

Planned Adaptation Strategies and Climate Variability: Evidence from NSSO Households Level Data

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ABSTRACT

By using 70th round National Sample Survey Organisation unit level data, the study examines the role of planned adaptation strategies in the agriculture to deal with climate variability. The yield gap was calculated in technically advanced and backward farms across the agro climatic zones in India. The calculated yield gap results show that there is a higher potential to increase farm productivity up to 195 quintals per hectare in irrigated farmers in the Eastern Plateau and Hills Region. The study also found that only 12.32 & 14.63 percent landless and marginal farmers have taken the technical advice to increase farm productivity in the Western Dry zone and Islands zone. Therefore, the study recommended that these zones need special policy intervention to moderate degree of adverse impact of climate variability.

1. Introduction

An adaptation to climate change in agriculture aims to minimise farmers' vulnerability by improving their ability to cope with the adverse impact of climate change (Smith and Wandel, 2006). The degree of climate-induced vulnerability in the absence of new adaptation strategies will increase in the most backward and populated continents, viz., Africa and Asia (Humble et al., 2011). The literature claimed that if no preventive and curative measures were taken, then till the end of this century, agriculture in Asian and Africa would be very futile (Mendelsohn and Dinar, 2003; Rosenzweig and Parry, 1994; Downin, 1999; Smith and Wandel, 2006 and Humle et al., 2011). Rosenzweig and Parry (1994) suggested that there is great potential to increase food production under climate change in many regions of the world if adaptation strategies would be taken into consideration. The estimated results show that adaptation has potential to reduce food deficit in Africa from 50 to 20 percent and 15 to 25 percent in Asia (Mendelsohn and Dinar, 2003).

The adaptation strategies are broadly categorised into two groups, viz., (i) autonomous and (ii) planned. The adaptation that does not constitute a conscious response to climate stimuli, but it triggered by ecological changes in the natural system and key market or welfare changes in human system refers autonomous adaptation (IPCC, 2001b). An autonomous adaptation can be a reaction of a farmer against climate change that he/she the changes cropping pattern, uses different harvest and planting dates, uses of indigenous crop-pest management practices (Mendelsohn and Dinar, 2003). Planned adaptation strategies are conscious policy options or response strategies often multi-sectoral in nature, aimed at altering the adaptive capacity of the agricultural system or facilitating specific adaptation, i.e., deliberate crop selection and distribution, substitution crop selection and distribution, application of new technologies, new land management techniques and resource use efficiency related techniques (Reilly and Schimmelpfening, 1999 and Easterling, 1996).

Adger et al. (2003) also has categorised adaptation strategies into two categories, viz., (i) generic and (ii) specific. Generic adaptations include factors such as education, income, institutional, political and cultural which tend to be related to development in general. Specific adaptations refer to special interventions that specifically aim to reduce the impact of particular climate hazards. For example, a cyclone warning system is an intervention aimed at the forewarning population at risk due to cyclone (Sharma and Patwardhan, 2008). The root cause of climate change is uncertainty about them. Therefore, a rational farmer has a wider sense of adaptation strategy, which best fit for his land.

1.1 Adaptation Strategies in Agriculture: A Review

The role of adaptation strategies in the Indian agriculture has vitality. Because Indian agriculture has highly exposed, most sensitive and less resilient to climate change (IPCC, 2007b and Shengcai T. et al., 2011). Heterogeneous agro-climatic conditions (Gol, 2015), continuous decline in mean land size (1.15 hectare & 80 percent marginal farmers, but operated only 44 percent cropped area, Gol, 2015), majority of crop area under rainfed conditions (60 percent area under rainfed condition, Rao et al., 2011), variability in climatic factors, i.e., rainfall and temperature (Goswami et al., 2006 and Abebe et al., 2016), decline in agricultural investment (Singh P., 2014), higher dependency on farming for employment (57 percent population depended on agriculture for employment, NSSO, 2012), illiteracy (32.20 percent rural population has illiterate, Census, 2011) show that agriculture is no more profitable business in India if no adaptation measures have taken in the future (Hinkel J., 2011).

It is an extremely important that new adaptation strategies and measures should be increased to build up a capacity of a system to overcome external shocks or change (O'Brien et al., 2004b and Hahn et al., 2009). More precisely, the assessment of farm-level adaptation strategies is important as a tool for

managing a variety of risks associated with climate change in agriculture (Brenkert and Malone, 2005; Adger and Vincent, 2005; Vincent, 2007).

