

Climate change induced farmers suicides in Vidarbha and Marathwada regions of Maharashtra, India.

El cambio climático indujo suicidios de agricultores en las regiones de Vidarbha y Marathwada de Maharashtra, India.

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ABSTRACT

Global climate change has substantial modifications in environmental conditions. This results in an adverse impact on various aspects. Of the various aspects, the impact on agriculture is pronounced. The impact on agriculture will be varied due to the vulnerability of different farmers' groups owing to their agricultural land size, economic and social background. Indian farmers/cultivators and agricultural labourers are committing suicide since 1995. Of the various reasons for their suicides climate change is also one of them. This study was carried out in the Vidarbha and Marathwada regions of Maharashtra state of India where the maximum number of farmers are committing suicides. A purposive random sampling was carried out in eight districts to identify the sample population (n=230) of marginalized farmers (<1.00 ha. agricultural land). A specially designed and developed interview schedule was prepared to elicit the primary information. In addition, the National Sample Survey's 'Situation Assessment of Agricultural Households and Land and Holdings of Households in Rural India, 2019' was also referred to identify climate change-induced factors for farmers' suicides. The results revealed high seed cost, late or no seed germination, less or no irrigation facility, new insect/pest attack, high fertilizer, insecticide, and pesticide cost, less crop yield, crop failure, no farmers/crop insurance, and not getting minimum support price are some of the other major causes which result into taking a loan from a moneylender with a high-interest rate (60-120% p.a.) results into high debt (average amount of outstanding loan per agricultural household in Maharashtra was Rs. 82,085/-, US \$994.24 [54.0%], and all India Rs. 74,121/-, US \$897.78 [50.2%]). These causes result in a vicious cycle in which farmers got entrapped for several years as a result of which they had a mental or emotional disorder and under its influence they commit suicide. Climate change-induced debt is identified as the cause of farmers' suicide in India. The cotton belt is identified as a suicide belt in India. The central and state government have to understand this issue from this dimension also and need to take proactive action suitably to break this vicious cycle and free the farmers from the trap to transform them from subsistence farming to sustainable farming and leverage their life to lead a dignified life and pave a way for a sustainable society and sustainable development at large.

Keywords: Climate change, Farmers suicide, Maharashtra, Marathwada, Vidarbha.

RESUMEN

El cambio climático global tiene modificaciones sustanciales en las condiciones ambientales. Esto tiene como resultado un impacto adverso en varios aspectos. De los diversos aspectos, el impacto en la agricultura es pronunciado. El impacto en la agricultura será variado debido a la vulnerabilidad de los diferentes grupos de agricultores debido al tamaño de sus tierras agrícolas y su entorno económico y social. Los agricultores/cultivadores y trabajadores agrícolas indios se están suicidando desde 1995. Entre las diversas razones de sus suicidios, el cambio climático también es una de ellas. Este estudio se llevó a cabo en las regiones de Vidarbha y Marathwada del estado de Maharashtra en la India, donde el mayor número de agricultores se suicidan. Se llevó a cabo un muestreo aleatorio intencional en ocho distritos para identificar la población de muestra (n=230) de agricultores marginados (<1,00 ha. de tierra agrícola). Se preparó un programa de entrevistas especialmente diseñado y desarrollado para obtener la información primaria. Además, también se hizo referencia a la "Evaluación de la situación de los hogares agrícolas y las tierras y propiedades de los hogares en la India rural, 2019" de la Encuesta Nacional por Muestra para identificar los factores inducidos por el cambio climático que explican los suicidios de los agricultores. Los resultados revelaron un alto costo de las semillas, germinación tardía o nula de las semillas, menos o ninguna instalación de riego, nuevos ataques de insectos/plagas, altos costos de fertilizantes, insecticidas y pesticidas, menor rendimiento de los cultivos, malas cosechas, falta de seguro para los agricultores/cosechas y no obtener El precio mínimo de apoyo son algunas de las otras causas importantes que resultan en que tomar un préstamo de un prestamista con una tasa de interés alta (60-120% anual) resulte en una deuda alta (el monto promedio de préstamo pendiente por hogar agrícola en Maharashtra fue de Rs. 82.085/-, 994,24 dólares estadounidenses [54,0%], y toda la India 74.121 rupias/-, 897,78 dólares estadounidenses [50,2%]). Estas causas resultan en un círculo vicioso en el que los agricultores quedan atrapados durante varios años a consecuencia de lo cual padecen un trastorno mental o emocional y bajo su influencia se suicidan. La deuda inducida por el cambio climático se identifica como la causa del suicidio de los agricultores en la India. El cinturón de algodón se identifica como cinturón suicida en la India. El gobierno central y estatal también deben entender este problema desde esta dimensión y tomar medidas proactivas adecuadas para romper este círculo vicioso y liberar a los agricultores de la trampa para transformarlos de una agricultura de subsistencia a una agricultura sostenible y aprovechar sus vidas para llevar una vida digna. la vida y allanar el camino para una sociedad sostenible y un desarrollo sostenible en general.

Palabras clave: Cambio climático, suicidio de agricultores, Maharashtra, Marathwada, Vidarbha.

INTRODUCTION

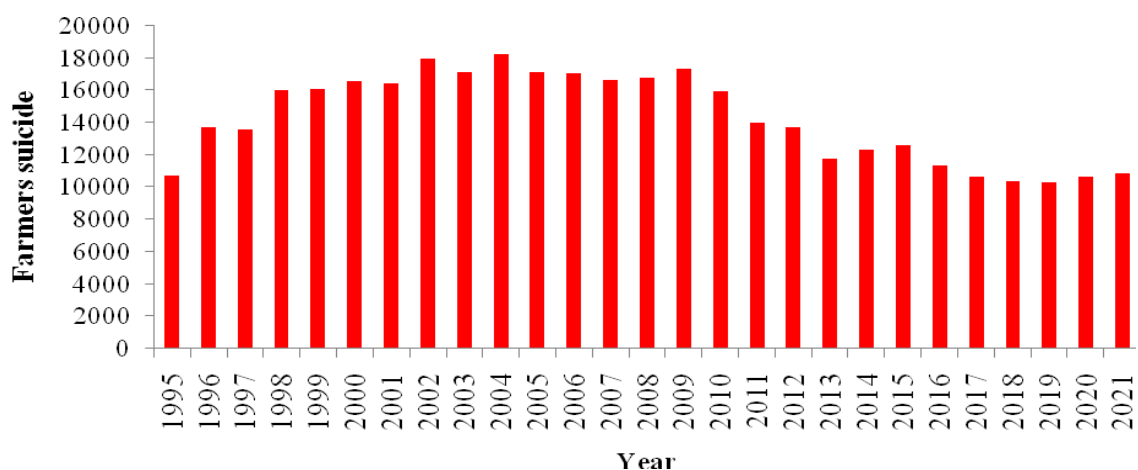
Agriculture is closely associated with the climate of a particular area. Intergovernmental Panel on Climate Change in its assessment report observed considerable changes in global temperature, precipitation patterns, and incidence of extreme weather events. Climate change is probably the most complex and challenging environmental problem faced by the world today and is increasingly recognized as a potent threat to agriculture in general and food security in particular (Rama Rao *et al.*, 2016). Climate change will result in a change in the natural phenomenon which will harm agriculture. Of the various farmers' groups in India,

marginalized farmers—land holding <1.0 hectare (ha.) (<2.5 acres)—owing to their vulnerability to climate change will be at receiving end.

Agriculture plays a pivotal role in the Indian economy. It contributes one-sixth to the gross domestic product and employs 56% Indian workforce. Indian agriculture is the home of small and marginal farmers (80%) (Dev, 2012). Climatic changes and increasing climatic variability are likely to aggravate the problems of future food security by exerting pressure on agriculture. Climate change will also have an economic impact on agriculture, including changes in farm profitability, prices, supply, demand, trade and regional comparative advantages (Singh *et al.*, 2017).

Studies in India, Sri Lanka, the USA, Canada, England and Australia have identified farming as one of the riskiest occupations associated with a high suicide rate than in the general population. In India, farmers' suicides had been reported in various states, viz. Maharashtra, Punjab, Andhra Pradesh, Kerala and various other states with varied cultural practices and farming patterns (Mishra, 2006). Farmer suicide has turned out to be a major socio-economic concern in India that has resulted in profound implications for the quality of life of farmers. According to the United Nations Commission on Sustainable Development, one farmer committed suicide every 32 minutes between 1997 and 2005 in India (Manjunatha and Ramappa, 2017).

The data on farmers'/cultivators' and agricultural labourers' suicides in India from 1995 to 2021 is depicted in Figure 1. The total number of suicides in this duration is 3,86,250 with an average of 14,305 suicides/year or 40 suicides/day. The maximum (n=18241) farmers' suicide was recorded in 2004; whereas, the minimum (n=10281) in 2019. A declining trend was observed in farmers' suicide in the last decade (2009-19). Of the total number (n=1,64,033) of suicides in 2021 in India, suicide contribution by persons engaged in the farming sector was 6.6% (n=10,881). Maharashtra remains in the first position with the highest percentage share of suicides of persons engaged in the farming sector in India from 2015 onwards. The percentage contribution of Maharashtra was always above 30% with a maximum (38.19%) in 2019 (ADSI, 2021). The farmer suicide in Maharashtra for 2021 and 2022 were 2743 and 2942 respectively.



