REVIEW OF RESEARCH
ISSN: 2249-894X
IMPACT FACTOR : 5.7631(UIF)
UGC APPROVED JOURNAL NO. 48514
VOLUME - 8 | ISSUE - 9 | JUNE - 2019

CHANGES IN CROPPING PATTERN TO MITIGATE CLIMATE CHANGE RISK

Pawar Vandana K.
Ph.D. Scholar (Economics)
Sardar Patel University, VallabhVidynagar,Anand, Gujarat.

ABSTRACT:

Climate change phenomena are a global reality. It is serious challenge for agriculture. Majority of Indian population is dependent for their livelihood on agriculture and climate change has its impact adversely on agriculture. Literature review indicate that Indian agriculture will witness small negative impact caused by climate change in near future but in long run Indian agriculture may be seriously affected. Crop diversification is considered as an important instrument for acceleration of agricultural growth by promoting food security, generation of employment and income, poverty alleviation, judicious use of natural resources and ecological management in India. This paperstudy about the changes in cropping pattern in Gujarat as risk mitigation of climate change. A diversified cropping pattern has helped in improving farmer's income therefore cropping pattern diversification can be found as a risk minimisation strategy in present scenario.

KEYWORDS: *Agriculture and Environment, Climate Change, Crop diversification*

JEL Classification: *Q15, Q54, Q16*

1. INTRODUCTION

As said by Mahatma Gandhi, "India lives in villages and agriculture is the soul of Indian economy" before six decade ago. As we entered in the new millennium, the situation remains the same. Agriculture is the most important sector of Indian Economy. Indian agriculture sector contribute for 18 per cent in Gross Domestic Product (GDP) and provides 50 per cent employment to the countries workforce. The world's largest producer of pulses, rice, wheat, spices and spice products and second largest producer of fruits and vegetables is India (MEA, 2015). As far as production of paddy, wheat, pulses, groundnut, rapeseeds, natural products, vegetables, sugarcane, tea, jute, cotton, tobacco leaves India is in main three countries. But, the volatility of agricultural growth has declined substantially over timein India. In particular, production of cereals has become more vigorous to drought. As weather is most important factor in agriculture and it still depend on climate and weather in India, close to 52 per cent (73.2 million hectares area of 141.4 million hectares net sown area) of it is still not irrigated and rain fed. Currently India able to secure food supplies under these changing conditions. There will be more extreme weather conditions, with more droughts, heavy rainfall and storms in agricultural production regions as per climate model predicted. Which is imposing severs risk andpotential crop

failure. India's climate could become warmer under conditions of increased atmospheric carbon dioxide.Crop diversification is taken as an important tool to mitigate effect of climate change which would help to accelerate growth of agricultural in India by promoting food and nutritional security, income and employment generation, poverty alleviation, judicious use of natural resources and ecological management. In this paper, attempt was made to study changes in cropping pattern in Gujarat as risk mitigation of climate change. A diversified cropping pattern has helped in improving farmer's income therefore cropping pattern diversification can be found as a risk minimisation strategy in present scenario.

2. CLIMATE CHANGE AND AGRICULTURE

Climate change scenarios comprehend higher temperatures, changes in precipitation, and higher atmospheric CO2, concentrations;for agriculture there are three ways in which the Greenhouse Effect may be important. "First, increased atmospheric CO2 concentrations can have a direct effect on the growth rate of crop plants and weeds. Secondly, CO2 induced changes of climate may alter levels of temperature, rainfall and sunshine that can influence plant and animal productivity. Finally, rise in sea level may lead to loss of farmland by inundation and increasing salinity of groundwater in coastal areas(Mahato, 2014)."Shortages of water and land, deterioration in soil quality, and of course climate change induced temperature increases and rainfall variability, are all going to impact agriculture can be seen from figer-1. Climate change affect negatively on agriculture, are severe which is projected to have a great effect on food production and may threaten the food security and farmer's income.