Studies on adaptation in agriculture explored following adaptation strategies. First, farming experiences have a long history of responding to climate change by developing a wide range of management practices, such as pre-monsoon dry seeding, stubble mulching, crop rotation and intercropping to cope with climate change (Hulme et al., 2011). Second, construction of micro water harvesting system across the country in response to abrupt climate fluctuations, such as drought. It ensured water supply in the off rainy season to not only agriculture but also domestic consumption (Brookes et al., 2005). Further, it also helps to reduce consumption of groundwater and helps in the maintaining water reserve for the future generation (Mendelsohn and Dinar, 2003). Third, crop diversification, i.e., mixed crop-livestock farming system, use of different seed varieties, changing planting and harvesting dates, mixing high productive drought-resistant varieties and high yield water sensitive crops have increased farm productivity in one hand and on the other hand, reduces the resource requirement and harnessed from climate change (Bradshaw et al., 2004). Fourth, improved irrigation intensity helps to reduce agricultural vulnerability to climate variability (Gupta et al., 2012 and Rosenzweig and Parry, 1994). This is evident in the Indian agricultural system after the green revolution (Ramasamy, J. and P. Moorthy, 2012). In India, with the help of improving irrigation technology, the cropped area of high irrigation intensive crops, i.e., rice, which and sugarcane has increased tremendously (Gol, 2012). It also reduced the dependency on monsoon rainfall and enhanced the degree of adaptive capacity (Mendelsohn and Dinar, 2003). Fifth, demographic features also have major determinants of farm productivity. In the low-lying area, farmers generally give preference to irrigate intensive food crops, viz., rice, wheat, and sugarcane etc., whereas in the up-lying areas, horticultural crops, apple, tea, mangoes, and peanuts are produced (Gol, 2012). Therefore, it is important that the cropping pattern should be in favor of geographic conditions to maintain area specific sustainability. Lastly, institutional access to credit, seeds and fertilizers are key contributing factors to reduce climate-induced vulnerability in the agriculture (Mruthyunjya and Praduman, 1989). Investment in the agriculture in terms of infrastructure development, i.e., check dams, expansion of canal irrigation and relaxation in the credit norms helps to increase farm productivity.

Based on the previous discussion, it is identified that climate change has a potential impact on the Indian farming system. Therefore, adaptation strategies, i.e., generic and specific have an important role to moderate the degree of vulnerability. An advanced farmer with equipped to advance training not only deal with climate variability/change, but also increase farmer productivity. Therefore, the present study aims to identify the impact of extensions services, i.e., agricultural training on farm productivity in both irrigated insured and unirrigated areas across the agro-climatic zones of India.

This paper is organised as follows. In the next section, the data set, information about the sources and technical aspects of the estimation model are discussed, which is followed by

results and discussion in section III. Concluding remarks are made in the final section.

2. Materials and Methods

2.1 Study Area

India, located in South Asia, is bordered by the Bay of Bengal, the Arabian Sea, the Indian Ocean, Pakistan, Bhutan, China, Nepal, Burma and Bangladesh. India is the world's 7th largest country by area and 2nd most populous country with more than 1.3 billion residents (world population reviewer, 2018). It has 3287469 square kilometre area with 943 gender ratio and 382 population density per square kilometre (Census, 2011). Further, India has geographically divided into 15 agro-climate zones (ACZs), 36 states and 640 districts (Appendix-A).

2.2 Data

The present study uses household level data obtained from 70th (January- December 2013) round of national sample survey organization (NSSO). Data was collected from 4529 villages and 70107 households. Information on various aspects of farming such as farming practices and preferences, availability of resources, awareness of technology, development, and access to modern technology were collected.

2.3 Estimation Method

The role of total factor productivity (TFP) growth that emerges from agricultural research & development, extension services, new knowledge and practices in achieving the multiple goals, brings to our focus that technology dissemination that provides us a provision scope to increase income at a farm level. Therefore, yield gap in the farmers who have taken agricultural training and those do not was calculated in the irrigated and unirrigated farming system in the all agro climatic zones of India by using the following equation (1).

$$Y_g = \left\{ 1 - \frac{Y_a}{Y_r} \right\} * 100$$

Where, Y_g , Y_a and Y_r are yield gap, actual mean yield and reference yield respectively. Actual mean yield are average of yield at farmers' plots, 90th percentile of yield distribution was used as reference yield for a given crop at a given ACZ during the reference period. Further, descriptive statistics was uses to estimate land size wise adaptation strategies to maximize farm productivity.

