

# Assessment of farmers knowledge and perception towards the usage of sugarcane trash and environmental safety

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## Research Article

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# Abstract

## Purpose

In Maharashtra's Kolhapur district, open field burning of sugarcane trash (ST) is a major concern. This pollutes the environment, loses energy, and has a detrimental effect on biodiversity. As a result, a study was conducted to learn more about the underlying cause of sugarcane trash burning.

## Methods

The face-to-face interview of 186 sugarcane growers were carried in Kolhapur district of Maharashtra (India). The impact of age and education on behavior of farmers towards the usage of sugarcane trash were analyzed with help of M.S Excel, and Past-3 software and Drivers, Pressures, State, Impact, Response (DPSIR) model.

## Results

The age and education has non-significant effect on burning of sugarcane trash even though at 10% level of significance. The 61.12 % farmers burn the sugarcane trash in the field, whereas 38.70 % used for other purposes. The farmers (95.69 %) are very well know that burning of sugarcane trash has a detrimental effect on the environment. The 80 % farmers reported fear of rats, snakes and scorpion to use sugarcane trash as mulch in field as well as 42 % farmers reported burning of sugarcane trash in field has benefits.

## Conclusions

The study revealed that farmers have knowledge and understanding on how to use sugarcane trash for benefits but due to utilization barriers they burned the sugarcane trash in the field. There is need a robust policy as well as extension activity to address this issue.

# Introduction

Sugarcane is one of the world's oldest commercial crops, originating in tropical and subtropical regions (Powar et al. 2020). This accounts for roughly 60% of global sugar production. Brazil is leading country for sugarcane production followed by India (Kasulla et al. 2021). Sugarcane farming covers 16 Mha of land worldwide that yielding 112 MT of sugar. In India, sugarcane is grown on around 5 Mha that yielding annually 25–26 MT of sugar and 6.5 MT of sugarcane trash. This sugarcane is processed in 530 sugar mills in India (Powar et al. 2020; Powar et al. 2021). The states such as Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, Gujarat, Bihar, Haryana, and Punjab are the major sugarcane producing states in India. Uttar Pradesh alone accounts for half of the country's sugarcane production, with Maharashtra following closely behind. Tamil Nadu has the highest sugarcane productivity among the states, followed by Maharashtra and Karnataka (Kasulla et al. 2021; Powar et al. 2021).

Sugarcane cultivation is popular in the Kolhapur district of Maharashtra state and the total area under sugarcane cultivation is 0.149 Mha that yearly producing 12.491 MT of sugarcane (Powar et al. 2020). The average sugarcane productivity in Kolhapur district is 83.68 tons/ha (Powar et al. 2020, 2021). Presently, the green sugarcane tops are used as cattle fodder, while dry sugarcane leaves used for soil mulching, composting, burying infield to improve soil fertility, cogeneration plant fuel, biogas generation, ethanol production, and pulp and paper industries. In spite of that a significant amount of ST is burned on the farm. This pollutes the environment, loses the energy, and has a detrimental effect on biodiversity. According to Rossetto et al. (2010), open burning of ST in the field results in nitrogen (N) loss of 44 kg/ha/year and roughly 70-73 % potassium (K) loss from the soil. Mendoza (2014) identifies the negative effect of burning of ST on the environment. They reported the GHGs liberated during the burning of ST *viz.*, CO<sub>2</sub> (10410 equivalent to CO<sub>2</sub> per ha), CH<sub>4</sub> (467 equivalent to CO<sub>2</sub> per ha), CO (1241 equivalent to CO<sub>2</sub> per ha), N<sub>2</sub>O (830 equivalent to CO<sub>2</sub> per ha). To overcome this issue government of India has regulated different laws to prevent the open burning of agriculture residues *viz.*, "Section 144 of the Civil Procedure Code (CPC) to ban burning of paddy", "The Air Prevention and Control of Pollution Act, 198", "The Environment Protection Act, 1986 and The National Tribunal Act, 1995" (Bhuvaneshwari et al. 2019). Despite the above all facts, farmers refer to the open burning of sugarcane trash. This issue was thoroughly reviewed, and no single author was found to have worked on it. Therefore a study was conducted to learn more about the underlying cause of sugarcane trash burning.

# Methodology

## Study area

Kolhapur district is located in Maharashtra's southernmost region. It covers the area from the western Sahyadri hills to the eastern Krushna river, with the northern limit beginning at the Warana river and extending south to Karnataka state boarder. Kolhapur has a moderate climate and district's latitude and longitude coordinates are 16° 41' 28" N and 74° 14' 41" E, and its entire geographical area is 7685.00 km<sup>2</sup>, or 2.5 % of Maharashtra's total area. Rain falls in the district from both the south-west and north-east monsoons (Powar et al. 2020; Powar et al. 2021).

## Collection of data and analysis

The required data for study were collected with face-to-face interview with 186 farmers. The care should be taken that each category having sufficient number of entries. The prepared questionnaire for survey is given in Table 1. Table 1 has two parts, first part contains the basic information of farmers such as age and education, and second part contains the questionnaire to study the farmers' knowledge, behavior, and experience towards usage of sugarcane trash. The surveyed data then coded and entered into excel sheet. The Chi square test was performed with Excel special statistical tool 'Megastat'. Chi square score were used to study the impact of age and education on usage of sugarcane trash and environmental safety. The Past-3 software were used for Particle Component Analysis (PCA) that determines the relationship between the background of farmers and their knowledge, and perception towards the usage of sugarcane trash, and environmental safety. Similar software was also used by Shammi et al. 2020 for analysis. DPSIR (Drivers, Pressures, State, Impact and Response Model of intervention) was used for describing the interactions between society and the environment. Similarly, the DPSIR modelling framework was used to assess the effectiveness of implemented responses. Data and information on all of the different elements in the DPSIR chain were collected as a first step and in second step the theoretical linkages between these various features were proposed.