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Figure 1: Farmers/cultivators and agricultural labourers' suicide in India

In India, seven states account for 87.5% of total suicides in the farming sector. The states are Maharashtra, Karnataka, Telangana, Madhya Pradesh, Chhattisgarh, Andhra Pradesh and, Tamil Nadu. Punjab, which benefited most from the Green Revolution, also presents a depressing picture of farmers' suicides. During 1995-2015, 4687 farmers' suicides have been reported in Punjab of which 1334 were from Mansa district alone (Farmers' Suicides in India – Reasons and Responses, 2022). Between 1995 to 2011 the farmers' suicide trend was ranging from 5.30 to 7.66 per 1,00,000 individuals. Farmer suicides account for approximately 10% of all suicides in India (Mahapatra, 2017). The female to male farmers, cultivators and agricultural labourers suicide percentage was always <10% for India and Maharashtra state. Of the records maintained by National Crime Record Bureau (NCRB), India from 2015 to 2021, only one transgender agricultural labour from Tamil Nadu in 2017 committed suicide.

In India farmers/cultivators and agriculture labourers are committing suicides. Figure 2 depicts agriculture labourers' suicides in India and Maharashtra for 2015-2021. From the figure, it can be seen that an increase in agriculture labourers' suicides in 2020-21 both at India and Maharashtra levels.

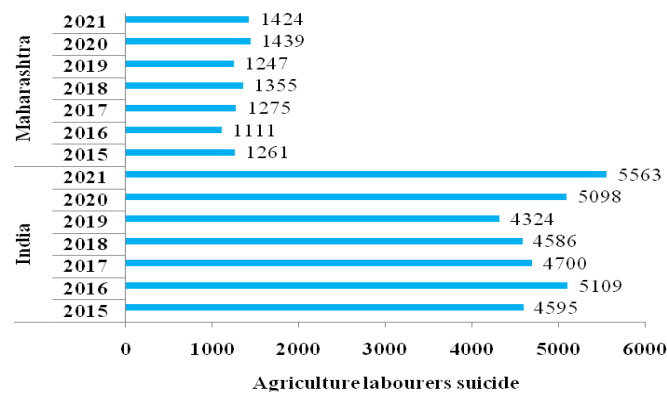


Figure 2: Agricultural labourers' suicide in India and Maharashtra

A combined farmers and agricultural labourers suicide trend in Maharashtra for 2015-2021 is depicted in Figure 3. The figure indicates that farmers'/cultivators' suicide is decreasing from 2019-2021; however, agricultural labourers' suicides are increasing.

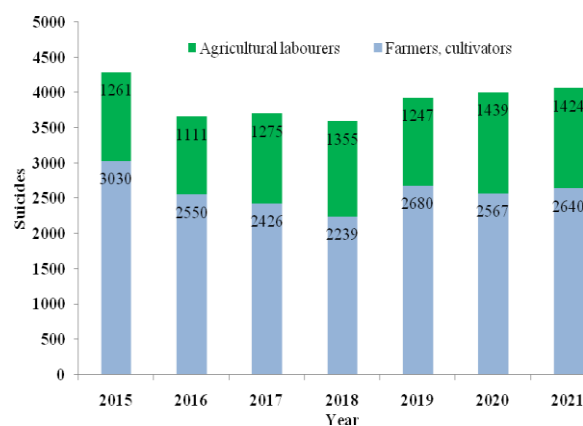


Figure 3: Farmers and agricultural labourer's suicides (male and female) in Maharashtra

Female farmers/cultivators and agricultural labourers' suicide for 2015-2021 for India and Maharashtra is presented in Figure 4. In the year 2019, a maximum (n=575) female agricultural labourers committed suicide in India and 157 in Maharashtra. The number of female agricultural labourers' suicide has seen a declining trend from 2019 onwards.

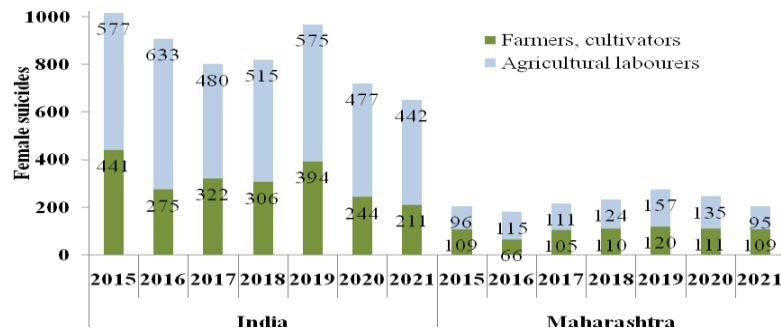


Figure 4: Female farmers, cultivators and agricultural labourers' suicide

The percentage of agricultural labourers' suicide to the persons engaged in the the farming sector in India and Maharashtra are presented in Table 1. The agricultural labourers' contribution at the national level ranges from 36.46% (2015) to 54.28% (2014). Except for 2015, the agricultural labourers' contribution was always above 42%. In the case of Maharashtra, it ranges from 29.38% (2015) to 37.70% (2018). The contribution was always above 30%.

Table 1: Percentage of agricultural labourers to the persons engaged in the farming sector

Year	India	Maharashtra
2014	54.28	35.86
2015	36.46	29.38
2016	44.89	30.34
2017	44.11	34.45
2018	44.31	37.70
2019	42.05	31.75
2020	47.74	35.92
2021	51.12	35.03

Values are in percentage

Distribution of farmers' suicide by land holding data was maintained for 2014 and 2015 only by NCRB, India. From the data, it can be concluded that at the India level, average farmers' suicide for this duration was in the order of small (3067) > marginal (1887) > medium (1729) > large (145.5). A similar trend was also recorded for Maharashtra state with small (1310) > marginal (730.5) > medium (721.5) > large (37).

According to Manjunatha and Ramappa (2017) (Table 2), marginal operational holdings had committed more suicides in India (50.3%) followed by small (25.9%) whereas, least by large farmers (7.9%).

Data on the total farmers' suicides in the Marathwada region of Maharashtra state along with the district-wise breakup of the region is presented in Table 3. It is observed that 1133, 1053 and 991 farmers committed suicides in the year 2015, 2016 and, 2017 respectively, from the region. Table 4 shows the information on the landholding of the victims, the data revealed that 39.68 and 31.57% of victims were having small (1.01 to 2.00 ha.) and marginal (up to 1.00 ha.) landholding, respectively and 21.25% of victims were from semi-medium (2.01 to 4.00 ha.) type of landholding. About 6.56 and 00.94% of victims were from medium (4.01 to 10.00 ha.) and large holdings (above 10.00 ha.), respectively. It shows that the majority of the victims were marginal and small farmers (Venkateswarlu *et al.*, 2019).

According to NCRB, India persons carrying out suicides in India are using different means. An analysis of 10 years (2012-2021) revealed that suicides by means of hanging are most preferred (Average 48.01%, range 37-57.8%) followed by poison intake (Average 26.76%, range 25-29.1%). The poison intake means is further divided into poison insecticide (Average 15.98%, range 10.9-17.9%) and other poison (Average 10.77%, range 8.2-15.1%). Thus, it can be pointed out that farmers in Maharashtra perhaps may be committing suicides by consuming pesticides used in agriculture followed by hanging.

Maharashtra state is considered to be India's farmers' suicides epicentre (Rukmini, 2015). Of the different groups of farmers in India, marginalized and small group of farmers have committed more suicides in India. The plausible reasons for this need to be explored. Perhaps, there may be several dimensions to the farmers' suicides in India. In addition to socioeconomic and psychosocial circumstances, climate-change-induced factors may also be responsible. The literature review revealed a paucity of studies on climate-change-induced farmers' suicides in the Vidarbha and Marathwada regions of Maharashtra state of India. Thus, this is the identified gap in the subject domain. This study is aimed to assess the plausible reasons for climate change-induced farmers' suicides in the study area. The study outcome will add a new understanding of climate change-induced reasons for marginalized farmers' suicide in the study area. Furthermore, the initiatives to be taken at the national and state levels by policy formulation and mechanism for the implementation of the same can be initiated. In addition, climate-smart agriculture measures are to be introduced to reduce these farmers' suicides.