3. Results and Discussion

3.1 Agro Climatic Zone wise Land Size

Table 1 shows agro climatic zone wise land size. It highlights that the landless farmer (less than 0.002 hectares land) ranges from 29.52 percent in Southern Plateau and Hills Region to 63.47 percent in Western Dry Region. Marginal farmer (0.003-1 hectare land) ranges from 19.04 percent in Western Dry Region to 33.20 percent in Eastern Himalayan Region. Small farmer (1-2 hectare land) ranges from 7.06 percent in Lower Gangetic Plain Region to 24.49 percent in

Southern Plateau and Hills Region. Semi-medium farmer (2-4 hectare land) ranges from 2.45 percent in Lower Gangetic Plain Region to 12.52 percent in Upper Gangetic Plain Region. Medium farmer (4-10 hectares land) ranges from 0.48 percent in Western Dry Region to 12.35 percent in Upper Gangetic Plain Region. Large farmers (more than 10 hectares land)

range from zero percent in East Coast Plains and Hills Region to 2.75 percent in Upper Gangetic Plain Region. In totality, landless and marginal farmers are dominating to the Indian farming system. These farmers are highly vulnerable, have the least adaptive capacity and resources to sustain livelihoods.

Table 1: Agro Climatic Zone wise Land Size

ACZs	Landless	Marginal	Small	Semi-medium	Medium	Large	Total
WHR	60.56	24.44	9.65	3.74	1.47	0.14	100.00
EHR	40.05	33.20	21.26	4.45	1.02	0.02	100.00
LGPR	61.15	28.62	7.06	2.45	0.68	0.04	100.00
MGPR	45.79	29.02	15.14	7.35	2.50	0.20	100.00
UGPR	35.21	20.33	17.29	12.52	12.35	2.30	100.00
TGPR	32.73	23.73	18.01	14.14	9.32	2.07	100.00
EPHR	35.07	30.67	21.23	8.55	4.02	0.46	100.00
CPHR	38.24	30.24	19.25	8.35	3.22	0.70	100.00
WPHR	35.25	24.25	19.25	10.25	8.25	2.75	100.00
SPHR	29.52	28.84	24.49	11.53	4.59	1.03	100.00
ECPHR	44.13	26.93	23.21	2.29	3.44	0.00	100.00
WCPGR	54.84	27.50	10.22	6.15	0.99	0.30	100.00
GPHR	38.96	30.30	15.28	9.52	5.03	0.91	100.00
WDR	63.47	19.04	10.17	6.84	0.48	0.00	100.00
IR	41.31	29.19	17.81	7.83	3.34	0.52	100.00

Source: Estimated from NSSO 70th Round. Notes: WHR, EHR, LGPR, MGPR, UGPR, TGPR, EPHR, CPHR, WPHR, SPHR, ECPHR, WCPGR, GPHR, WDR & IR stands for Western Himalayan Region, Eastern Himalayan Region, Lower Gangetic Plain Region, Middle Gangetic Plain Region, Upper Gangetic Plain Region, Trans Gangetic Plain Region, Eastern Plateau and Hills Region, Central Plateau and Hills Region, Western Plateau and Hills Region, Southern Plateau and Hills Region, East Coast Plains and Hills Region, West Coast Plains and Ghat Region, Gujarat Plains and Hills Region, Western Dry Region and Island Region

3.2 Land Size with Farmers taken Agricultural Training

Table 2 shows land size wise, technically efficient farmers in the different agro climatic zones. It was found that there is a positive relationship between lower land size and skilled farmers. In other words, the share of farmers taken agricultural training also higher in the landless and marginal farmers. Landless skilled farmers were lowest (12.32 percent) in Western Dry Region, whereas highest in the Lower Gangetic Plain Region (54.52 percent). Marginal farmers were lowest in Iceland Region (14.63 percent), whereas highest in the East Coast Plains and Hills Region (47.83 percent). Small farmers were lowest in the Western Himalayan Region (3.13 percent), whereas highest in the East Coast Plains and Hills Region (34.78 percent). Further, semi-medium farmers were lowest the

East Coast Plains and Hills region (0.00 percent), whereas highest in the Iceland Region (19.51 percent). Furthermore, medium farmers were lowest in the Lower Plain Region and Central Plains and Hills Region (0.00 percent), whereas highest in the Gujarat Plains and Hills Region (17.33 percent). Lastly, large farmers were lowest in the Eastern Himalayan Region, East Coast Plains and Hills Region and Island Region (0.00 percent), whereas highest in the Trans Gangetic Plains Region (9.43 percent). In totality, it was found that there is a hill-shape relationship between land size and technical efficiency. Landless and marginal farmers have taken highest agricultural training/information from different government and non-government resources.