## Results

### Demographic characteristics of surveyed farmers

Table 2 shows the demographic characteristics of the surveyed farmers. The age group 20-30 years old had the highest participation (59 %) in the survey, followed by the age group of 30-40 (15 %), 40-50 (15 %), and >50 (10.75 %) years old, respectively. Agriculture graduates (37.63 %) had the most involvement in the survey, followed by other graduations (34.95 %) (science, arts, commerce etc.), 1-12<sup>th</sup> std. (17.20 %) and illiterates (10.21 %), respectively. According to preliminary research, discussions with experts, local government officials, and local residents, sugarcane trash management operations are dominated by men. As a result, the participation of females in the study was not compared to that of males. According to district census handbook Kolhapur-2011, the literacy rate in Kolhapur district is 81.51 %, with 88.57 % of males and 74.22 % of females (Government of India 2011).

### Impact of age on farmers' knowledge and behavior towards the usage of sugarcane trash

Table 3 lists 11 questions that were used to assess the farmer's knowledge, behavior, and perception towards the usage of sugarcane trash with respect to age. According to the study results, 49.46 % (92) of farmers had a higher income from jobs/business than from farming. It means that 49.46 % of farmers cultivate their farms as a side business, while 50.54 % (94) of farmers rely on farming for their primary source of income. The age has a significant effect ( $p < 0.05$ ) on the source of income. Farmers aged 20-30 years reported the highest income (60 %) from business/job than farming, followed by farmers aged >50 (40 %), 40-50 (35.71 %), and 30-40 (28.57 %) years, respectively (Table 3). Above discussion reported that the young farmers are given more preference for jobs/business over the farming and experienced farmers are earned more money from the side business.

According to the data, 30% (56) of farmers have received special agricultural training or education (Table 3). As a result, 70% (130) of farmers have not received any agricultural education or training. The age has a significant effect ( $p < 0.05$ ) on agricultural education. The famers from the age group of 20-30 years old reported the largest percentage of education from agriculture (38.18

%), followed by those in the 30-40 (28.57 %), 40-50 (14.29 %), and >50 (10 %) years old age groups, respectively (Table 3). According to the above debate, the younger generation is interested in pursuing a professional career in agriculture.

The 61.29 % (114) farmers were reported that they lighten the sugarcane trash after sugarcane harvesting and 38.71 % (72) farmers reported they used the sugarcane trash for other things. The age has a significant effect ( $p < 0.01$ ) on the burning of sugarcane trash in the field. The farmers from the age group of 30-40 years old had reported highest percent (85.71 %) of burning of sugarcane trash in the field, and followed by farmers in the age group of 20-30 (60 %), 40-50 (57.14 %) and >50 (40 %) years old, respectively (Table 3). The above discussion shows that the younger generation is more adamant about burning sugarcane trash rather than using it for other purposes.

The usefulness of sugarcane trash as an organic fertilizer for agriculture is known by 77.41 (144) % of farmers, whereas 22.58 % (42) farmers are oblivious. The awareness of the importance of sugarcane trash as an organic fertilizer for agriculture is significantly affected by age ( $p < 0.05$ ). Farmers over the age of 50 reported the highest percentage (90 %) of knowledge on how to use sugarcane trash for organic farming, followed by farmers in the age group of 40-50 (85.71 %), 20-30 (78.18 %), and 30-40 (57.14 %) years old, respectively (Table 3). According to the previous conversation, experienced farmers were optimistic about using sugarcane trash as an organic fertilizer for crops.

The burning of sugarcane trash has a negative impact on the environment had reported by 95.69 % (178) of farmers, while 4.30 (8) % are unaware. The age has a significant effect ( $p < 0.01$ ) on knowledge and awareness of farmers towards the negative impact of burning of sugarcane trash on the environment. The farmers from the age group of 20-30 and 40-50 years old had shown highest (100 %) knowledge and awareness towards the burning of sugarcane trash has a detrimental effect on the environment, and followed by farmers in the age group of >50 (90 %) and 30-40 (78.57 %) years old, respectively (Table 3). According to the above debate, the majority of farmers from all age groups are aware that burning sugarcane debris has a detrimental impact on the environment.

The detrimental impact of burning of sugarcane trash on the crop/tree around the field/boarder of farm was reported by 73.11 % (136), whereas 26.88 % (50) farmers are oblivious. The age has a non-significant effect on knowledge and awareness of farmers towards the harmful impact of burning of sugarcane trash on the crop/tree around the field/boarder of farm. The farmers from the age group of 40-50 years (85.71 %) old had most knowledge and awareness towards the negative impact of burning of sugarcane trash on the crop/tree around the field/boarder of farm followed by farmers in the age group of 30-40 (78.57 %), <50 (70 %) and 20-30 (69.09 %) years old, respectively (Table 3). In this scenario, age has no bearing on the farmers' knowledge and understanding towards the harmful impact of burning of sugarcane trash on the crop/tree around the field/boarder of farm.

The impact of media, publications, government agencies/officials, agricultural organizations or any sources be able to enhance the knowledge and awareness of farmers on how to use sugarcane trash to improve the soil fertility with respect to age of farmer was investigated. The 41.93 % (78) farmers were agreed with above agencies playing an important role in the knowledge and awareness of farmers how to use sugarcane trash to improve soil fertility, while 58.06 % (108) farmers were disagreed. The age has a significant impact ( $p < 0.01$ ) on knowledge and awareness of farmers towards the use of sugarcane trash to increase soil fertility. The farmers from the age group of 40-50 (64.29 %) years old had highest positive response that above agencies playing an important role in the knowledge and awareness of the farmers on how to use sugarcane trash to increase soil fertility, and it followed by farmers in the age group of 30-40 (50 %), 20-30 (38.18 %) and > 50 (20 %) years old, respectively (Table 3). According to the above discussion, experienced farmers are more likely to use published media to expand their expertise.