Table 2: Operational holdings of victim households

States	% of holding to total operated land	Number of HHs as a % to total no. of victim HHs	Average operated holding size per victim HH (Acres)
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	Marginal	Small	Medium	Large	Marginal	Small	Medium	Large	Irrigated	Unirrigated	Total
Maharashtra	40.0	42.0	10.0	8.0	40.0	36.0	18.0	6.0	0.5	3.5	4.0
MP	70.0	12.0	14.0	4.0	32.0	15.0	33.0	20.0	2.3	0.9	3.2
Telangana	37.9	52.1	10.0	0.0	58.0	38.0	4.0	0.0	1.1	1.1	2.2
AP	16.5	31.1	22.4	30.0	43.4	33.3	13.3	10.0	2.8	1.3	4.1
Chhattisgarh	29.4	18.9	12.6	39.1	76.0	14.0	6.0	4.0	0.6	3.0	3.6
Karnataka	19.6	26.0	45.7	8.7	59.7	20.6	17.8	1.9	1.1	1.8	2.9
Kerala	25.0	55.0	20.0	0.0	48.0	45.0	7.0	0.0	3.1	0.0	3.1
TN	20.0	28.0	52.0	0.0	50.0	26.0	24.0	0.0	3.6	0.0	3.6
UP	57.1	28.6	14.3	0.0	83.4	13.3	3.3	0.0	1.4	0.0	1.4
Gujarat	7.0	16.0	43.0	34.0	27.0	27.0	33.0	13.0	2.6	3.3	5.9
Punjab	7.2	13.3	20.0	59.5	33.0	27.0	17.0	23.0	6.6	0.0	6.6
Haryana	0.0	1.5	13.1	85.4	0.0	14.3	28.6	57.1	17.9	0.0	17.9
WB	27	58.6	14.4	0.0	76.7	20.0	3.3	0.0	1.1	0.1	1.2
Total	28.2	28.1	27.0	16.7	50.3	25.9	15.9	7.9	1.9	1.5	3.4

MP: Madhya Pradesh, AP: Andhra Pradesh, TN: Tamil Nadu, UP: Uttar Pradesh, and WB: West Bengal. HH: Households (Manjunatha and Ramappa, 2017)

Table 3: Farmer suicides in Marathwada region, Maharashtra

Year	Aurangabad	Latur	Beed	Parbhani	Jalna	Hingoli	Osmanabad	Nanded	Total
2010	02	04	79	22	04	02	23	55	191
2011	00	04	73	23	06	05	25	33	169
2012	02	00	91	35	06	03	22	39	198
2013	04	03	98	17	08	02	29	46	207
2014	56	44	152	70	32	31	71	118	574
2015	144	106	301	104	83	41	164	190	1133
2016	151	116	222	98	76	49	161	180	1053
2017	139	94	207	125	91	56	126	153	991
Total	498	371	1223	494	306	189	621	814	4516

Source: Divisional Commissionrate Office, Aurangabad (Venkateswarlu *et al.*, 2019)

Table 4: Victims according to their land holding in Marathwada region, Maharashtra

District	Landholding (ha.)				
	Marginal	Small	Semi-medium	Medium	Large

	(Up to 1.00)	(1.01 to 2.00)	(2.01 to 4.00)	(4.01 to10.0)	(Above 10.00)
Parbhani	15 (37.50)	16 (40.00)	07 (17.50)	02 (05.00)	-
Hingoli	15 (37.50)	16 (40.00)	06 (15.00)	02 (05.00)	01 (2.50)
Nanded	13 (32.50)	19 (47.50)	05 (12.50)	03 (07.50)	-
Beed	15 (37.50)	12 (30.00)	09 (22.50)	04 (10.00)	-
Jalna	14 (35.00)	15 (37.50)	05 (12.50)	04 (10.00)	02 (5.00)
Osmanabad	13 (32.50)	14 (35.00)	10 (25.00)	03 (07.50)	-
Latur	06 (15.00)	18 (45.00)	14 (35.00)	02 (05.00)	-
Aurangabad	10 (25.00)	17 (42.50)	12 (30.00)	01 (02.50)	-
Marathwada (N=320)	101 (31.57)	127 (39.68)	68 (21.25)	21 (6.56)	03 (0.94)

Figures in the parenthesis indicate the percentage (Venkateswarlu *et al.*, 2019)

MATERIALS AND METHODS

Study area: To carry out this study, eight districts of Maharashtra state from Vidarbha (n=4) and Marathwada (n=4) regions were selected. The paddy is cultivated in Chandrapur district (Figure 5); whereas, cotton is in Amravati, Wardha, and Yeotmal districts (Figure 6). The pulses are cultivated in Latur, Beed, Osmanabad and Parbhani districts (Figure 7). The climatic condition of the study area varies from a dry and sub-humid climate with annual average rainfall varying from 650-800 mm (Latur) to 1142 mm (Chandrapur). The soil type includes medium to deep red and black soil with lime mix (Chandrapur) to Deccan trap (Beed). The ownership of the agricultural land lies with the farmers and it depends on the rainfall.

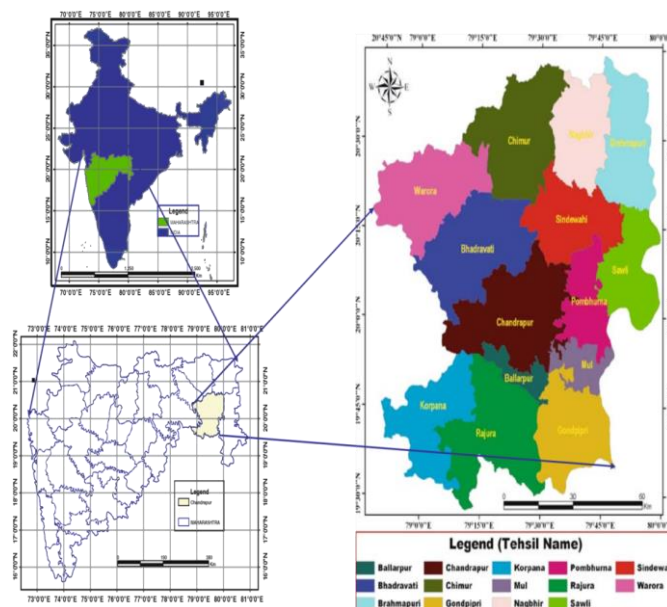


Figure 5: Paddy cultivating study area

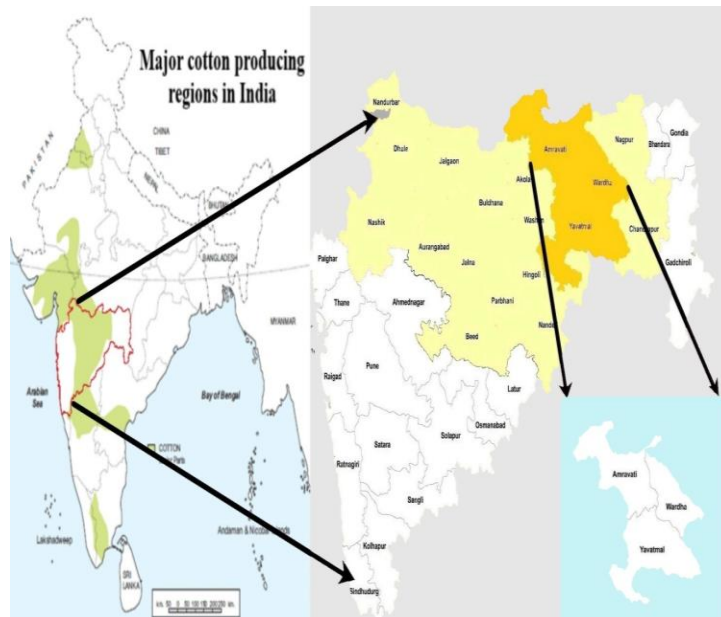


Figure 6: Cotton cultivating study area

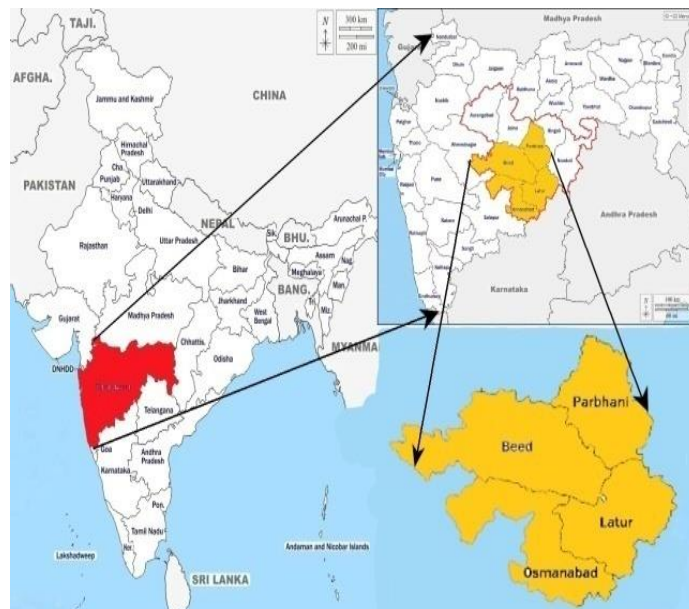


Figure 7: Pulses cultivating study area

The sample design comprising of the crops cultivated from the study area and sampling locations details are presented in Table 5. The sample population (n=230) was drawn from the study area from marginalized farmers with land holding <2.5 acres (<1 ha.). The inclusive criteria for sample population identification were those farmers with land holding <2.5 acres and are engaged in agriculture as a major occupation for >15 years. To elicit the primary data from the respondents a specifically designed and developed tool was constructed. A structured enquiry form consisting of 192 questions was developed after carrying out a pilot study. It consists of close-ended questions. This tool (interview schedule) was comprehensive and self-sufficient to evaluate the impact of climate change on marginalized farmers and to identify the plausible reasons for the farmers' suicide. The tool comprises four sections viz. respondents' profile

including socio-economic information, perceptions regarding climate variability, impact during sowing, crop growth, harvesting, and livestock and adaptation measures adopted. The tool comprises several questions in each section with suitable options. The Likert scale was used for options preparation. Emphasis was laid upon getting quantitative information to arrive at a conclusive and comparable point.