Table 2: Agro Climatic Zone and Land Size wise Farmers taken Agricultural Training in different Agro Climatic Zones (In Percentage)

ACZs	Landless	Marginal	Small	Semi-medium	Medium	Large	Total
WHR	43.75	29.69	3.13	10.91	9.38	3.14	100.00
EHR	27.85	36.53	28.54	4.34	2.74	0.00	100.00
LGPR	54.52	36.79	5.69	2.67	0.00	0.33	100.00
MGPR	29.75	43.75	12.75	11.00	1.75	1.00	100.00
UGPR	23.01	42.32	12.35	12.36	8.25	1.71	100.00

TGPR	16.35	27.04	22.01	10.70	14.47	9.43	100.00
EPHR	26.95	25.03	30.23	12.72	4.80	0.27	100.00
CPHR	36.25	45.25	12.32	5.32	0.00	0.86	100.00
WPHR	45.65	23.69	21.32	5.23	3.25	0.86	100.00
SPHR	20.41	28.84	30.88	12.06	6.12	1.69	100.00
ECPHR	17.39	47.83	34.78	0.00	0.00	0.00	100.00
WCPGR	34.33	40.80	5.97	6.96	5.97	5.97	100.00
GPHR	16.00	30.67	32.00	4.00	17.33	0.00	100.00
WDR	12.32	25.65	29.25	12.35	14.32	6.11	100.00
IR	51.22	14.63	14.63	19.51	0.01	0.00	100.00

Source: Estimated from NSSO 70th Round.

3.4 Agro Climatic Zone and Land Size wise Farmers Taken Technical Advice

Technical advices about showing dates, seed varieties, a combination of fertilizers, and the use of ICTs also have a positive impact on farm productivity. It also bridges the yield gap between rainfed and irrigated farms. Table 3 shows agro climatic zone and land size wise farmers' awareness about technical efficiency. It was found that the majority of landless and marginal farmers have taken technical advice from agricultural universities, KisanVikas Kendra, non-government organizations and, self-help groups. Landless farmers in the Island Region (72.50 percent) have accessed highest technical advice, whereas in the East Coast Plains and Hills Region was only 5.56 percent (lowest). On the contrary, only 12.50 (lowest) percent marginal farmers in the Island Region have accessed

technical information from different sources, whereas in the East Coast Plains and Hills Region nearly 50 percent farmers were benefited. Further, in the Island Region only 10 percent (lowest) small farmers has accessed technical information, whereas more than 40 percent (highest) farmers belong to the East Coast Plains and Hills Region have accessed technical information. On the contrary, in the East Coast Plains and Hills Region, it was found that there is not a single farmer belong to the semi-medium land size group have accessed technical information, whereas only 18.33 percent (highest) farmers have access of technical information in the Trans Gangetic Plain Region. Moreover, medium and large farmers across the region have taken least technical advices from the different sources. In totality, it was also found that there is a hill shape relationship between land size and technical information accessible across the agro climatic zones.

Table 3: Land Size wise Farmers access to Technical Advice for any of the Crops in different Agro Climatic Zones (In Percentage)

ACZs	Landless	Marginal	Small	Semi-medium	Medium	Large	Total
WHR	54.80	25.86	11.05	4.67	3.42	0.20	100.00
EHR	34.40	33.80	26.14	4.76	0.86	0.04	100.00
LGPR	45.50	36.94	10.35	5.92	1.24	0.05	100.00
MGPR	27.71	34.20	20.84	11.45	5.49	0.31	100.00
UGPR	40.21	32.54	10.23	10.52	4.18	2.32	100.00
TGPR	15.04	23.88	21.76	18.83	15.32	5.17	100.00
EPHR	22.76	30.50	27.58	12.42	6.18	0.56	100.00
CPHR	23.12	36.25	25.56	10.24	3.32	1.51	100.00
WPHR	36.14	22.25	15.24	10.25	12.45	3.67	100.00
SPHR	20.50	28.38	26.96	15.25	7.04	1.87	100.00
ECPHR	5.56	50.00	44.44	0.00	0.00	0.00	100.00
WCPGR	42.77	31.13	14.93	9.78	0.75	0.64	100.00
GPHR	26.41	35.38	19.02	12.46	5.23	1.50	100.00
WDR	42.52	36.25	18.23	3.00	0.00	0.00	100.00
IR	72.50	12.50	10.00	5.00	0.00	0.00	100.00

Source: Estimated from NSSO 70th Round.