After sugarcane harvesting, 93.54 % (174) of farmers reported they utilize the green tops as animal fodder, while 6.45 % (12) reported they use them for other purposes. The age has a non-significant effect on use of green sugarcane tops as fodder for animals. The farmers from the age group of 30-40 (100 %) years old reported highest usage of green sugarcane tops as fodder for animals, and followed by farmers in the age group of 40-50 (92.86 %), 20-30 (92.73 %) and >50 (90 %) years old, respectively (Table 3). According to the findings of the survey, the majority of farmers from all age groups used the green sugarcane tops as the fodder for animal without bearing on age of farmers.

Similarly, the usage of green sugarcane leaves as fodder for animals during sugarcane growth period was investigated. The 73.11 % (136) farmers claimed they used green sugarcane leaves as fodder for animals during sugarcane growth period, while 26.88 % (50) farmers not-claimed. The age has a significant effect ( $p < 0.01$ ) on usage of green sugarcane leaves as fodder for animals during

sugarcane growth period. The farmers from the age group of 20-30 years old had claimed highest (88 %) usage of green sugarcane leaves as fodder for animals during sugarcane growth period and followed by farmers in the age group of 30-40 (78.57 %), >50 (70 %) and 40-50 (42.86 %) years old, respectively (Table 3). According to the study, farmers of all ages used green sugarcane leaves as animal fodder during the sugarcane growth phase.

From surveyed data, 33.33 % (62) farmers used sugarcane trash for mulching, whereas 66.66 % (124) farmers never did. The age has a significant effect ( $p < 0.05$ ) on usage of sugarcane trash for mulching. The farmers from the age group of > 50 years old (60 %) had claimed highest usage of green sugarcane trash for mulching and followed by farmers in the age group of 20-30 (34.55 %), 30-40 (21.43 %) and 40-50 (21.43 %) years old, respectively (Table 3). According to this survey, young farmers are more enthusiastic about using sugarcane trash for mulching.

Farmers' responses to the question of whether there are any benefits to burning sugarcane trash in the field with respect to farmer's age were explored. Yes, there are benefits to burning sugarcane trash in the field, according to 41.93 % (78) of farmers, but no, according to 58.06 % (108) of farmers. The age has a non-significant effect on the knowledge and awareness of the farmers towards the question 'are there any benefits of burning of sugarcane trash in the field?' The farmers from the age group of 40-50 years old gave the highest (57.14 %) positive response towards the question 'are there any benefits of burning of sugarcane trash in the field?', and followed by farmers in the age group of 20-30 (46 %), 30-40 (35.71 %) and > 50 (30 %) years old, respectively (Table 3). Farmers have claimed that burning sugarcane trash in the field has the following benefits: eradicating pest and disease breeding places, removing trash overburden from the field, and removing the barrier to prepare the field for the next crop. In this scenario, age has no bearing on the farmers' knowledge and understanding towards the benefits of burning of sugarcane trash in the field

[About Table 3 here]

## Impact of education on farmers' knowledge and behavior towards the usage of sugarcane trash

Table 4 shows the 11 questions that were used to examine the farmer's knowledge, behavior, and perception towards the usage of sugarcane trash with respect to education. According to the findings, 45.69 % (85) of farmers earned more money from jobs/business than they did through farming. Education has a significant impact on the source of income of farmers ( $p < 0.01$ ). Farmers with agricultural education (52.86 %) showed the strongest interest in the job/business than farming, followed by any graduation (49.23 %), 1-12 std (50 %), and illiterate farmers (50 %) (00 %), respectively (Table 4). As per above analysis, the educated peoples in the study region are focusing on jobs and businesses rather than farming. As a result, the talented force of people is not interested in agriculture. This is one of the main reasons why modern technologies are not adopted in the study area. Similarly, the education has a significant effect ( $p < 0.01$ ) on agricultural specific training. Farmers with agricultural education (100%) expressed the greatest desire to attend the special trainings, followed by farmers with any graduation (6.15%), 1-12 std (6.25%), and illiterate farmers (0%). (Table 4). According to the argument, agriculturalists are more interested in attending specific training to create a professional career in agriculture, whereas farmers from other education streams are less interested.

The lighting of sugarcane trash in the open field is a major concern in the study area. This issue was investigated in relation to farmer education, and it was discovered that education has a significant ( $p 0.01$ ) effect on field burning of sugarcane trash. Farmers who were illiterate (89.47 %) reported the highest percentage of sugarcane trash burning in the field, followed by farmers with any graduation (72.31 %), 1-12th grade (56.25 %), and agriculture (54.29 %), respectively (Table 4). According to the findings of the study, agriculture graduates are more aware of the risks associated with trash burning. As a result, they are less involved in the field burning of sugarcane trash.

The sugarcane trash is possible to decompose for obtaining organic fertilizer. Therefore, the knowledge and awareness of surveyed farmers were studied with respect to education. It was found that education has a significant effect ( $p < 0.01$ ) on the knowledge and awareness towards the use of sugarcane trash as an organic fertilizer for agriculture. Farmers with an agricultural education had the most knowledge and awareness about using sugarcane trash for organic fertilizer (81.54 %), followed by any graduate (68.75 %), 1-10th std (68.75 %), and illiterate farmers (10.53 %), respectively (Table 4). The above analysis revealed that the educated farmers demonstrated an excellent understanding and attitude toward using sugarcane trash as an organic fertilizer for crops.

The burning of sugarcane trash has a negative impact on the environment and it was studied with respect to education of farmers. The education has a significant effect ( $p < 0.01$ ) on knowledge and awareness of farmers towards the negative impact of burning of sugarcane trash on the environment. Farmers with an agricultural education (97.14 %) had the most knowledge and awareness about burning of sugarcane trash has a negative impact on the environment, followed by any graduate (96.92 %), 1-10th std (93.75 %), and illiterate farmers (10.53 %), respectively (Table 4). The above study reported that majority of farmers from all education group has well awareness that burning of sugarcane trash has a harmful effect on the environment, except for illiterate farmers.