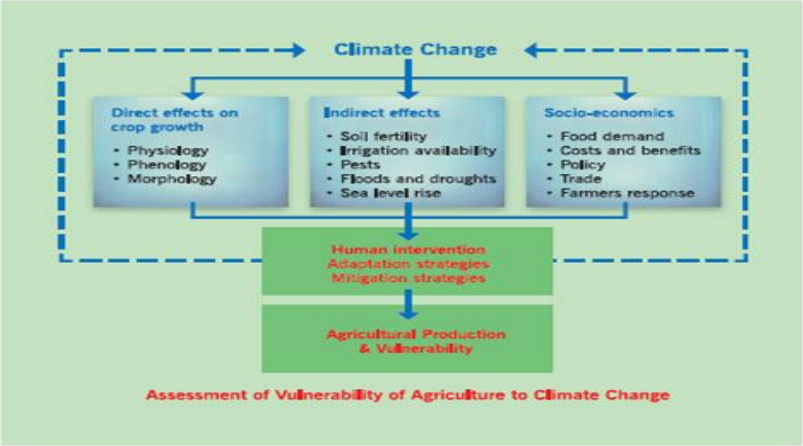

Figure-1 impact of climate change on Agriculture

3. IMPACT OF CLIMATE CHANGE ON WORLD'S AGRICULTURE

World agriculture faces a Failure within this century because of global warming. Overall, agricultural productivity for the entire world is projected to decline between 3 and 16 % by 2080. Developing countries, many of which have average temperatures that are already near or above crop tolerance levels, are predicted to suffer an average 10 to 25% decline in agricultural productivity the 2080s. Increased temperatures in many parts of Africa will reduce food production. The decrease in rainfall in Australia will reduce crop yields. The increase in rainfall combined with a moderate increase in temperatures in North America may benefit food production.The burden of climate change is likely to fall disproportionately on the poorer countries of the world (Mahato, 2014).

4. IMPACT OF CLIMATE CHANGE ON INDIA'S AGRICULTURE

India's agriculture is more dependent on monsoon from the ancient periods. Any change in monsoon trend severally affects agriculture.Even the growing temperature is affecting the Indian agriculture. A 1^{o}C growing temperature may reduce production of wheat, soybean, mustard, groundnut,

and potato by 3-7%. In the states of Jharkhand, Odisha and Chhattisgarh alone, rice production losses during severe droughts (about one year in five) average about 40% of total production, with an estimated value of $800 million (Pandey, 2007). The major impacts of climate change will be on rain fed or un-irrigated crops, which is cultivated in nearly 60% of cropland. A temperature rise by 0.5°C in winter temperature is projected to reduce rain fed wheat yield by 0.45 tonnes per hectare in India (Lal et al., 1998). Recent studies done at the Indian Agricultural Research Institute indicate the possibility of loss of 4 – 5 million tons in wheat production in future with every rise of 1°C temperature throughout the growing period. Increased droughts and floods are likely to increase production variability. Rice production is accounted to decrease by almost a tonne/hectare if the temperature goes up by 2°C. In Rajasthan, a 2°C rise in temperature was estimated to reduce production of Pearl Millet by 10-15%. Agriculture will be badly affected in the coastal regions of Gujarat and Maharashtra, as fertile areas are vulnerable to inundation and salinization (Mahato, 2014).Climate change is one of the risk factor for the agriculture production. Climate change is taking toll on India's agricultural productivity and farmer's income (Economic Survey, 2018).

5. CLIMATE CHANGE AND AGRICULTURE IN GUJARAT

Gujarat is in the extreme West of India. It has tropical climate, namely sub humid, arid and semi arid spread over different region of the state. North Gujarat region comprising of Kutch, part of Banaskantha, Mehsana and North Western part of Saurashtra have arid climate while the South Gujarat sub humid climate and in the rest of the state, semi arid climate. Temperature varies from 6 to 45$_0$C. Annual rainfall varies from 250mm in the North West and to more than 1500mm in south Gujarat. Out of 225 talukas, 56 talukas are drought prone.As seen in Table-1, Gujarat is divided into seven agro-climatic regions: (1) Southern Hills (Dangs and Valsad districts), having humid climate and 1793 mm average rainfall; (2) Southern Gujarat (Surat and Bharuch districts) with semi-arid climate, with 974 mm rainfall; (3) Middle Gujarat (Vadodara, Kheda and Panchmahal districts) having semi-arid climate, with 904 mm rainfall; (4) Northern Gujarat (Ahmedabad, Mehsana, Gandhinagar, Sabarkantha and Banaskantha districts) semiarid climate and average rainfall of 735mm; (5) North-west Arid (Kutch district) having extremely arid climate and 340 mm rainfall; (6) North Saurashtra (Amreli, Bhavnagar, Surendranagar, Jamnagar and Rajkot districts) having semiarid climate with 537 mm of average rainfall, and (7) South Saurashtra (Junagadh district); climate here is dry sub-humid with 844 mm average rainfall. Cultivation of crops in each agro-climatic sub-division is conditioned by water availability among others.