3.3 Farmers' Perception

Farmers' perception of the usefulness of technical advice has also summarised in Table 4. The calculated results show that more than 60 percent of farmers were perceived that the

information provided was beneficial across the agro climatic zones. The calculated results show that in the Island Region more than 90 percent of farmers have benefited, whereas nearly 40 percent of farmers in the Southern Plateau and

HillsRegion have benefitted. Further, six percent in the Island Region and 59.73 percent in the Southern Plateau and HillsRegion perceived that the information was moderately benefitted. In totality, it was found that the majority of farmers

across the agro climatic zones have perceived that the information provided on farm-practices was benefitted and boosted farm productivity.

Table 4: Farmers' Perception on Technical Advice (In Percentage)

Agro Climatic Zone	Beneficial	Moderately Beneficial	No Effect	Harmful	Don't know	Total
WHR	74.72	22.58	2.61	0.03	0.07	100
EHR	60.15	36.55	2.29	0.00	1.01	100
LGPR	73.6	21.95	3.95	0.01	0.50	100
MGPR	60.04	34.68	4.25	0.23	0.81	100
UGPR	60.84	31.50	3.53	0.65	3.48	100
TGPR	69.35	25.09	3.36	0.07	2.14	100
EPHR	63.19	33.14	3.05	0.25	0.37	100
CPHR	60.04	34.68	4.25	0.23	0.81	100
WPHR	60.84	31.50	3.53	0.65	3.48	100
SPHR	40.27	59.73	0.00	0.00	0.00	100
ECPHR	65.85	29.78	2.18	0.64	1.55	100
WCPGR	79.84	15.82	2.14	1.35	0.86	100
GPHR	60.04	34.68	4.25	0.23	0.81	100
WDR	60.84	31.50	3.53	0.65	3.48	100
IR	94.00	6.00	0.00	0.00	0.00	100

Source: Estimated from NSSO 70th Round.

3.4 Yield Gap

The yield gap was calculated between rainfed and irrigated farms (Table 5). Further, yield gap also calculated in the technically advanced and backward farmer. The calculated results show that there is win-win situation for technically advanced farmers across the agro climatic zones. The calculated yield gap results show that there is a higher potential to increase farm productivity up to 195 quintals per hectare in irrigated farmers in the Eastern Plateau and Hills Region, whereas lower potential was found in the Lower Gangetic plains, i.e., 54 quintal per hectare. Further, yield gap in the rainfed farms also found, but it was lower compared to irrigated farmers. The calculated yield gap results show that yield gap was lower (17 quintal per hectare) in the Lower Gangetic Plain

Region and highest (90 quintal per hectare) in the Central Plains and Hills Region.

The comparison also was made between those farmers were taken technical advice and those do not. It shows that there has a vast gap. In the irrigated farm, farmers, those were not taken technical advice; the yield gap was ranging from 10 quintals per hectare in Gujarat Plains and Hills Region to 108 quintals per hectare in the Western Plateau and Hills Region. Furthermore, in the unirrigated farms, yield gap ranges from 12 quintals per hectare in the Lower Gangetic Plains Region to 54 quintals per hectare in the Island Region respectively.

Table 5: Yield Gap (Quintal/ Hectare)

Agro Climatic Zone	Farmers taken technical advice		Farmers do not taken technical advice	
	Irrigated Area (Productivity)	Unirrigated Area (Productivity)	Irrigated Area (Productivity)	Unirrigated Area (Productivity)
WHR	102	32	66	13
EHR	112	22	78	16
LGPR	54	17	49	12
MGPR	90	50	90	20
UGPR	103	36	45	29
TGPR	152	32	56	21
EPHR	195	36	62	23
CPHR	102	90	99	63
WPHR	112	25	108	21

SPHR	102	42	98	34
ECPHR	125	52	96	24
WCPGR	41	53	25	21
GPHR	12	51	10	23
WDR	86	49	90	45
IR	86	65	96	54

Source: Estimated from NSSO 70th Round.