Table 5: Sample design

Crop	District	Taluka	Sampling location (Sample population number)
Paddy	Chandrapur	Chandrapur	Mamla (10), Nimbada (14), Borda (9), Pimpalkhuta (7), Lohara (7), Nandgur (11),Walni (12)
Cotton	Wardha	Seloo	Sindhi railway (4), Palegaonbai (7), Pipra (9)
	Yavatmal	Ghatanji	Nukti (14), Murli (9)
	Amravati	Bhatkuli	Bhatkuli (4), Sayat (18)
Pulses	Osmanabad	Bhoom	Bhongiri (14), Songiri (9)
	Beed	Wadwani	Hivargaon (1), Vahegaon (19), Pusra (4)
	Parbhani	Jintur	Mathla (14), Panjri (10)
	Latur	Renapur	Kalewadi (13), Kalegaon (6), Renapur (5)

The identified farmers were made aware of the study and ensure the confidentiality of the responses made by them. One-to-one interviews were carried out. The questionnaire was explained in the regional language (Marathi) to get the proper responses. The responses were marked by Research Assistant to avoid any mistakes. During the field investigation, Focused Group Discussion was also attempted. Photographs were also taken to support the results of the study. The data collected from this group of marginalized farmers was quantitative. The generated primary data was analyzed based on crops grown by these farmers. The data were analyzed and converted into a percentage for ease of comparison and understanding. Data analysis for the study was carried out with the help of various statistical tools viz. Microsoft Excel, SPSS and OriginPro. In addition, secondary data from National Sample Surveys 'Situation Assessment of Agricultural Households and Land and Holdings of Households in Rural India, 2019' was consulted to assess various factors responsible for farmers' suicide from the identified study area.

RESULTS AND DISCUSSION

The results of the field investigation revealed maximum (96%) male farmers were engaged in agricultural activity with primary (4th standard) and middle school (8th standard) education. Very few (8.50%) farmers had secondary (10th standard) and above education. Maximum (>90%) farmers own the agricultural land (< 1.0 ha.) and it is rainfed and cultivates two crops (in paddy and pulses cultivating crops) in a year whereas, in cotton cultivating crops, farmers are cultivating only one crop. The cell phone use profile in the paddy cultivating areas revealed >50% don't have a cell phone; whereas, in the case of cotton and pulses >55% have it. Smartphone use is limited (<13%). From the different social groups, Other Backward Classes (OBC) dominates (37.5%) in this group of farmers. The social profile of the farmers is in the order of other backward classes > scheduled caste > scheduled tribes > nomadic tribes. Of the sample population, 61% belongs to below poverty line [a person who

earns < Rs.6,400/- (US \$77.51) in rural areas and < Rs.11,850/- (US \$143.52) in urban areas per month] and all farmers had food grain cards and purchase food grains from government outlets. Monthly electricity consumption for domestic purposes is maximum in the range of Rs. 251-500/- (US \$3.25-6.49) 72.85% and <Rs. 250/- (US \$3.24) 21.42%. Of the different substances abused by this group of marginalized farmers (Figure 8) tobacco use is maximum (67% in paddy) followed by cigarette/bidi (a local cigarette made up of unprocessed tobacco wrapped in leaves) (24% in paddy) and gutkha (a mixture of chewing tobacco, betel nut, spices and other ingredients) consumption (17% in paddy).

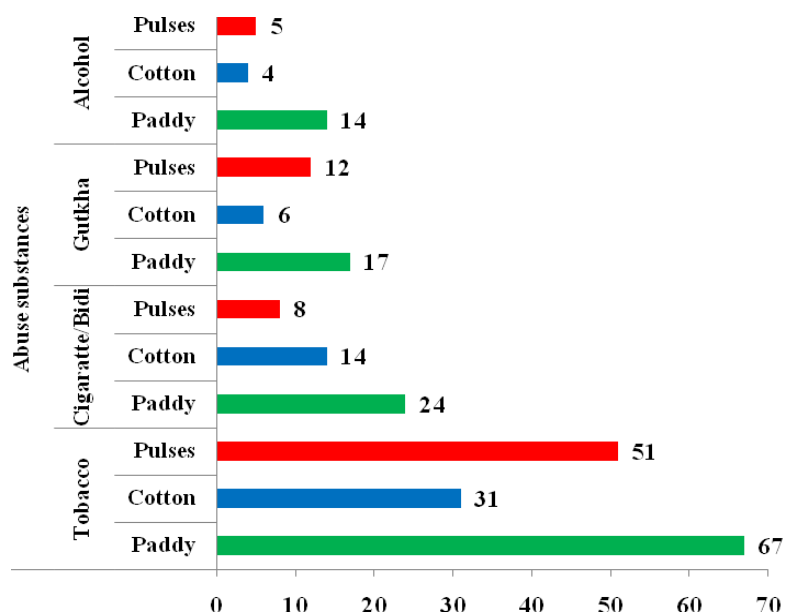


Figure 8: Substances abuse by farmers

The climate variability (Figure 9) as perceived by this group of farmers includes high temperature, increase in flood incidences, low rainfall, change in precipitation pattern, increase in drought incidences and extreme weather events and decrease in irrigation water.

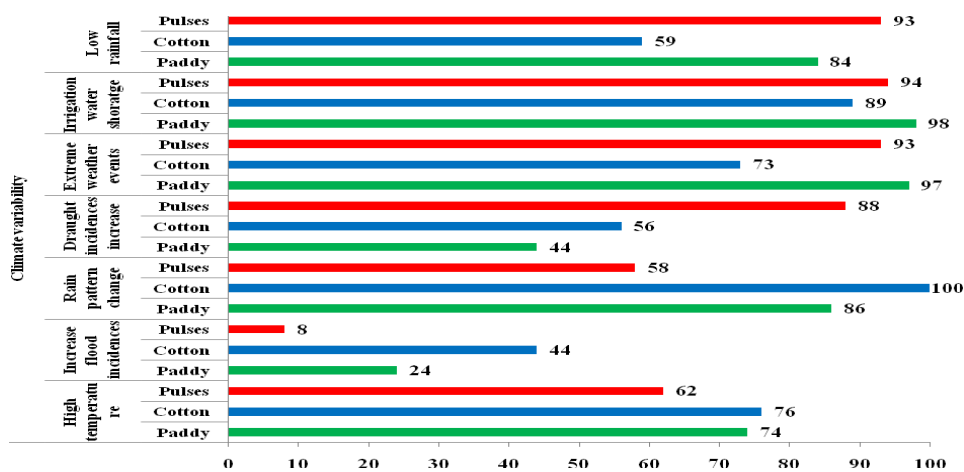


Figure 9: Climate variability perceived by farmers

Climate change impact on crops include late/no seed germination, crop growth reduced, production reduced, increased insect pest incidences, soil fertility reduction and poor quality of yield (Figure 10). It has

been recorded that if seeds do not germinate in first sowing then farmers carry out a second round of seed sowing. The new types of insect/pest affecting the crops every year was also a prominent observation.

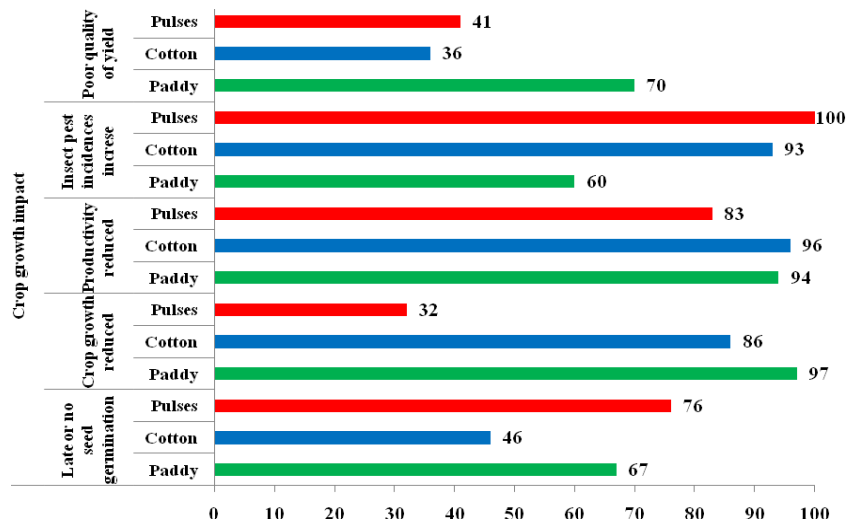


Figure 10: Crop growth impact due to climate change

The effectiveness of the pesticide is reduced; whereas, the use of chemical fertilizers has increased. The increase in the cost of insecticides and pesticides has also been reported. In addition, more quantity of fertilizer and insecticide use has also been reported (Figure 11).