The harmful impact of burning of sugarcane trash on the crop/tree around the field/boarder of farm was studied with respect to education of farmer. The education has a significant effect ( $p < 0.01$ ) on knowledge and awareness of farmers towards the harmful impact of burning of sugarcane trash on the crop/tree around the field/boarder of farm. Farmers with an any graduation (75.38 %) had the most knowledge and awareness about harmful impact of burning of sugarcane trash on the crop/tree around the field/boarder of farm, followed by agriculture graduate (72.86 %), 1-10th std (68.75 %), and illiterate farmers (10.53 %), respectively (Table 4). The study revealed that the majority of graduate's farmers has well awareness and knowledge towards the harmful impact of burning of sugarcane trash on the crop/tree around the field/boarder of farm.

The impact of media, publications, government agencies/officials, agricultural organizations or any sources be able to enhance the knowledge and awareness of farmers on how to use sugarcane trash to improve the soil fertility with respect to education of farmer was investigated. The education has a significant impact ( $p < 0.01$ ) on knowledge and awareness of farmers towards the use sugarcane trash to increase soil fertility. Farmers with an agriculture education (57.14 %) had the most knowledge and awareness about harmful impact of burning of sugarcane trash on the crop/tree around the field/boarder of farm, followed by any graduates (35.38 %), 1-10th std (25 %), and illiterate farmers (00 %), respectively (Table 4). As per above analysis, agriculture graduates are quite knowledgeable about how to obtain the information from the media, publications, government agencies/officials, agricultural organizations, and other sources.

The usage of green sugarcane tops as fodder for animals with respect to education were investigated. The education has non-significant effect on use of green sugarcane tops as fodder for animals. Farmers with an agriculture education (94.43 %) had the mostly used the green tops as animal fodder, followed by any graduates (90.77 %), 1-10th std (32 %), and illiterate farmers (100 %), respectively (Table 4). The above analysis proved that the majority of farmers from all education group are preferred the green sugarcane tops as fodder for their animals. Similarly, the usage of green sugarcane leaves as fodder for animals during sugarcane growth period was investigated. The education has a significant effect ( $p < 0.01$ ) usage of green sugarcane leaves as fodder for animals during sugarcane growth period. The illiterate farmers (100 %) had claimed highest usage of green sugarcane leaves as fodder for animals during sugarcane growth period and followed by farmers in the education group of any graduates, agriculture and 1-12<sup>th</sup> std, respectively (Table 4). According to the study, farmers of all education groups has used green sugarcane leaves as fodder for their animals during the growth period of sugarcane.

The use of sugarcane trash for mulching was studied with respect to education of farmer. The education has a significant effect ( $p < 0.01$ ) on usage of sugarcane trash for mulching. The farmers with agriculture education (50 %) had claimed highest percent use of sugarcane trash for mulch, followed by 1-12<sup>th</sup> std (25 %) any graduates (18.46 %), and illiterate farmers (10.53 %), respectively (Table 4). The above study reported that the agriculturalist are more positive towards the usage of sugarcane for mulching.

Farmers' responses to the question of whether there are any benefits to burning sugarcane trash in the field with respect to farmer's education were explored. Yes, there are benefits for burning sugarcane trash in the field, according to 38.17 % (71) of farmers, but no, according to 61.82 % (115) of farmers. The education has a significant effect ( $p < 0.01$ ) on the knowledge and awareness of the farmers towards the question 'are there any benefits of burning of sugarcane trash in the field?' The farmers with any graduation (49.23 %) had highest claim to answer of question 'are any benefits to burning sugarcane trash in the field' followed by agriculture graduates (35.57), 1-12<sup>th</sup> std (31.25 %) and illiterate farmers (10.53 %), respectively (Table 4). In this scenario, education has bearing on the farmers' knowledge and understanding towards the benefits of burning of sugarcane trash in the field.

## PCA analysis

The dominance tendency of perception demonstrates overall commonalities among interviewees, but no significant contributing factors. As a result, particle component analysis (PCA), a statistical tool, was employed to execute a factorial analysis (Yang et al.

2014). On the basis of the interviewees' backgrounds (Table 2), a PCA analysis was conducted, revealing farmers' attitudes on the usage of sugarcane trash (Table 3 and 4). Fig. 2 represents the PCA biplot of farmers' knowledge, behavior and backgrounds of interviewee towards use of sugarcane trash under PCA as constructed according to data collected. The length of the arrows shows the relative contribution of the variables to the axes and the perception–background relationship, while the direction of the arrows represents the correlation between each variable and the canonical axes and each other. The first component axes account for 99.42 % of the difference in perception–background of sugarcane trash utilization, while the second component axes account for 0.57 %. The reactions to the utilization of sugarcane trash were substantially connected with education, and age (Table 3 and 4). In Fig. 2, the greatest angular difference between the arrows for education and age revealed that these two characteristics had opposing effects on interviewees' knowledge, behavior, and backgrounds on the usage of sugarcane trash. As a result, age and education were important factors in promoting an understanding of the use of sugarcane trash. Table 5 represents the PCA biplot scores of farmers' knowledge and behavior towards use of sugarcane trash. The question 4, 5 and 6 has positive scores in first, and second principal component axis and they are more correlated with age. As a result, they are presented in first quadrant of biplot (Fig. 2 and Table 5). The question 3, 8 and 9 has negative scores in first principal component axis, while positive score for second principal component axis and they are more correlated with education. Therefore, they are presented in second quadrant of prepared biplot (Fig. 2 and Table 5). The question 10 has negative scores in first and second principal component axis, and they are not correlated with age and education. Therefore, they are reflected in third quadrant of prepared biplot (Fig. 2 and Table 5). Similarly, the question 1, 2, 7 and 11 has positive scores in first principal component axis, while negative score for second principal component axis and they are not correlated with age and education. As a result, they are reflected in fourth quadrant of prepared biplot (Fig. 2 and Table 5).