4. Conclusion and Policy Recommendations

The present study identified that there is a positive relationship between farm productivity and adoption of modern technology. Landless and marginal farmers owned more than 80 percent of the Indian agriculture. These farmers are highly exposed and sensitive and least resilient capacity to climate variability/change. To cope or moderate adverse impacts of current and future climate variability/ change, differential adaptive measures were adopted prescribed by the different organization, viz., agricultural universities, NGOs and self-help groups. The adoption rate was higher in the highly exposed and sensitive land classes, viz., landless and marginal. This indicates that farmers are aware of the adverse impacts of climate change on farm productivity and ready to adopt prescribed combat measures. Yield gap estimation shows that India has much potential to increase per hectare farm productivity through improved irrigation, diversification of cropping pattern and adoption of modern technology. This is a good indicator for India, where a continuously increasing

population has a major barrier in the path of economic development. Further, through judicious use of natural resources and incorporating modern technology, India not only sustains livelihoods of the population, but also will be a potential exporter of agro- products in South Asia. Based on the above findings, present study prescribed following policy to strengthen Indian agriculture.

- It is found that only 12.32 & 14.63 percent landless and marginal farmers in the Western Dry & Island zones were taken technical advice. Therefore, these zones need special policy interventions.
- Yield gap in the Lower Gangetic Plains zone was found higher (195 quintals per hectare) in irrigated farms and 90 quintals per hectare in the Central Plateau and Hills zone. These zones have potential to feed the continuous increasing population. Therefore, by using an appropriate technology, this yield can be taped.

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Appendix- A

Agro Climatic Zone wise Distribution of States and Districts

Agro Climatic Zone	State	Districts
Western Himalayan Region	Himachal Pradesh	Bilaspur, Chamba, Hamirpur, Kangra, Kinnaur, Kullu, Lahul and Spiti, Mandi, Shimla, Simaur, Solan, Una
	Jammu & Kashmir	Anantnag, Badgam, Baramula, Doda, Ganderbal, Jammu, Kargil, Kathua, Kistwar, Kupwara, Leh, Pulwama, Rajouri, Ramban, Samba, Srinagar, Udhampur
	Uttarakhand	Almora, Bageshwar, Chamoli, Champawat, Dehradun, Haridwar, Nanital, PauriGarwal, Pithoragarh, Rudraprayag, TehriGarwal, Udhham Singh Nagar, Uttarkashi
Eastern Himalayan region	Arunachal Pradesh	Anjaw, Changlang, Dibang Valley, East Kameng, East Siang, Lohit, Papumpare, Tawang, Tirap, Upper Siang, Upper Subansiri, West Kameng, West Siang
	Assam	Barpeta, Baksa, Bongaigaon, Cachar, Darrang, Dhemaji, Dhubri, Dibrugarh, Dima Hasao, Goalpara, Golaghat, Hailakandi, Jorhat, Kamrup, KarbiAnglong, Karimganj, Kokrajhar, Lakhimpur, Nagaon, Nalbari, Sivasagar, Shonitpur, Tinsukia, Udalguri
	Manipur	Chandel, Imphal East, Imphal West, Tamenglong, Thoubal, Ukhrul
	Meghalaya	East Garo Hills, East Jaintia Hills, East Khasi Hills, North Garo Hills, RiBhoi, South Garo Hills, South West Garo Hills, South West Khasi Hills, West Garo Hills, West Jaintia Hills, West Khasi Hills
	Mizoram	Aizwal, Lunglei
	Nagaland	Dimapur, Kiphire, Kohima, Peren, Mon, Wokha, Zunheboto
	Sikkim	East Sikkim, North Sikkim, South Sikkim, West Sikkim,
	Tripura	West Tripura, South Tripura, North Tripura,
West Bengal	Alipurduar, Darjeeling, Jalpaiguri	
Lower-Gangetic Plain	West Bengal	Bankura, Bardhaman, Birbhum, Coochbehar, East Midnapur, Hooghly, Howrah, Kolkata, Malda, Murshidabad, Nadia, North 24 Parganas, North Dinajpur, Purulia, South 24 Parganas, South Dinajpur, West Midnapur
Middle-Gangetic Plain	Uttar Pradesh	Ambedkarnagar, Azamgarh, Ballia, Balrampur, Basti, Chandauli, Deoria, Faizabad, Ghazipur, Gonda, Gorakhpur, Jaunpur, Kushinagar, Maharajganj, Mau, Mirzapur, Rohtas, SantRavidas Nagar, Santkabirnagar, SantRavidas Nagar, Shravasti, Sidharth Nagar, Sonbhadra, Sultanpur, Varanasi
	Bihar	Araria, Arwal, Aurangabad, Banka, Begusarai, Bhagalpur, Bhojpur, Buxar, Darbhanga, East Champaran, Gaya, Gopalganj, Jamui, Jehanabad, Kaimur, Katihar, Khagaria, Kishanganj, Lakhisarai, Madhepura, Madhubani, Munger, Muzaffarpur, Nalanda, Nawada, Patna, Purnea, Rohtas, Saharsa, Samastipur, Saran, Sheikhpura, Sitamarhi, Siwan, Supaul, Vaishali, West Champaran
Upper Gangetic Plain Region	Uttar Pradesh	Agra, Aligarh, Allahabad, Amethi, Auraiya, Badaun, Bagpat, Baharich, Barabanki, Bareilly, Bijnor, Bulandshahr, Etah, Etawah, Farrukhabad, Fatehpur, Firozabad, GautamBudh Nagar, Gaziabad, Hapur, Hardoi, Hathras, JyotibaPhule Nagar, Kanpur Dehat, Kanpur Nagar, Kannauj, Kasganj, LakhimpurKheri, Lucknow, Mainpuri, Mathura, Meerut, Moradabad, Muzaffarnagar, Pilibhit, Pratapgarh, Rae Bareilly, Rampur, Saharanpur, Shahjahanpur, Shambhal, Shamli, Shiddarthnagar, Sitapur, Unnao
Trans Gangetic	Chandigarh,	Chandigarh