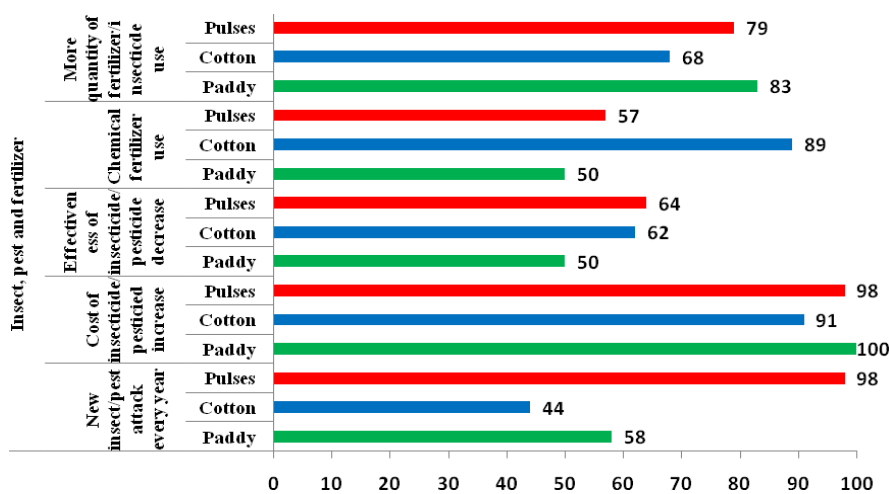


Figure 11: Insects, pests, and fertilizer impact

Additional climate change impact on crops include an increase in weed growth, new and different types of weed affecting crops, production cost increase, the profit received decreased, per acre yield in last five years decrease, climate change has destroyed the crop partially/completely. Farmers have reported that they do not receive the minimum support price (MSP) of the crops (Figure 12). The cost of production for the crops studied is comparatively higher than the supportive price provided by the state government under MSP. Maximum (average 83.66%) farmers reported that they do not get subsidies on fertilizer and seed. In the event of natural calamities, the government provides compensation for crop loss. A lack of awareness was observed

among farmers for life insurance/crop insurance. Maximum (average 65.33%) farmers do not receive any warning for natural disasters (Figure 13).

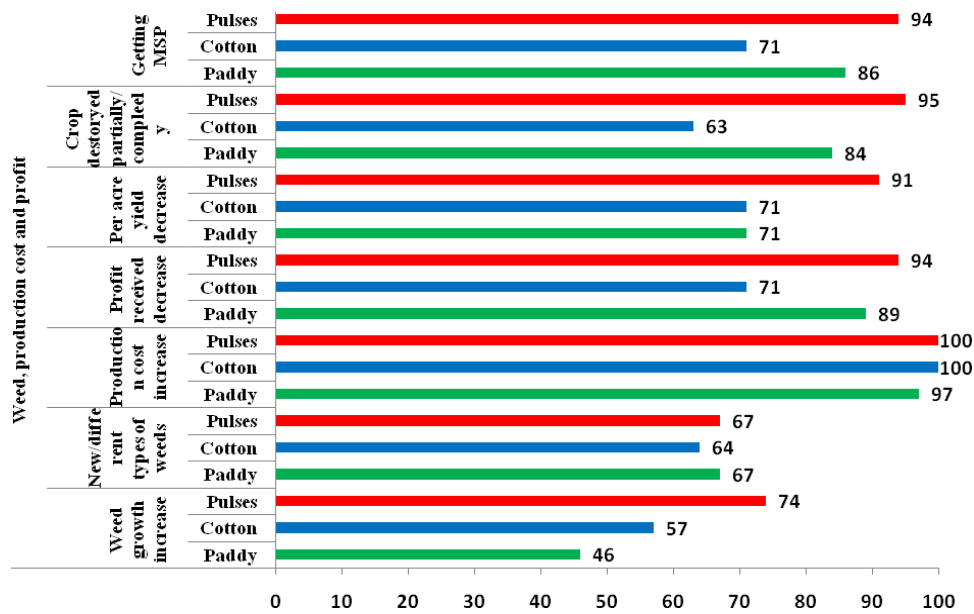


Figure 12: Weed, production cost and profit issue

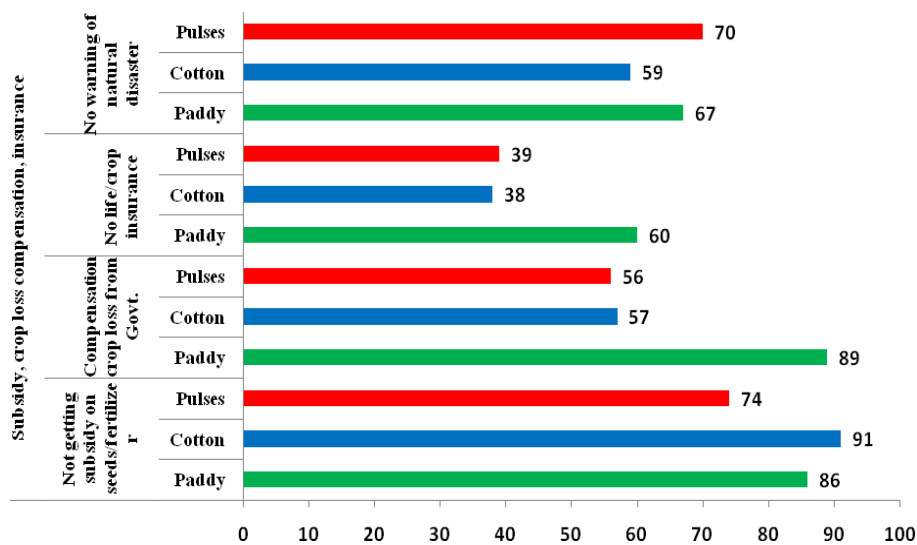


Figure 13: Subsidy, crop loss compensation and insurance

About 40% of farmers have received a benefit from the farm loan waiver scheme. To carry out various agricultural activities farmers need capital and to meet this demand they take a loan from a money lender at a very high rate (60-120% p.a.). Moreover, to meet their financial needs farmers mortgaged the gold jewellery of their wives (70%). Farmers have also reported that they are highly (98%) dependent on credit from a bank to carry out agricultural activities (Figure 14). No bullock carts have been received by the farmers from the government scheme.

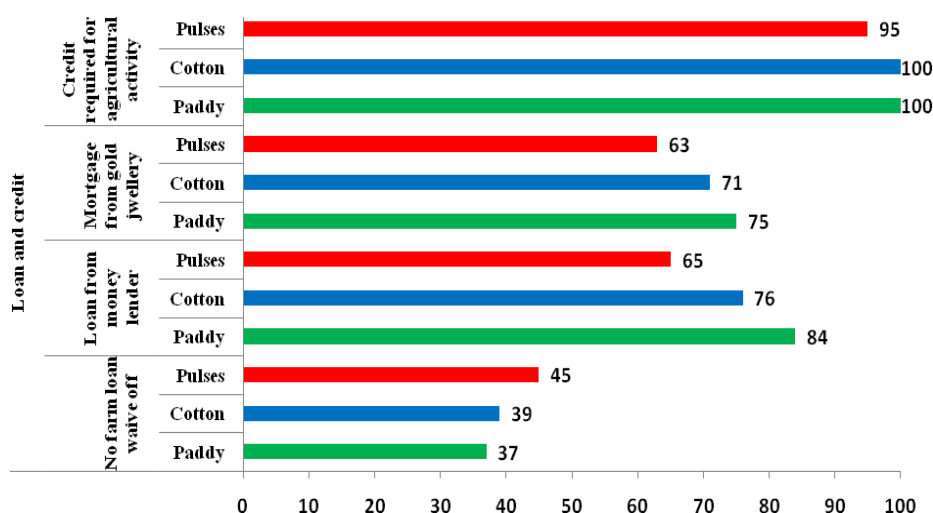


Figure 14: Loan and credit were taken by the farmers

To carry out various agricultural and other activities farmers require credit. This credit requirement is met from various sources. Table 6 provides issues related to the formal and informal credit systems in India. According to the 'Situation Assessment of Agricultural Households and Land and Livestock Holdings of Households in Rural India, 2019' (National Sample Survey, 2021) at the national level the use of fertilizers by farmers to enhance the crop yield was in the order of chemical fertilizers (73.3%) > manures (44.35%) > bio-fertilizer (12.15). About 83% of farmers purchase these chemicals and bio-fertilizer from the local market. In addition, plant protection materials viz. chemical and bio-pesticides revealed maximum (44.45%) farmers use chemical pesticides as compared with bio-pesticides (8.3%). As the quantity of fertilizer and insecticide/pesticide use has increased leading to more capital investment.