## DPSIR model

The interdependence of the components and interactions between society and the environment were described using the DPSIR model (wiki). (2020). This model has been used by the European Environmental Agency to define the relationship between society and the environment. This model is based on five primary structural frame components: drivers, pressures, state, impact, and intervention response model. Figure 3 depicts the Drivers, Pressures, State, Impact, and Response (DPSIR) model for sugarcane trash usage in western Maharashtra in terms of health and environmental issues. The primary goal of this DPSIR model was to determine the fundamental factors that contribute to the burning of sugarcane trash. According to the DPSIR model framework, the reasons for farmers' forces towards the burning of sugarcane trash are as follows: urgently prepare the land for the next crop (22 %), reduce the burden of trash from the field (22 %), destroy the breeding places of weeds and pest (12 %), keep rodents, scorpions, and snakes at bay (33 %), and lack of utilization technology (11 %) (Fig. 3 and 4). The DPSIR model framed the driving pressure to burn sugarcane trash in the field as taking longer time to decompose, reducing the growth of the next crop, being difficult to perform primary and secondary tillage operations, trash collection being labour intensive, trash having no economic value, and being difficult to use as fuel. Due of these demands, 61% of sugarcane producers burn their trash in the field. As a result, environmental pollution, biomass energy loss, impacted crop and tree growth, health difficulties, and soil nutrient loss have been found in the research area To avoid this issue, the Indian government has enacted legislation such as "Section 144 of the Civil Procedure Code (CPC)," "The Air Prevention and Control of Pollution Act, 198," "The Environment Protection Act, 1986," and "The National Tribunal Act, 1995". Due to inactive implementation of above policies farmers refer the open burning of sugarcane trash.

## Discussion

The use of stakeholders' knowledge about sugarcane trash is critical for developing appropriate solutions for decreasing environmental and health issues. The goal of this study was to assess attitudes and levels of understanding about the use of sugarcane trash so that reasonable actions might be taken to avoid the dangers of sugarcane trash burning and to reduce potential damage to agricultural systems. To manage the sugarcane trash, men appeared to accept greater responsibility than women. As a result, there was no comparative study between men and women was conducted (Powar et al. 2020). The decision-making power of questioned farmers is greatly influenced by their age and education. Farmers' ability to obey hazard warnings supplied by the chemical industry and regulatory bodies was limited by a lack of education, according to Yang et al. 2014. Open burning of sugarcane trash is a prevalent practice among the farmers all throughout the world. The main causes for this are a lack of labor and insufficient time to prepare the subsequent crop (Jain et al. 2014; Mohan and Ponnusamy 2011). The benefits of open burning ST include the elimination of weed-seeds, the elimination of breeding areas of pests and pathogens, the elimination of overburdening of

trash, and the removal of the rubbish barrier from the farming activities (Powar et al. 2020). It also has drawbacks, such as the loss of organic matter and nutrients (N (6-7 kg/acre), P (1-1.7 kg/acre), K (14-25 kg/acre), S (1.2-1.5 kg/acre), Urea (32 kg/acre), DAP (5.5 kg/acre) and Potash (51 kg/acre)) from the soil, as well as the emission of greenhouse gases like CH<sub>4</sub>, CO, and CO<sub>2</sub> (De Figueiredo and La Scala 2011; Kaur 2017). Mulching ST increases total agricultural production, protects the soil from erosion, maintains soil temperature, protects the soil from direct radiation, increases biological activities in the soil, improves water infiltration, prevents evapotranspiration, suppresses weed growth, improves soil moisture, increases organic matter in soil, increases carbon sequestration, increases ratoon crop productivity, and recycles nutrients (Wood 1991; Yadav et al. 1994; Graham et al. 2002; Rossetto et al. 2010). Nonetheless, it has some negative effects on the crop, including reduced ratoon sprouting, fire risk, water logging in the field, nitrogen losses from the soil, pest/disease occurrences, and difficulties in farm operations (de Carvalho Macedo et al. 2001; Rossetto et al. 2010; Gómez et al. 2014; Hass and Lima 2018). The advantages of ST composting are it improves the soil porosity with adding more humus, it improves the plant growth, it reduces the soil erosion and runoff of water, the nitrogen, phosphorus and potassium content in soil is increased with composting the ST (De Figueiredo and La Scala 2011; Mohan and Ponnusamy 2011; Nakhla et al. 2017). However, the slow decomposition rate of compost produced from sugarcane trash limits its use (Powar et al. 2022). Green sugarcane tops have long been utilized as animal fodder in India (Rathod et al. 2017). The ST, on the other hand, is described as unpalatable, with low digestion, dense fibrous content, low nitrogen, soluble carbs, and minimal minerals and vitamins. Furthermore, it includes a greater level of lignin, making it unsuitable for use as livestock fodder (Rathod et al. 2017). As a result, the value addition of ST is required to meet the animal's nutritional requirements. Dry sugarcane trash is a bulky and light material that takes up a lot of space. This can be a significant disadvantage during transportation (Fig. 2). The problem can be solved by chaffing the material into little bits using a mechanical chaff cutter (10 to 15 cm). Dry trash is high in fibre (32.3 %), carbohydrates (56 %), and hemicellulose (26.9 %) and it can only be used as a substitute for dry fodder like as wheat or rice straw. It does, however, contain less protein (3.54 %) than other cereal straws like rice or wheat. Mineral sources include calcium 0.66 %, phosphorus 0.10 %, magnesium 0.28 %, zinc 10.15 ppm, and copper 3.98 ppm (Rao et al. 2018). To overcome the aforementioned concerns, farmers of all ages and educational levels will need to participate in extensive training programmes.