Table 1: Major Characteristics of Agro-Climatic Zones of Gujarat

Agro-climatic zone	Climate	Type of soil	Rainfall (mm)
South Gujarat	Semi arid to drysub-humid with heavy rain fall	Deep black with few patches of coastal alluvial, laterite and medium black	> 1500
South Gujarat	Semi arid	Deep black clayey	1000-1500
Middle Gujarat	Semi arid	Deep black, medium black to loamy sand	800-1000
North Gujarat	Arid to semi arid	Sandy loam to sandy	625-875
Bhal and Coastal Area	Arid to semi aridMedium black,	poorly drained and saline	625-1000
South Saurashtra	Dry sub humid Shallow	medium black calcareous	625-750
North Saurashtra	Dry sub humid Shallow	medium black	400-700
North West Gujarat	Arid to semi arid	Sandy and saline	250-500

6. CLIMATE CHANGE/ VARIABILITY IN GUJARAT

Rainfall variability: Gujarat state receives about 95% of its annual rainfall through the influence of SW monsoon during June to September period. The subdivision wise rainfall analysis revealed that Saurashtra and Kutch subdivision have mean annualrainfall of 428 mm with coefficient of variation of 44% and decreasing trend of –5% per 100 years while Gujarat sub division has mean annual rainfall of 863 mm with coefficient of variation of 32% and decreasing trend of –5% per 100 years.Temporal and spatial variability of rainfall analysis suggested occurrence of floods and drought side by side (Pandey et al 1999). Kutch having less rainfall (<350 mm) had highest annual rainfall variability (57%) while the Dangs having highest rainfall (1792 mm) had lowest rainfall variability (29%). On monthly basis, the coefficient of variability is still higher, being >100% in Kutch even in monsoon months. Among four months of monsoon months, July contributes 35-45% of annual rainfall. Kutch is having 80% chances of getting low rainfall (<500 mm), the Dang and Valsad have 70% chances of getting higher rainfall (>1500 mm). Kutch district and parts of Banaskantha, Patan, Surendranagar, Rajkot and Jamnagar districts were found prone to experience moderate to severe droughts in more than 30 % of the years (Pandey et., al. 1999).

Minimum Temperature: The annual average minimum temperature of Gujarat during 1957 was 20.8°C which increased to 22.0°C, which shows an increase in the minimum temperature of Gujarat by about 1.2°C. The annual average minimum temperature for winter months (November, December, January and February) of Gujarat has also increased by 1.28°C over the past 50 years.

Maximum Temperature: The annual average maximum temperature of Gujarat during 1957 was 32.7°C which increased to 33.4°C, with an increase in the maximum temperature of Gujarat by about 0.7°C. The annual average maximum temperature for summer months (March, April, May and June) of Gujarat showed an increase of about 1.2°C over the past 50 years . Most of the observatories exhibited a steady increasing trend in mean maximum temperature, decadal and 30 years moving averages during summer season in Gujarat. The decadal and the 30 years moving averages of mean maximum temperature during summer season increased.

Cold wave conditions have decreased considerably over the past decade representing an increase in night temperature. As compared to an average of 103 cold wave conditions in Saurashtra and Kutch region in the decade 1969-1978, the average cold wave conditions recorded in the past decade (1999-2008) were only 13. The rise in normal mean minimum temperature during winter season was found to 0.3ºC as compared to the annual mean minimum rise of 0.107ºC. The maximum rise in minimum temperature was found to be in winter months in comparison to other months of the year.