Table 6: Issues related to formal and informal credit systems in India

Issues	National Banks	Co-operatives	Moneylenders	Relatives
Ease of availability	Procedure locked	Manageable	Easy	Not so easy
Time required	Long delays	Delayed	Instant	Some delays
Amount availability	By rule, Less	Influence matter	Highest	Depends
Interest rate	Up to 14% p.a.	18% p.a. average	60-120% p.a.	Low
Recovery method	Relatively mild	Severe	Harassment/Sale deed	Emotional

(Fernando *et al.*, 2009)

The climate change impact on crops includes no/late seed germination (63%). Farmers rely on purchased seeds to carry out agricultural activities. The percentage of households by the quality of purchased seed in paddy, good quality seeds are reported 73.35%; whereas, for pulses 75.48% and 61.95% for cotton. When no seeds are germinated farmers have to carry out a second round of sowing which results in an additional financial burden on them by purchasing new seeds (National Sample Survey, 2021).

The minimum support price (MSP) is a form of market intervention by the Government of India to ensure farmers are against any sharp fall in farm prices. About 84% of farmers have revealed that they do not get MSP. The awareness about MSP was reported by 46.75%, 26.69% and 33.25% of farmers for paddy, pulses and cotton respectively. In the case of awareness of procurement agency under MSP 35.3%, 17.41% and 21.35% were aware of it for paddy, pulses, and cotton respectively. The crops sold to procurement agencies revealed only 16.5%, 3.2% and 10.4% sold paddy, pulses, and cotton respectively to them. Of the percentage output sold under MSP for paddy, pulses and cotton were 24.2%, 5.73% and 12.7% respectively. This indicates a gloomy scenario for the awareness about MSP and sale of crops among farmers (National Sample Survey, 2021).

For life/crop insurance, 46% farmers have no life/crop insurance (Figure 13). The percentage of crop-producing agricultural households that have insured their crop was in the order of cotton (27.1%) > paddy (11.1%) > pulses (10.06%). Of the percentage of insuring agricultural households that have received insurance documents for paddy, pulses and cotton were 43.1%, 42.51%, and 50.02% respectively. The three major reasons for not insuring the crops are not aware of it > not interested > not aware about availability of facility. Of the crops cultivated from the study area, maximum (41.95%) paddy cultivating farmers were not aware of it. The case of not interested were (23.85%) and not aware of availability of facility (13.75%). In the case of paddy, it was 39.4%, 13.49% and 23.08% for not aware, not aware of the availability of the such facility and not interested respectively. For cotton farmers not aware of it was 34.85%, not aware of the availability of such facility 10.95%, and not interested 25.15%. Thus, unawareness about crop insurance has emerged as one of the major reasons for not doing the same (National Sample Survey, 2021).

Crop loss was experienced by several farmers. Of the crops studied from the study area it was in the order of pulses (57.58%) > cotton (46.55%) > paddy (31.65%). Of the various reasons identified for the crop loss inadequate rainfall/draught has emerged as the major one for cotton (68.9%), pulses (53.49%), and paddy (45.65%) followed by disease/insects/animal 24.1%, 23.89% and 24.05% for paddy, pulses and cotton respectively. Irrigation facility is available to only one-third farmers of in India, which makes them vulnerable to crop loss due to the non-availability of rainfall and inadequate irrigation facility (National Sample Survey, 2021). The average monthly income and expenditure for each size class of land possessed at the national level are presented in Table 7. From the table, it can be observed that of the different size class of land possessed by the farmers, marginalized farmer (<1.0 ha.) has the minimum income (Rs. 8046/- US \$98.12). The monthly income of this group of the farmer is less than farm labourers (<0.01 ha. land holding) (Rs. 11,204/-, US \$136.63). The reason for this can be assigned to the income from wages, crop production and farming of animals was higher in labours than marginalized farmers. The monthly average expenditure was Rs. 412/- (US \$5.02). This was also the minimum among the various groups of farmers. As the monthly income is minimum the capital in hand to carry out various agricultural activities gets limited. These farmers have to depend upon capital from other sources which always makes a certain amount of outstanding loans to them (National Sample Survey, 2021).

Table 7: Average monthly income and expenditure (2019)

Size class of land possessed (ha.)	Average monthly income Rs. (US \$)	Average monthly expenditure Rs. (US \$)
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<0.01	11,204 (136.63)	885 (10.79)
0.01-0.40	7522 (91.73)	279 (3.40)
0.40-1.00	8571 (104.52)	545 (6.64)
1.01-2.00	11449 (139.62)	848 (10.34)
2.00-4.00	16435 (200.42)	2109 (25.71)
4.01-10.00	28292 (354.02)	3816 (46.53)
10.00+	60758 (740.95)	7088 (86.43)

(National Sample Survey, 2021)

The monthly expenses for crop production by the marginalized farmer were Rs. 1974/- (US \$24.07). The expenses incurred are in the order of human labour > fertilizer/manure > seeds > irrigation > plants protection chemicals. In the case of farming animals, the monthly expense of this group of marginalized farmers was Rs. 2448/- (US \$29.85). The maximum monthly expenditure was towards animal feed (Rs. 1739/-, US \$21.20) followed by labour charges Rs. 552/- (US \$6.73). The average monthly expenses for non-farm businesses was (Rs. 17413/-, US \$212.35) while receipts were Rs. 23899/- (US \$291.45) which makes them again the minimum net receiver (Rs. 6486/-, US \$79.09) from the various group for farmers (National Sample Survey, 2021).

As the income from the agricultural and non-farm business is limited, the farmers seek credit from different sources which makes them indebted always. The average amount of outstanding loans per agricultural household for this group of marginalized farmers was Rs. 42576/- (US \$521.41). The percentage of the indebted marginalized agricultural household was 44.6% and the percentage distribution of indebted marginalized agricultural households was 31.1% (National Sample Survey, 2021).

To meet the financial requirements of agricultural activities these groups of marginalized farmers seek credit from various institutional and non-institutional sources. In institutional sources scheduled commercial banks (36.7%) were the first choice followed by cooperative societies (6.4%). In the case of non-institutional sources, professional money lenders (16.9%) were the first choice followed by relatives and friends (6.35%). The percentage distribution of the amount of outstanding loans by the purpose of loan taken by the marginalized farmers is in the order of revenue expenditure in farm business (20.45%) > for housing (18.2%) > capital expenditure in farm business (17.05%) > other consumption expenditure (12.65%) (National Sample Survey, 2021).

The average monthly income of farmers from different sources for Maharashtra was Rs. 11,492/- (US \$140.14), whereas monthly expenditure on productive assets was Rs. 960/- (US \$11.70). The average monthly paid-out expenditure for crop production was Rs. 3500/- (US \$42.68) with maximum expenditure for fertilizer/manure (25.1%) followed by human labour (19.9%). For farming of animals average monthly expenses were Rs. 3151/- (US \$38.42) with a maximum for animal feed (72.4%) followed by labour charges (19.1%). The average monthly receipt from the non-farm business was Rs. 8614/- (US \$105.04) and only 9.8% of agricultural households engaged in non-farm business. The average amount of outstanding loans per agricultural household in Maharashtra was Rs. 82,085/- (US \$1001.03) which was about 54% of indebted agricultural

households. This average outstanding loan for farmers in Maharashtra was higher than the average amount for all India farmers (Rs. 74,121/-, US \$903.91). The amount of outstanding loans by sources of loan taken from institutional sources was in the order of scheduled commercial bank (41.8%) > co-operative society (18.6%) > co-operative bank (9.1%). In the case of non-institutional sources it was relatives and friends (6.6%) > professional money lenders (5.3%) > other non-institutional agencies (1.7%). The amount of outstanding loans by purpose revealed maximum (43.9%) farmers in Maharashtra seek the loan for revenue expenditure in farm business followed by capital expenditure in farm business (26.7%) (National Sample Survey, 2021).

The major reasons (n=14) (Figure 15) identified from the results obtained from the study perhaps may cause the marginalized farmers' suicides. These reasons are the average of the results obtained from three cropping areas of the study area. The farmers have reported (98%) they need credit to carry out their agricultural activity. However, to get multiple credits from government banks is difficult whereas, from moneylenders is possible with an extremely high-interest rate (60-120% p.a.). The higher cost of insecticide/pesticide may be another reason (96%). As new insect pest attacks and their incidences have increased every year to cope with them farmers are using insecticides/pesticides in high quantity and at high frequency. Irrigation water scarcity is perhaps another problem (94%) which may catalyst other agricultural problems.

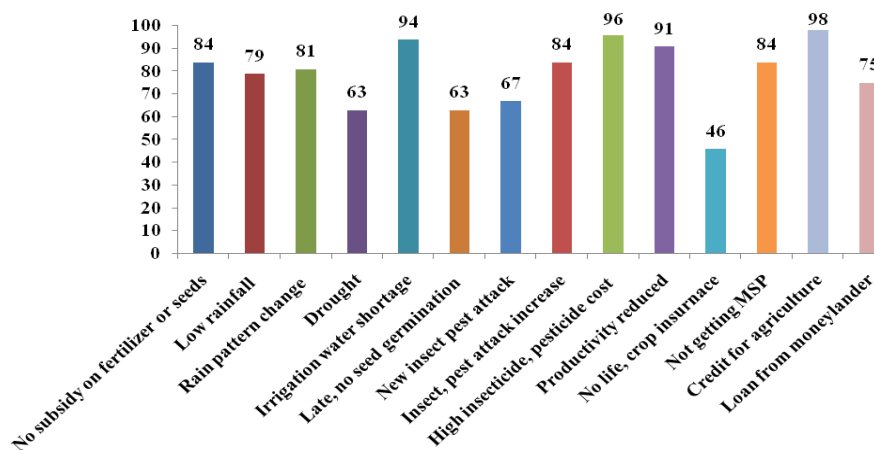


Figure 15: Major reasons identified which may cause farmers' suicide

The climate change-induced vicious cycle responsible for farmers' suicide is depicted in Figure 16. From the figure, it can be seen that initial climate change-induced aspects are later responsible for the high debt which over a prolonged period results in mental and emotional disorders which perhaps force the farmers to commit suicides as an easy way to break the clutches of this cycle.