## Study recommendation

Kolhapur district has a good education level, with 89.79 % of residents having at least a primary education, according to a survey. The impact of education on farmer earnings has been observed. Farmers with a high level of education would rather job than farm. Similarly, they earn more money than farming. Due to this situation farmers are busier in jobs than farming, as a result, they do not have time to properly handle sugarcane trash. This is one of the main reasons for the burning of sugarcane trash. Agriculture education also improves the farmers' knowledge and behavior toward the use of sugarcane trash for beneficiaries. As a result, agriculturists are required to engage in farming. According to research, farmers are well aware that burning sugarcane trash causes pollution, wastes energy, and destroys beneficial microorganisms present in the soil. Despite the fact that farmers prefer the open burning of sugarcane trash. The lack of extension of available technologies, poor policy execution, and the lack of subsidiaries to use sugarcane trash for beneficiaries are the main issues cited. Farmers' minds will be changed by strong policies and subsidiaries.

## Conclusion

This study highlight the farmer's knowledge, awareness and behavior towards the use of sugarcane trash for beneficiaries with respect to age and education. The age and education has significant effect ( $p < 0.01$  or  $0.05$ ) on burning of sugarcane trash, use of sugarcane trash as organic fertilizer, detrimental effect of burning of sugarcane trash on the environment, use of green sugarcane leaves as fodder and mulching. All farmers were uses green sugarcane leaves as fodder and they show non-significant effect with respect to age. The study revealed that farmers have well knowledge and awareness how to utilize the sugarcane trash for beneficiaries. Despite the fact that they attempted the sugarcane trash burning in the field due to lack of extension of available technologies, poor policy execution, and the lack of subsidiaries to use sugarcane trash for beneficiaries.

## Declarations

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### Compliance with Ethical Standards

Conflict of Interest: The authors declare that they have no conflicts of interest.

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## Tables

<b>Part 1: Basic Information</b>
<ol style="list-style-type: none"> <li>1. Age</li> <li>2. Education</li> </ol>
<b>Part 2: Farmers' knowledge, behaviour, and experience towards use of sugarcane trash</b>
<ol style="list-style-type: none"> <li>1. Do you earn more from farming than from a job or a business?</li> <li>2. Have you taken any special training or education related to agriculture?</li> <li>3. Do you light sugarcane trash in the field after harvesting?</li> <li>4. Do you know the importance of sugarcane trash as an organic fertilizer for agriculture?</li> <li>5. Do you know that burning of sugarcane trash has a detrimental effect on the environment?</li> <li>6. Did burning of sugarcane trash after harvesting affect the crop around the field or damage the trees on the boarder of farm?</li> <li>7. Did you get information from media, publications, government agencies / officials, agricultural organizations or any other way on how to use sugarcane trash to increase soil fertility?</li> <li>8. Do you use sugarcane green tops as fodder for animals after harvesting of sugarcane?</li> <li>9. Do you use sugarcane green leaves as fodder for animals during sugarcane growth?</li> <li>10. Have you ever used dried sugarcane leaves as mulching paper?</li> <li>11. Is there any benefits of burning of sugarcane trash in the field?</li> </ol>

**Table 1 The survey questionnaires on farmers' knowledge and behavior towards the usage of sugarcane trash**

**Table 2 Social and demographic characteristics of surveyed farmers**

	20-30	30-40	40-50	> 50
Age (Year)				
Percentage (n)	59 (110)	15 (28)	15 (28)	10.75 (20)
Education	Illiterate	1-12 <sup>th</sup> Std.	Any graduation	Agricultural
Percentage (n)	10.21 (19)	17.20 (32)	34.94 (65)	37.63 (70)

**Table 3 impact of age on farmers' knowledge and behavior towards the usage of sugarcane trash**

Survey questions	Yes/No answers	Age, Years				Chi score
		20-30	30-40	40-50	>50	
Do you earn more from farming than from a job or a business?	Yes, n (%)	66 (60)	8 (28.57)	10 (35.71)	8 (40)	12.61*
	No, n (%)	44 (40)	20 (71.43)	18 (64.29)	12 (60)	
Have you taken any special training or education related to agriculture?	Yes, n (%)	42 (38.18)	8 (28.57)	4 (14.29)	2 (10)	10.61*
	No, n (%)	68 (61.82)	20 (71.43)	24 (85.71)	18 (90)	
Do you light sugarcane trash in the field after harvesting?	Yes, n (%)	66 (60)	24 (85.71)	16 (57.14)	8 (40)	11.14**
	No, n (%)	44 (40)	4 (14.21)	12 (42.86)	12 (60)	
Do you know the importance of sugarcane trash as an organic fertilizer for agriculture?	Yes, n (%)	86 (78.18)	16 (57.14)	24 (85.71)	18 (90)	9.53*
	No, n (%)	24 (21.82)	12 (42.86)	4 (14.29)	2 (10)	
Do you know that burning of sugarcane trash has a detrimental effect on the environment?	Yes, n (%)	110 (100)	22 (78.57)	28 (100)	18 (90)	27.74**
	No, n (%)	0 (00)	6 (21.43)	0 (00)	2 (10)	
Did burning of sugarcane trash after harvesting affect the crop around the field or damage the trees on the boarder of farm?	Yes, n (%)	76 (69.09)	22 (78.57)	24 (85.71)	14 (70)	3.69 <sup>ns</sup>
	No, n (%)	34 (30.91)	6 (21.43)	4 (14.29)	6 (30)	
Did you get information from media, publications, government agencies / officials, agricultural organizations or any other way on how to use sugarcane trash to increase soil fertility?	Yes, n (%)	42 (38.18)	14 (50)	18 (64.29)	4 (20)	11.08**
	No, n (%)	68 (61.82)	14 (50)	10 (35.31)	16 (80)	
Do you use sugarcane green tops as fodder for animals after harvesting of sugarcane?	Yes, n (%)	102 (92.73)	28 (100)	26 (92.86)	18 (90)	2.49 <sup>ns</sup>
	No, n (%)	8 (7.29)	0 (00)	2 (7.14)	2 (10)	
Do you use sugarcane green leaves as fodder for animals during sugarcane growth?	Yes, n (%)	88 (80)	22 (78.57)	12 (42.86)	14 (70)	16.22**
	No, n (%)	22 (20)	6 (21.43)	16 (57.14)	6 (30)	
Have you ever used dried sugarcane leaves as mulching paper?	Yes, n (%)	38 (34.55)	6 (21.43)	6 (21.43)	12 (60)	10.04*
	No, n (%)	72 (65.25)	22 (78.57)	22 (78.57)	8 (40)	
Is there any benefits of burning of sugarcane trash in the field?	Yes, n (%)	46 (41.82)	10 (35.71)	16 (57.14)	6 (30)	4.28 <sup>ns</sup>
	No, n (%)	64 (58.18)	18 (64.29)	12 (42.86)	14 (70)	

Significant difference between effect of age on utilization of sugarcane trash, ns = not significant difference, \*p < 0.05, \*\*p<0.01.