In the southern part of the Gujarat heat wave conditions have increased, while they have decreased in northern parts. Supply and management of water resources are uncertain because of Climate Change. Changes in climate variables like temperature increases affect the hydrologic cycle by directly increasing evaporation of available surface water and vegetation transpiration. Consequently, these changes can influence precipitation amounts, timings and intensity rates, and indirectly impact the fluidity and storage of water in surface and subsurface reservoirs (i.e., lakes, soil moisture and groundwater). Variation in the major long-term climate variables like air temperature, precipitation, and evapotranspiration impact on surface water resources directly and indirectly. There is complex relationship between climate change and groundwater. Highest inconsistency in rainfall could result in regular and continuous changes in groundwater levels, saline intrusion in coastal aquifers because of sea level rise and resource reduction (Singh and Kumar, 2010).

7. CROP CULTIVATION IN GUJARAT

Availability of water is important condition for the crop cultivation in each agro-climatic zone. 20% of the area of Gujarat is considered drought-prone, with inconsistency in rainfall.Land is progressively becoming anobligatory constraint to agricultural expansion. Irrigation helps improve

land yielding capacity via crop intensification. Cropping intensity increased from 105 per cent in early-1960s to 113 per cent until early- 1990s. By early-2000s, the cropping intensity declined to 111 per cent and again got increased to 118% in 2015-16. A noticeable rise was seen in a few pockets in the middle and south Gujarat, while it continued to decline in the Saurashtra region. Gujarat's agriculture is dominated by small landholdings even though it is depend on weather. In 1995-96, the average size of operational holdings was 2.6 ha, which further declined to 2.1 ha in 2015-16 of the total holdings, 63 per cent are of less than or equal to 2 ha. The total geographical area of 196.0 lakh ha of the State, 99.63 lakh ha (more than 50 per cent) was under net cultivable area in 2014-15. About 66 lakh ha area of the state is rain fed and two-third of the area of the state comes in arid and semi-arid tropics. The gross irrigated area was 56.14 lakh ha accounting for 45.97 per cent of total cropped area. Gross cropped area was around 1.17 million ha. The cropping intensity across the State was 118.23 per cent and irrigation intensity was 132.62 per cent. Among the major crops the largest cropped area was occupied by cotton (18.95 lakh ha) followed by groundnut (16.31 lakh ha); wheat (13.21 lakh ha); pulses (8.24 lakh ha); rice (7.81 lakh ha); bajra (7.79 lakh ha); castor (7.06 lakh ha) and maize (5.13 lakh ha). The area under fruits and vegetables together comprised of 2.16 lakh ha in 2015-16. The total operational land holders in the State were 48.86 lakh with an average of 2.03 ha per land holder. Among the landholders, 37.16 per cent were marginal farmers, 29.25 per cent were small farmers, 22.10 per cent were semi- medium farmers, 10.49 per cent were medium farmers and 1.21 per cent was large farmers.

Cropping pattern in Gujarat shows that up to early 1990s, main food crops were Bajara and Jowar and main non-food crops were Cotton and Groundnut. After liberalisation significant changes have taken place in Gujarat cropping pattern.

Area under cereals which was around 40 per cent of the gross cropped area (GCA) in the early-1980s, declined to 36 per cent during TE 1992-93. Currently, the share of cereals is only 27 per cent (a decline of about 7 lakh ha since TE 1992-93). Area share of bajra that had remained constant at around 13 per cent till early-1990s has reduced to half in TE 2014-15. Similarly, area under jowar declined from 6.2 per cent of GCA to only 1.3 per cent during this period in 2009-10 and further decreased to 1.02 per cent in TE 2014-15.

Table 4 Changes (%) in cropping pattern in Gujarat: TE 1982-83 to TE 2014-15 ('000 ha)