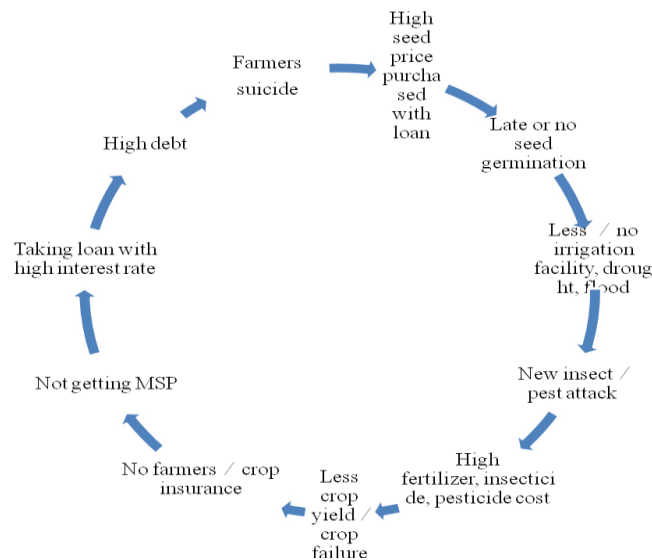


Figure 16: Vicious cycle for farmers' suicides

Parvathamma (2016) stated various reasons for farmer suicides, such as monsoon failure, high debt burdens, genetically modified crops, government policies, public mental health, personal issues and family problems. Indra Shekhar Singh has stated that it is unfathomable that farmers' suicides are increasing every year, especially in the cotton growing belts. The reasons for the suicides are crop failures, rising input costs and low market prices often trap the farmers in a cycle of debt. Farmers haven't fully recovered from the lockdowns yet too (Krishnan, 2022).

The price of cotton and chilli seeds went up by 400% (Narasimha Rao and Suri, 2006). Furthermore, in the era of Intellectual Property Rights farmers can't store, reuse and share seeds and compel to purchase new seeds every year (Shiva *et al.*, 1999). Thus, to meet this increased cost of seeds and new seeds farmers are purchasing the seeds with the loan amounts from institutional or non-institutional sources. This creates a financial burden on them from the start of crop cultivating activity which goes on multiplying if seeds do not germinate after the second round of seed sowing. The cotton belt is identified as the suicide belt in India.

Thomas and Tavernier (2017) reported a Bt. farmer facing an unfavourable expenditure-yield ratio will find themselves in a more precarious position than non-Bt. farmer. In addition, there is a definite association between economic factors associated with Bt. cotton farming and farmer-suicide. A study in the Vidarbha region of Maharashtra had associated indebtedness (87%) and deterioration in the economic status (74%) as major risk factors for suicide (Mishra, 2006). Suicide among female farmers is on the rise. Women engaged in farming have reported high levels of stress, fatigue and depression (Gallagher and Delworth, 2003). Female farmers have an additional burden of performing household chores apart from farming. This makes farm women a high-risk category for suicide. England, Australia and now India had reported suicide among this gender (Behere, 2008).

Presently only about 35% of the total agricultural land in India is irrigated. There are other infirmities, which keep most farmers at subsistence levels. The fragmentation of land holdings is a major cause, with about 83% of farmers considered small or marginal with less than 2 ha. each. This implies that over 80% of the

farmers in India hold about 35% of the total cultivated land. To compound matters there has hardly been any new creation of irrigation potential by the State for the last 25 years (Hindustan Times, 2017). Non-availability of irrigation facilities is identified as the major problem leading to farmers' suicide.

The farmers' suicide in the water-deficit states of Maharashtra, and Karnataka is a manifestation of how the water crisis and thereby failure to meet production demands have intensified the menace. This is particularly true in the backdrop of continued failed monsoons (Farmers' Suicides in India – Reasons and Responses, 2022). Low rainfall, irrigation water scarcity, and drought have been triggering factors for farmers' suicides in the study area.

According to Manjunatha and Ramappa (2017), the maximum (33.1%) farmers from a pan-India study that committed suicides were illiterate followed by matriculation (10th standard) (22.8%). In the case of Maharashtra, it was illiterate (40.0%) followed by middle school (8th standard) (28.0%). The family types of these farmers were nuclear (59.1%) and remaining (40.9%) with joint and 91.3% were married. For Maharashtra state, the joint family type was maximum (72%) with 92% married farmers. The place of suicide by farmers was their home (56.6%) followed by the farm (36.2%) at the national level whereas for Maharashtra a reverse trend was observed with a farm (54%) as a preferred place followed by home (38%). The farmers depended upon groundwater as a major source of irrigation (~70%) at the national level and its percentage was higher (80%) for Maharashtra state. The net profit per acre for paddy was nil, pulses were Rs. 1490/- (US \$18.17), and cotton Rs. -687/- (US \$-8.37) for Maharashtra and India was Rs. 29,926/- (US \$364.95) for paddy, Rs. 21,308/- (US \$259.85) for pulses and Rs. 18,496/- (US \$225.56) for cotton.

The month-wise farmers' suicide analysis revealed maximum (629, 12.2%) farmers committed suicides at the national level in October 2015 followed by 589 (11.4%) in August 2015. A similar trend was also observed for Maharashtra state (344 in October 2015 and 340 in August 2015) (Manjunatha and Ramappa, 2017). Kharif crops are grown with the onset of monsoon in different parts of the country and Maharashtra and these are harvested in September and October. The important crops grown during this season are paddy, maize, jawar, bajra, pulses, cotton, jute, groundnut, and soybean. Due to the non-realisation of expected output, October 2015 month has become the 'suicide month' in the cropping calendar. India receives southwest monsoon from June to September and maximum rainfall in August making it the wettest month of the year. Percentage departure of All India Observed Rainfall from Normal for 2015 revealed that rainfall for June month was only 16% from normal whereas the rest of the monsoon season has recorded negative trends in July (-17%), August (-22%), and September (-24%). Thus, making total monsoon departure from normal -14%. Due to very less rainfall, only the first month of monsoon (June 2015, 16%) may have not resulted desired crop growth thus making August 2015 another 'suicide month' for the farmer. In the case of the Marathwada and Vidarbha regions of Maharashtra state, the departure was -40% and -11% respectively during the monsoon of 2015. For Marathwada, it was -85% and -40% whereas for Vidarbha it was -56% and -6% for July and August 2015 respectively. In the rainy season (July-October of 2015) farmers committed suicide (44%, average 11%) as compared with the rest of the year (November-June, 56%, average 7%). Thus, during the rainy season if no/scanty rainfall followed by late or no seed germination and a second round of seed sowing with the high cost of other agricultural activities may have promoted suicide activity in the farmers.

Insuring a hectare of orange orchard in Nagpur district of Maharashtra state costs Rs. 60,000/- (US \$731.70) and the compensation in the case of eventual loss of output is Rs. 80,000/- (US \$975.60). The premium (Rs. 60,000/-) is equally shared by farmers, state and central government (Rs. 20,000/- each, US \$243.90 each). However, the gap between the premium and insurance is too narrow (Rs. 20,000/-, US \$243.90). The investment of Rs. 20,000/- towards premium contribution by marginalized and small group of farmers is even very high. This high premium contribution is the reason farmer are shying away from getting orchards insured despite facing losses due to unseasonal rains and hailstorm almost every year. In the year 2023, out of 21,000 ha. of orange orchards in Nagpur only 1,983 ha. (9.44%) has been insured. In case of Wardha district it was 49 ha. (1.11%) out of 4,400 ha. This insurance premium has been increased (three times) two years ago (Arya, 2023).

Of the various social causes identified by Manjunatha and Ramappa (2017) for farmers' suicide at the pan-India level, drug/alcohol addiction has been identified as a major one (25.9%). From this study, maximum (50%) farmers are addicted to tobacco consumption followed by cigarette/bidi smoking (15.33%).

NCRB of India points out that in 2474 suicides out of the studied 3000 farmer suicides in 2015 the victims had unpaid loans from local banks. Moreover, a shift away from the usual trend also revealed that of the loans taken by these farmers, only 9.8% were loaned from money lenders. Thus, the pressure or muscle power of money lenders could be far from being a major driving force, as is otherwise perceived (Farmers' Suicides in India—Reasons and Responses, 2022). To meet the credit requirement for agricultural activities farmers rely upon non-intuitional sources of credit which mainly include moneylenders with high-interest rates (60-120% p.a.).