**Table 4 Impact of education on farmers' knowledge and behavior towards the usage of sugarcane trash**

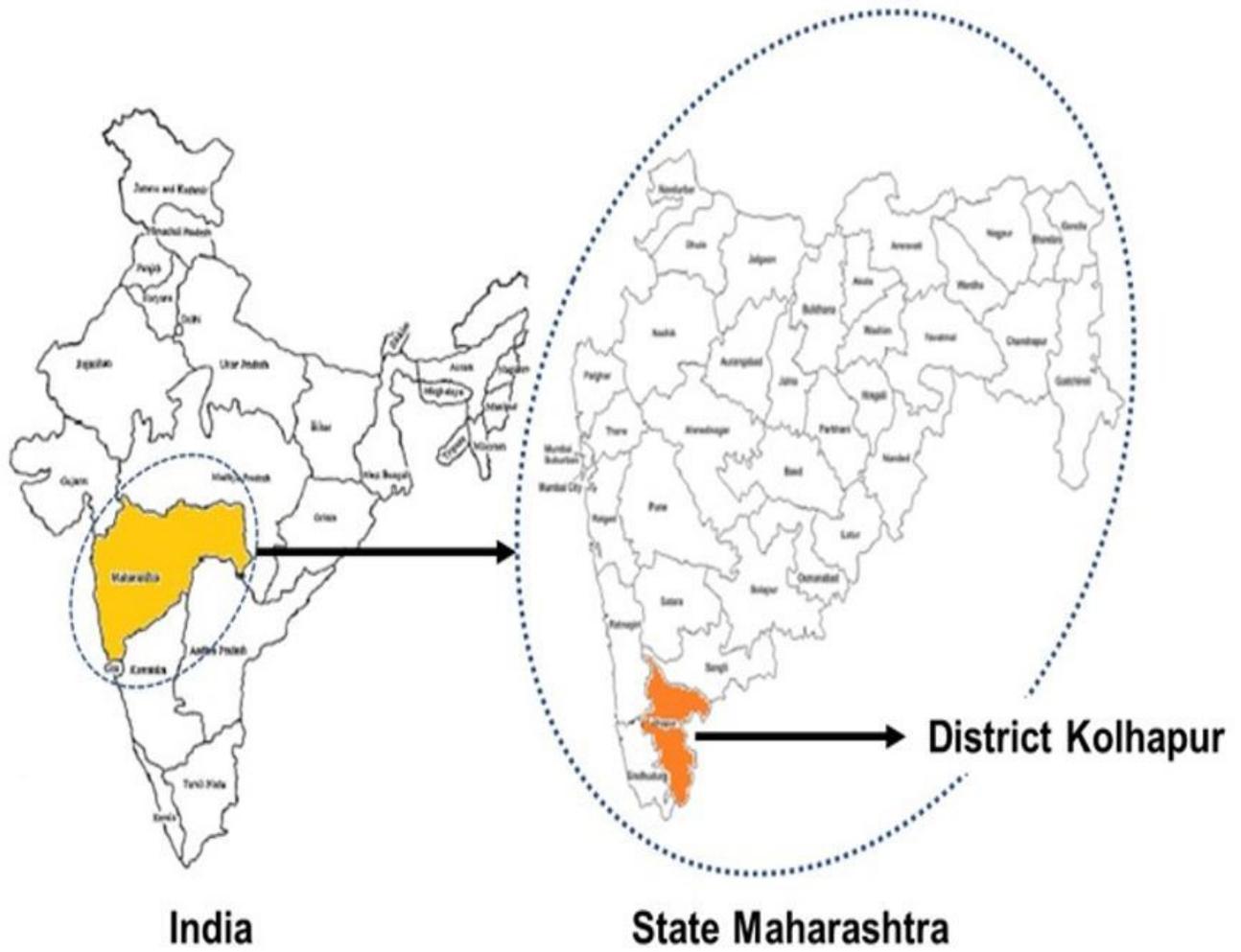
Survey questions	Yes/No answers	Education				Chi score
		Illiterate	1-12 <sup>th</sup> std.	Agriculture	Any graduation	
Do you earn more from farming than from a job or a business?	Yes, n (%)	0 (00)	16 (50)	37 (52.86)	32 (49.23)	18**
	No, n (%)	19 (100)	16 (50)	33 (47.14)	33 (50.77)	
Have you taken any special training or education related to agriculture?	Yes, n (%)	0 (00)	2 (6.25)	70 (100)	4 (6.15)	63.67**
	No, n (%)	19 (100)	30 (93.75)	00 (00)	61 (93.85)	
Do you light sugarcane trash in the field after harvesting?	Yes, n (%)	17 (89.47)	18 (56.25)	38 (54.29)	47 (72.31)	11.05**
	No, n (%)	2 (10.53)	14 (43.75)	32 (45.71)	18 (27.69)	
Do you know the importance of sugarcane trash as an organic fertilizer for agriculture?	Yes, n (%)	2 (10.53)	22 (68.75)	58 (82.86)	53 (81.54)	43.34**
	No, n (%)	17 (89.47)	10 (31.25)	12 (17.14)	12 (18.46)	
Do you know that burning of sugarcane trash has a detrimental effect on the environment?	Yes, n (%)	2 (10.53)	30 (93.75)	68 (97.14)	63 (96.92)	116.37**
	No, n (%)	17 (89.47)	2 (6.25)	02 (2.86)	02 (3.08)	
Did burning of sugarcane trash after harvesting affect the crop around the field or damage the trees on the boarder of farm?	Yes, n (%)	2 (10.53)	22 (68.75)	51 (72.86)	49 (75.38)	30.44**
	No, n (%)	17 (89.47)	10 (31.25)	19 (27.14)	16 (24.62)	
Did you get information from media, publications, government agencies / officials, agricultural organizations or any other way on how to use sugarcane trash to increase soil fertility?	Yes, n (%)	0 (00)	8 (25)	40 (57.14)	23 (35.38)	24.97**
	No, n (%)	19 (100)	24 (75)	30 (42.86)	42 (64.62)	
Do you use sugarcane green tops as fodder for animals after harvesting of sugarcane?	Yes, n (%)	19 (100)	32 (100)	64 (91.43)	59 (90.77)	4.87
	No, n (%)	0 (00)	0 (00)	06 (8.57)	06 (9.23)	
Do you use sugarcane green leaves as fodder for animals during sugarcane growth?	Yes, n (%)	19 (100)	18 (56.25)	50 (71.43)	54 (83.08)	15.34**
	No, n (%)	0 (00)	14 (43.75)	20 (28.57)	11 (16.92)	
Have you ever used dried sugarcane leaves as mulching paper?	Yes, n (%)	2 (10.53)	8 (25)	35 (50)	12 (18.46)	20.98**
	No, n (%)	17 (89.47)	24 (75)	35 (50)	53 (81.54)	
Is there any benefits of burning of sugarcane trash in the field?	Yes, n (%)	2 (10.53)	10 (31.25)	27 (38.57)	32 (49.23)	10.18**
	No, n (%)	17 (89.47)	22 (68.75)	43 (61.43)	33 (50.77)	