Crop	1982-83	1987-88	1992-93	1997-98	2003-04	2009-10	2014-15
Rice	5.44	5.78	6.12	6.67	5.99	6.18	7.14
Jowar	10.19	10.65	6.18	3.98	1.71	1.32	1.02
Bajra	13.80	14.82	13.32	11.8	9.56	6.50	5.56
Wheat	5.64	4.26	5.42	5.83	5.20	9.17	9.52
Maize	2.82	3.48	3.51	3.80	4.36	3.55	4.08
All cereals	40.27	40.64	35.52	32.76	27.27	26.77	27.32
Gram	0.96	0.71	0.84	0.98	0.78	1.48	2.12
Arhar	2.86	3.97	3.97	3.54	2.92	2.26	3.04
All pulses	7.87	8.43	8.66	8.11	7.04	6.79	8.96
Foodgrains	48.14	49.07	44.18	40.86	34.31	34.11	36.28
Groundnut	19.79	17.78	17.62	16.57	17.89	15.80	14.92
Sesamum	1.22	1.29	2.39	2.53	3.39	2.16	2.14
Castor	1.79	2.12	3.14	3.79	3.02	3.43	3.76
oilseeds	24.65	23.63	26.67	25.99	26.89	23.79	23.02
Sugarcane	1.02	1.27	1.62	2.13	1.840	1.76	1.72
Cotton	14.06	12.42	10.65	14.00	15.42	20.48	18.92
Tobacco	1.10	1.29	1.29	1.22	0.86	0.45	0.43
Spices	1.22	1.00	1.82	1.58	2.18	4.41	4.38
Other crops	9.81	11.32	13.77	14.22	18.50	15.00	18.50
GCA	10883	9484	10750	11088	10948	11787	11784

Source: Crop & Season Reports, Department of Agriculture, GoG (Various years)

On the other hand, average area under wheat has more than doubled, from 5.4 lakh ha in TE 1992-93 to nearly 9.5 lakh ha in TE 2014-15 and now shares 34 per cent of the total cereal area. Area under rice has remained more or less stable at 5-6 per cent of the GCA. areaunder groundnut that was 18-19 per cent of GCA throughout the 1980s, has declined to 15.8 per cent in 2014-15. Castor has gained from 2.1 per cent of GCA in TE 1982-83 to 3.5 per cent in TE 2014-15. Cotton was the dominant cash crops have 14 per cent of GCA early 1980. Considerable shifts in area under cotton have been witnessed during the post-reforms period. The share of cotton has doubled that is 20.5 per cent by TE 2014-15.About 12.2 lakh ha of area has been preoccupied by other crops, mainly coarse cereals and pulses, towards cotton in the post-reform period. Other crops that are substituting coarse cereals, pulses and oilseeds (to a lesser degree) are the spices, fruits, vegetables, floriculture and medicinal plants. The total area under spices rose from around 2 lakh ha in TE 1992-93 to 4.3 lakh ha in TE 2014-15. High-value crops such as spices, fruits, vegetables and medicinal plants occupy one-fifth of the GCA. The share of these crops was 8 per cent in TE 1982- 83, which rose to 14 per cent TE 1992-93 and further to 16 per cent in TE 2014-15. These trends advocate that cropping pattern in the state has changed in favor of superior, more remunerative cereals like wheat and high-value crops such as oilseeds, cotton, spices, fruits and vegetables, floricultural and medicinal plants. Groundnut and cotton, being the main cash crops, have retained their dominant position in the cropping pattern. Area under coarse cereals has declined because of their lack of competitiveness over other crops. On the other hand, area under oilseeds such as castor, mustard and sesame has expanded considerably, mainly as these crops provide better returns and encourage value-added agribusiness enterprises. Castor also has a high level of global demand. Overall, cropping pattern in the state after mid1990s is responding to the forces of globalization. Crop such as cotton, oilseeds, fruits, vegetables, spices and flowers, agreeable to processing and value addition, are on the increase.These crops essentially provide higher returns per unit of land, resulting in higher incomes and employment generation in the rural areas.

10. CONCLUSION

Cropping pattern in the state has changed in favour of superior, high-value crops such as cotton, spices, fruits and vegetables, floricultural and medicinal plants and more remunerative cereals like Wheat. In the cropping pattern groundnut and cotton the main cash crops have retained dominant position. Area under Oilseeds has expanded significantly and area under coarse and cereals has declined because of their lack of competitiveness in excess of other crops.

Thus crop diversification is anticipated to give a wider choice in the production of variety of crops in a given area so as to expand production related activities on various crops and also to lessen risk. Cropping pattern diversification can be said as a risk minimisation strategy due to climate change; because it clearly helps farmers raise their farm income.

REFERENCES:

Bhalla, and Singh, (2009) "Economic Liberalization and Indian Agriculture: A State wise Analysis." *Economic and Political Weekly,* 44 (52): 34-44.

Bhalla, G.S., and G. Singh, (2001), *Indian Agriculture: Four Decades of Development.* New Delhi, India: Sage Publications.