Plain Region	Delhi	Delhi
	Haryana	Ambala, Bhiwani, Faridabad, Fatehabad, Gurgaon, Hisar, Jhajjar, Jind, Kaithal, Karnal, Kurukshetra, Mahendragarh, Mewat, Palwal, Panchkula, Panipat, Rewari, Rohtak, Sirsa, Sonapat, Yamunanagar,
	Punjab	Amritsar, Barnala, Bathinda, Faridkot, Fatehgarh Sahib, Firozpur, Fazilka, Jalandhar, Kapurthala, Ludhiana, Mansa, Moga, Patiala, Sangrur, Sri Muktsar Sahib, Tarn Taran
	Rajasthan	Bikaner, Sriganganagar, Hanumangarh
Eastern Plateau and Hills Region	Chhattisgarh	Balod , Baloda bazar , Balrampur, Bemetara , Bijapur, Bastar, Bilaspur, Dantewada, Dhamtari , Durg, Gariyabandh, Janjgir, Jashpur, Kabirdham, Kanker, Kondagaon, Korba, Koriya, Mahasamund, Mungeli, Narayanpur, Raigarh, Raipur, Rajnandgaon, Sukma, Surajpur, Surguja
	Jharkhand	Bokaro, Chatra, Deogarh, Dhanbad, Dumka, East Singhbhum, Garhwa, Giridih, Godda, Gumla, Hazaribag, Jamtara, Khunti, Koderma, Latehar, Lohardaga, Pakur, Palmau, Ramgarh, Ranchi, Sahibganj, Saraikela, Simdega, West Singhbhum
	Madhya Pradesh	Anuppur, Balaghat, Dindori, Mandla, Shahdol
	Maharashtra	Bhandara, Gadchiroli, Gondia
	Odisha	Angul, Bargarh, Bolangir, Deogarh, Dhenkanal, Jharsuguda, Kalahandi, Keonjhar, Koraput, Mayurbhanj, Malkangiri, Nabarangpur, Puri, Sambalpur, Sonapur, Sundargarh,
	West Bengal	Darjeeling, Jalpaiguri
Central Plateau and Hills Region	Madhya Pradesh	Alirajpur , Betul, Bhind, Bhopal, Chhatarpur, Chhindwara, Damoh, Datia, Guna, Gwalior, Hoshangabad, Jabalpur, Jhabua, Katni, Morena, Narsimhapur, Panna, Raisen, Rewa, Sagar, Satna, Sehore, Seoni, Shivpuri, Sidhi, Singrauli, Tikamgarh, Umaria, Vidisha
	Rajasthan	Alwar, Baran, Banswara, Bharatpur, Bhilwara, Bundi, Chittaurgarh, Dausa, Dholpur, Dungarpur, Jhalawar, Karauli, Kota, Pratapgarh, SawaiMadhopur, Sirohi, Tonk, Udaipur
	Uttar Pradesh	Banda, Chitrakoot, Hamirpur, Jalaun, Jhansi, Lalitpur, Mahoba
Western Plateau And Hills Region	Madhya Pradesh	Bharwani, Burhanpur, Dewas, Dhar, Harda, Indore, Khargone, Khandwa, Mandsaur, Neemuch, Rajgarh, Ratlam, Shajapur, Ujjain
	Maharashtra	Ahmadnagar, Akola, Amravati, Aurangabad, Beed, Buldhana, Chandrapur, Dhule, Hingoli, Jalgaon, Jalna, Kolhapur, Latur, Nagpur, Nanded, Nandurbar, Nashik, Osmanabad, Parbhani, Pune, Sangli, Satara, Solapur, Wardha, Yavatmal
