adaptive capacity organic farmers, majority (52%) were 'moderately adaptable' and nearly half (48%) were 'highly adaptable'. For the conventional farmers, majority of (64%) were 'moderately adaptable' and 36 percent were less adaptable. The 'less adaptable' category of the organic group and 'highly adaptable' category of conventional group was found to be 'nil'. So it can be noted that organic farmers range from 'moderately adaptable' to 'highly adaptable' category whereas conventional farmers range from 'less adaptable' to 'moderately adaptable' category. Hence it can be inferred that the organic farmers are more adaptable to the consequences of climate change than conventional farmers.

Fig. 1. Distribution of respondents based on Integrated Adaptive Capacity Index



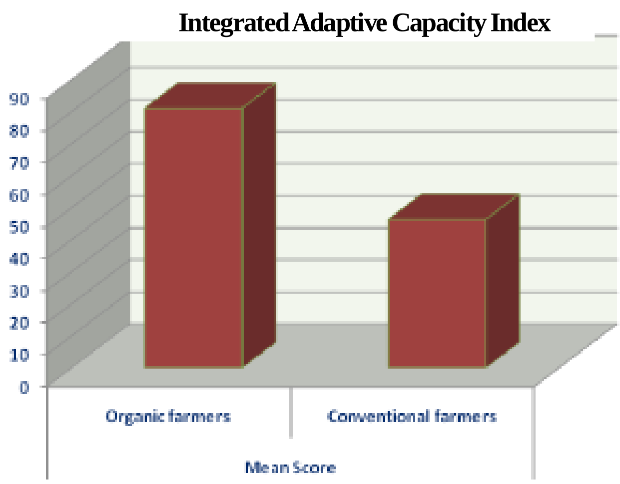
Comparison of Organic and Conventional farmers based on Integrated Adaptive Capacity Index.

Table 4. Comparison of Organic and Conventional farmers based on Integrated Adaptive Capacity Index (IACI)

Variable	Mean Score		'F' value
	Organic farmers (n =75)	Conventional farmers (n =75)	
IACI	81.05	46.35	3.905**

**. Significant at 1 percent level

Fig. 2. Comparison of Organic and Conventional farmers



The comparison of the mean scores of IAC index of organic (81.05) and conventional farmers (46.35) clearly indicated that there exist a significant difference between the two groups and the organic farmers were found to be more adaptive.

Hence it can be inferred that organic agriculture provides management practices that can help farmers to adapt with climate change through strengthening agro-ecosystems, diversifying crop and livestock production, and building farmers' ability to withstand the ill effects of climate change as well as helping the farmers to prevent and confront the climatic variability in a sustainable way.

Comparison of Organic and Conventional farmers based on the factors contributing to Integrated Adaptive Capacity Index (IACI): The mean scores with respect to the factors of Integrated Adaptive Capacity Index of the organic and conventional farmers are presented in Table 5.

From the Table 5, it is clear that there was significant difference between organic and conventional farmers, with respect to the six indicators of Integrated Adaptive Capacity Index, considered in this study. From the results, it could also be seen that the maximum variation between the organic and conventional farmers was with regard to the 'agricultural indicator'. This was attributed to the reason that, the techniques used in organic farming includes climate friendly techniques like rotating and diversifying crops, planting indigenous crop varieties, combining crop and livestock production, reducing soil tillage, use of organic manures, growing cover crops and agro forestry. Many of these practices enhance biodiversity, reduce waste and improve farmers' yields and incomes.

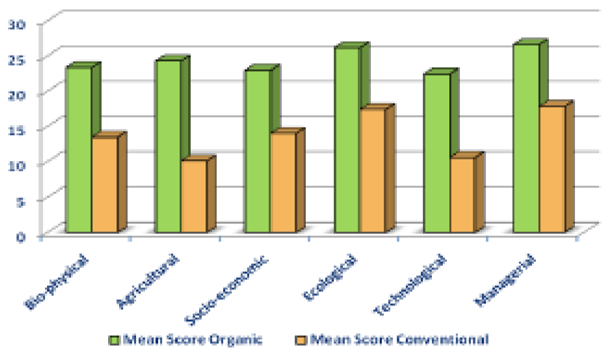
Table 5. Comparison of Organic and Conventional farmers based on the factors of Integrated Adaptive Capacity Index

Factors of IACI	Mean Score		z-value
	Organic	Conventional	
Bio-physical	23.35	13.47	6.98**
Agricultural	24.32	10.12	10.04**
Socio-economic	22.973	14.00	6.34**
Ecological	26.173	17.44	6.17**
Technological	22.453	10.573	8.40**
Managerial	26.626	17.84	6.21**

Z value: 1.96

The comparison of the mean scores of the farmers with respect to the bio-physical, agricultural, socio-economic, ecological, technological and managerial indicators of IAC index revealed that the organic farmers have better adaptive capacity than conventional farmers.

Fig. 3. Comparison of Organic and Conventional farmers based on the Factors of IAC Index



Comparison of organic and conventional farmers based on Soil test results : The farmers with maximum adaptive capacity index from same locality had been selected and detailed soil and plant analysis was conducted for testing nutrient availability and level of pesticide residue. The results of the pesticide residue level was found to be 'nil' for both organic and conventional farms, which indicated that the use of chemical pesticides was very limited and controlled among the farmers of the survey area.

Soil sample analysis had been conducted for knowing the nutrient availability in the soil and the results obtained are as follows:

Particulars	Organic		Conventional	
	Qnt.	Inference	Qnt	Inference
pH	5.36	Acidic	5.55	Acidic
CEC	0.08	Insufficient	0.08	Insu.fficient
Organic carbon (%)	3.375	More	2.85	More
Phosphorous (kg/ha)	32.15	More	3.61	Insufficient
Potassium (kg/ ha)	128.8	Medium	224.0	Medium
Calcium (ppm)	548	Normal	810	Normal
Magnesium (ppm)	50.50	Insufficient	37.75	Insufficient
Sulphur (ppm)	41.35	Normal	32.16	Normal
Iron (kg/ ha)	16.9	More	15.30	More
Manganese (ppm)	12.3	More	5.75	More
Zinc (ppm)	3.31	Normal	1.15	Normal
Copper (ppm)	5.88	More	4.26	More
Boron (ppm)	0.51	Normal	0.59	Normal

Qnt.= Quantity

From the table it can be seen that there is not much difference between organically and conventionally managed plots in the case of nutrient availability, even though the conventional farmers apply more chemical fertilisers.

CONCLUSION

The results of the study indicated that compared to conventional farmers, the organic farmers have better adaptation capacity for coping up with climate change. Thus from the study, it is concluded that, organic farming can be considered as one of the climate change adaptation strategies, as it provides a wide variety of benefits, along with additional benefits of biodiversity and environmental services, leading to safe food production and livelihood support. Promotion of organic farming helps in sustainable management of the natural resources, lowering of harmful environmental impacts, best resource use efficiency and effective waste management, leading to green economy.

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