The National Mental Health Association of the USA states that "No matter the race or age of the person; how rich or poor they are, it is true that most people who commit suicide have a mental or emotional disorder". Suicide is not a matter of economics. This is well supported by the data released by World Health Organisation in 2011. The suicide rate in India, an agrarian economy, was 13 per 100,000; that of industrialised, rich countries were often higher or comparable to South Korea 28.5, Japan 20.1, Russia 18.2, USA 12.6, Australia 12.5, and UK 11.8 (Farmers' Suicides in India – Reasons and Responses, 2022). The results obtained in this study are not in agreement with National Mental Health Association, USA. Marginalized farmers' suicide in India is owing to the initial agricultural factors which at a later stage result in poor economic conditions with high debt which over a prolonged period leads to mental and emotional disorders which perhaps force them to commit suicide.

Manjunatha and Ramappa (2017) reported farmers feel a repeated sense of hopelessness due to the loss of crops, income, and land. Another factor that increases suicides is social isolation due to the loss of communities as well as geographical remoteness. Lack of access to mental health services in rural areas and the stigma attached to treatment is also contributing factor. Depression arising from exposure to agricultural chemicals/pesticides may increase the risk for mood disorders and ultimately suicide.

The farmers' family after a farmer commits suicide has to face a major problem concerning earnings as the victim was the only breadwinner in the majority of the households. The family becomes insecure about their future and life and is under depression. The family members are harassed by moneylenders for the loan

amount. The other major impact is the discontinuation of agricultural activity. The farmer's widow is burdened with new responsibilities which many times she is not capable to fulfill it. In case of both parents committed suicide, the children are forced to stop their education and have to explore opportunities to fulfil their basic needs.

As conclusions, global climate change has a pronounced impact on agriculture. It varies from no or late seed germination to less productivity. Owing to the vulnerability of marginalized and small farmers to global climate change due to less landholding, poor economic conditions and social status are at receiving end. Of the various groups of farmers in India, marginalized and small groups of farmers/cultivators and labourers both genders are committing suicide for about three decades (1995-2023). Of various reasons identified for the farmers' suicide late/no seed germination, less/no irrigation facility, new insect/pest attack, high fertilizer, insecticide, pesticide cost, crop failure, no farmers/crop insurance, and not getting MSP leading to high debt are major ones. These reasons form a vicious cycle over a while and result in the formation of a mental/emotional disorder which forces them to commit suicide as an easy way to get rid of this cycle. Climate change induce debt is the major reason for farmers' suicides in India. Farmers' loans waiving up to a certain amount from both state and central government may have a limited period impact on farmers' suicide which again gathers momentum after the impact period gets over.

To overcome the climate change-induced farmers' suicide issue a comprehensive approach needs to be taken including the creation of a local/regional seed bank and the preservation of the previous year's seeds needs to be encouraged along with a supply of quality seeds at a subsidized rate. The crop selection and cultivation should be carefully carried out with more emphasis on less water-intensive crops. To minimize the impact of climate change, crop diversification should be encouraged. Different date planting nurseries will help to overcome the issue of no or late seed germination. A community-level farm tank by a group of farmers will help to meet the irrigation requirement in the lean period. The government should take measures for the creation of irrigation facilities by interlinking rivers and encouraging rainwater harvesting. Integrated pest management, push-pull technology, pheromone traps etc. will assist in insect pest management. Exposure to agricultural chemicals/pesticides should be minimized by using personal protective equipment. Cow dung manure and farm waste manure use should be motivated. Precision farming should be adopted along with the farm's soil nutrient analysis through Soil Health Card Scheme. Awareness about farmers and crop insurance should be carried out. The insurance premium should be affordable and the gap between premium and insurance should not be narrow. The government should ensure that farmers should get MSP within a stipulated period. The credit delivery system needs to be strengthened by increasing credit limits, simplifying loan procedures, subsidising loans, low rates of interest loans, and multiple-time loan facilities with late repaying earlier ones from a government bank. Input support to marginalized and small farmers of about Rs. 10,000/- (US \$121.95) per acre should be provided to farmers who can utilize it for agricultural activities. The non-institutional sources of finance need to be monitored and the functioning of the commercial bank needs to be improved. To ease the pressure on farmers to commit suicide the influence of moneylenders needs to be removed.

Access to mental health services, low-cost healthcare facilities and counselling by a psychologist in rural areas needs to be provided. A rehabilitation centre for drug/alcohol addiction needs to be established. Corporate, community and family farming should be encouraged to restrict further division of agricultural land. In addition, alternative and supportive source of income from dairy enterprises needs to be generated. A provision of pension to marginalized and small group of farmers will ensure economic stability in old age. Vocational training for the farmers' widows needs to be provided. Full scholarships and free education need to be provided to children who have lost both of their parents by committing suicide. The central and state government needs to formulate preventive and affirmative action to stop these farmers' suicides. The problem faced by this group of marginalized farmers perhaps may be different from large farmers (>10 ha. agricultural land). Thus, a separate policy is the need of the hour. A good policy and good institutional mechanism to implement the same will pave the way for sustainable agriculture and a sustainable society at large and will reduce the marginalized and small farmers' suicides in India. Thus, save farmers save agriculture.

REFERENCES

- ADSI. 2021. Accidental Deaths & Suicides in India 2021. National Crime Record Bureau, Ministry of Home Affairs, New Delhi.
- Arya, S. 2023. Premium too high, farmers turn back on orange insurance. Times of India, (Accessed on April 1, 2023).
- Behere, P. B. 2008. Farmers' suicide in Vidarbha and BC Roy award. Times of India. Nagpur edition. May 24
- Dev, S. M. 2012. Small farmers in India: Challenges and opportunities, WP-2012-014. Indira Gandhi Institute of Development Research, Mumbai. <http://www.igidr.ac.in/pdf/publication/WP-2012-014.pdf>.
- Farmers' Suicides in India—Reasons and Responses. 2022. <https://www.clearias.com/farmers-suicides/>. Accessed on 26 December 2022
- Fernando, N., Arun Kumar, and MIT School of Government (Pune, India). 2009. The tragedy of farmers' suicides in Vidarbha: A lesson and a ray of hope. New Delhi: Rupa & Co.
- Gallagher, E., and U. Delworth. 2003. Family farm business in a changing rural society. Canberra: RIRDC Research; 2003. The third shift: Juggling employment, family and the farm. (Rep No. 95/8)
- Hindustan Times. 2017. Look at the issue clearly, farmer suicides are driven more by psychology than economics. April 24, 2017. Accessed on December 26, 2022.
- Krishnan, M. 2022. India: Why are suicides among farmers on the increase? <https://www.telegraphindia.com/india/india-why-are-suicides-among-farmers-on-the-increase/cid/1883985>. Accessed on December 26, 2022.
- Mahapatra, D. 2017. Over 12,000 farmer suicides per year, Centre tells Supreme Court. Times of India. Available at: http://timesofindia.indiatimes.com/articleshow/58486441.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst. Accessed on December 26, 2022.
- Manjunatha, A. V., and K. B. Ramappa. 2017. Farmer suicides: An All-India Study, Agriculture Development and Rural Transformation Centre Report, Institute for Social and Economic Change, Karnataka.

- Mishra, S. 2006. Suicide of farmers in Maharashtra state: Report submitted to Government of Maharashtra.
- Narasimha Rao, P. and K. C. Suri. 2006. Dimensions of Agrarian Distress in Andhra Pradesh. *Economic and Political Weekly*, Vol. XLI, No. 16, pp: 1546-52.
- National Statistics Office. 2021. Situation Assessment of Agricultural Households and Land and Holdings of Households in Rural India, 2019. NSS 77th Round. Ministry of Statistics and Programme Implementation. Government of India.
- Parvathamma, G. L. 2016. Farmers Suicide and Response of the Government in India -An Analysis. *IOSR Journal of Economics and Finance*, 7(3): 1-6.
- Rama Rao, C. A., B. M. K., Raju, A. V. M. Sabba Rao, K. V. Rao, V. U. M. Rao, K. Ramachandran . . . Ch. Srinivasa Rao. 2016. District-level assessment of the vulnerability of Indian agriculture to climate change. *Current Science*, 110(10): 1939-1946.
- Rukmini, S. 2015. India's New Farm Suicides data: Myths and Facts. *The Hindu*. (Accessed on 2015 July 24).
- Shiva, V., E. Ashok, and J.H. Afsar. 1999. Globalization and Threat to Seed Security: Case of Transgenic Cotton Trials in India. *Economic and Political Weekly*, Vol. 34, pp. 601-613.
- Singh, M., M. K. Poonia and B. L. Kumhar. 2017. Climate change: Impact, adaptation, and mitigation: A review. *Agricultural Reviews*, 38 (1): 67-71.
- Thomas, G. and J.D. Tavernier. 2017. Farmer-suicide in India: Debating the role of biotechnology. *Life Sciences, Society and Policy*, 13: 8.
- Venkateswarlu, B., R. D. Ahire, and P. S. Kapse. 2019. Farmers Suicides in Marathwada Region of India: A Causative Analysis. *International Journal of Current Microbiology and Applied Sciences*, 8(4): 296-308. doi: <https://doi.org/10.20546/ijcmas.2019.804.034>