Southern Plateau and Hills Region	Andhra Pradesh	Anantapur, Chittoor, Cuddapah, Kurnool, Nellore
	Telangana	Adilabad, Hyderabad, Karimnagar, Khammam, Mahbubnagar, Medak, Nalgonda, Nizamabad, Rangareddy, Warangal
	Karnataka	Bagalkot, Belgaum, Bellary, Bangalore, Bidar, Bijapur, Chamarajanagar, Chickballapur, Chitradurga, Davanagere, Dharwad, Gadag, Gulbarga, Hassan, Haveri, Kolar, Koppal, Kalaburagi, Mandya, Mysuru, Raichur, Ramanagara, Tumkur, Yadgir
	Tamil Nadu	Coimbatore, Dharmapuri, Dindigul, Erode, Karur, Krishnagiri, Namakkal, Nilgiris, Pudukkottai, Salem, Tiruvannamalai, Tiruchirapalli, Tiruppur
East Coast Plains And Hills Region	Andhra Pradesh	East Godavari, Guntur, Krishna, Prakasam, Srikakulam, Vishakhapatnam, Vizianagaram, West Godavari
	Odisha	Balasore, Bhadrak, Boudh, Cuttack, Gajapati, Ganjam, Jagatsinghpur, Jajpur, Kandhamal, Kendrapara, Khurda, Nayagarh, Nuapada, Rayagada
	Puducherry	Puducherry
	Tamil Nadu	Ariyalur, Chennai, Cuddalore, Kanchipuram, Madurai, Nagapattinam, Perambalur, Ramanathapuram, Sivagangai, Thanjavur, Tirunelveli, Thiruvallur, Thiruvarur, Thoothukudi, Vellore, Villupuram, Virudhunagar
West Coast Plains and Ghat Region	Goa	Goa
	Karnataka	Chikmagalur, DakshinKannad, Kodagu, Shimoga, Udupi, Uttar Kannada
	Kerala	Alappuzha, Kannur, Ernakulam, Idukki, Kasaragod, Kollam, Kottayam, Kozhikode, Malappuram, Palakkad, Pathanamthitta, Thiruvananthapuram, Thrissur, Wayanad
	Maharashtra	Mumbai City, Mumbai Suburban, Palghar, Raigad, Ratnagiri, Sindhudurg, Thane
	Tamil Nadu	Kanniyakumari, Theni
Gujarat Plains and Hills Region	Gujarat	Ahmedabad, Amreli, Anand, Arvalli, Botad, Banaskanth, Bharuch, Bhavnagar, ChhotaUdepur, Dahod, Dangs, DevbhumiDwarka, Gandhinagar, Jamnagar, Junagadh, Kheda, Kutch, Mahisagar, Mehsana, Morbi, Narmada, Navsari, PanchMahals, Patan, Porbandar, Rajkot, Sabarkantha, Surat, Surendranagar, Tapi, Vadodara, Valsad
	Dadra & Nagar Haveli	Dadra & Nagar Haveli
	Daman & Diu	Daman & Diu
Western Dry Region	Rajasthan	Ajmer, Barmer, Churu, Jaipur, Jaisalmer, Jalore, Jhunjhunun, Jodhpur, Nagaur, Pali, Rajsamand, Sikar
Island Region	Andaman & Nicobar Islands	Nicobar, South Andaman, North & Middle Andaman
	Lakshadweep	Lakshadweep