Burke, J.J., Sauveplane C and Moench M, (1999) "Groundwater Management and Socio-Economic Responses", Natural Resources Forum, 23: 303-313.

Chand, R., P. Shinoj, A. Gulati, and K. Ganguly, (2011) "Managing Food Inflation in India: Reforms and Policy Options." Policy Brief 35, New Delhi, India: National Centre for Agricultural Economics and Policy Research.

Custodi, Emilio A.A., (2003) *Intensive Use of Groundwater Challenges and Opportunities*, Balkema Publishers, Tokyo, pp.93-112.

CWP, (2005) Some Critical Issues on Groundwater in India, *Report by Centre for Water Policy*, June 2005, New Delhi.

Datta, P.S., (2005) "Groundwater Ethics for Its Sustainability", *Current Science*, 89(5): 812-817.

Department for Food and International Development (DFID). (2004) Adaptation to climate change: The right information can help the poor to cope. Global and local environment team, policy division

Economic Survey, (2018) Ministry of Finance Department of Economic Affairs Economic Division, Government of India.

Government of Gujarat, (2012) State Agriculture Profile, (http://agri.gujarat.gov.in/informations/state_agri_profile), Government of Gujarat.

Government OfIndia, (2017) Report of the state level Co-ordination Committee to develop strategies and road map to double the farmers' income by 2022.

http://www.ccsniam.gov.in/research/KCG%20Final%20report.pdf

Kannan, K.P., (2011) "Agricultural Development in an Emerging Non-Agrarian Regional Economy: Kerala's Challenges." *Economic and Political Weekly,* 46 (9): 64-70.

Kumar Rohitashw and GautamHarender Raj, (2014) Climate Change and its Impact on Agriculture Productivity in India, *Journal of Climatology and Wheatear Forecasting,* 2(1).

Lal R., Stewert B. and Uphoff N., (1998) *Climate change and global food security,* Boca Raton (FL): CRC Press.

Mahato, (2014) "Climate Change and its Impact on Agriculture".*International Journal of Scientific and Research Publication,* 4(4).

Ministry of External Affairs, (2015) India in Business.Investment and Technology Promotion Division, Government of India.

MOEF (2010) Climate Change and India: A 4x4 Assessment. Indian Network for Climate Change Assessment Report 2, Ministry of Environment & Forests, Government of India.

MOEF (2010) Climate Change and India: A 4*4 Assessment, a Sector land Regional Analysis for 2030s, Ministry of Environment & Forests, Government of India.

Naik, G., Qaim M., Subramanian, A. and Zilberman, D., (2005) "Bt Cotton Controversy, Some Paradoxes Explained." *Economic and Political Weekly,* 40 (15): 1514-1517.

Pandey, V; Patel H.R. and Patel V.J., (2007) impact assessment of climate change on wheat yield in Gujarat using CERES- Wheat model, *Journal of Agro meteorology*, 9(2):149--157.

Patel, H.R., M.M.Luangaria; B.I.Karande; S.B. Yadav; A.V.Shah; V.K.Sood and Vyaspaney, (2015) Climate Change and Its Impact on major Crops in Gujarat, *Journal of Agro meteorology,* 17(2):190-193.

Raghavan, K., (1966) A climatological study of severe heat waves in India, Indian Journal .Met.Geophys., 17(4): 581-586.

Ray K., M. Mohanty and J.R. Chincholikar, (2009) Climate Variability over Gujarat, India. ISPRS Archives XXXVIII-8/W3 Workshop Proceedings: Impact of Climate Change on Agriculture, 17-18 December, Ahmadabad, India. Space Applications Centre, Indian Space Research Organization,:38-43.

Report of the Working Group on Risk Management in Agriculture for the Eleventh Five year plan (2007-2012)

Singh, R. D. and C. P. Kumar, (2010) Impact of Climate Change on Groundwater Resources. Proceedings of 2nd National Ground Water Congress, 22nd March 2010, New Delhi, Central Groundwater Board, New Delhi, pp. 332-350.

Sophoclous, M., (2003) "Environmental Implications of Intensive Groundwater Use with Special Regard to Streams and Wetlands", in Ramon Llamas

Uunited Nation Environment Program, (2003) Ground Water is Susceptibility to Degradation, United Nations Environment Program, Kenya.