Significant difference between effect of age on utilization of sugarcane trash, ns = not significant difference, \*p < 0.05, \*\*p<0.01.

Table 5 PCA biplot scores of farmers' knowledge and behavior towards the usage of sugarcane trash

Survey question	PC <sub>1</sub>	PC <sub>2</sub>
q1	-0.71941	0.017856
q2	-1.9355	0.056817
q3	0.20347	-0.18564
q4	0.93533	0.063488
q5	1.9418	0.16883
q6	0.62753	0.10969
q7	-1.1736	0.014234
q8	2.0534	-0.073571
q9	0.90108	-0.16386
q10	-1.6604	-0.022086

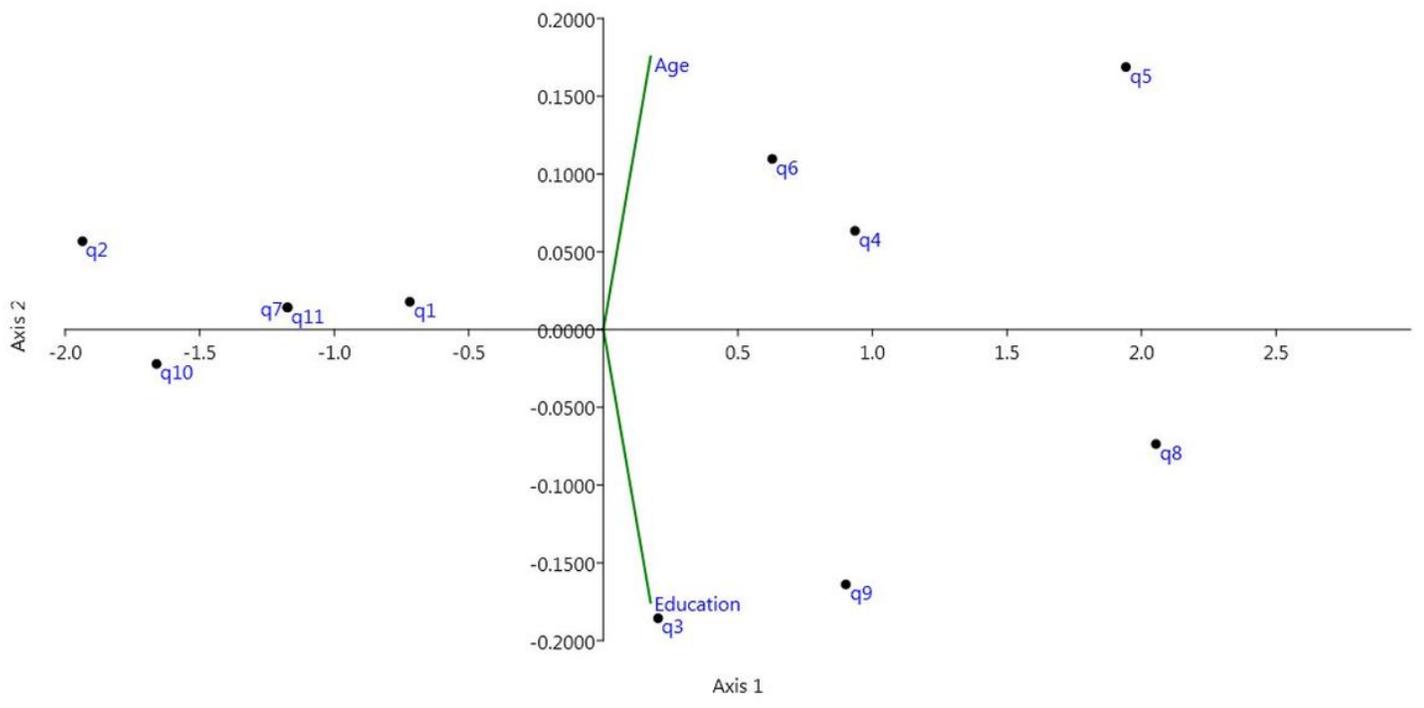
## Figures



Source: Powar et al. 2020

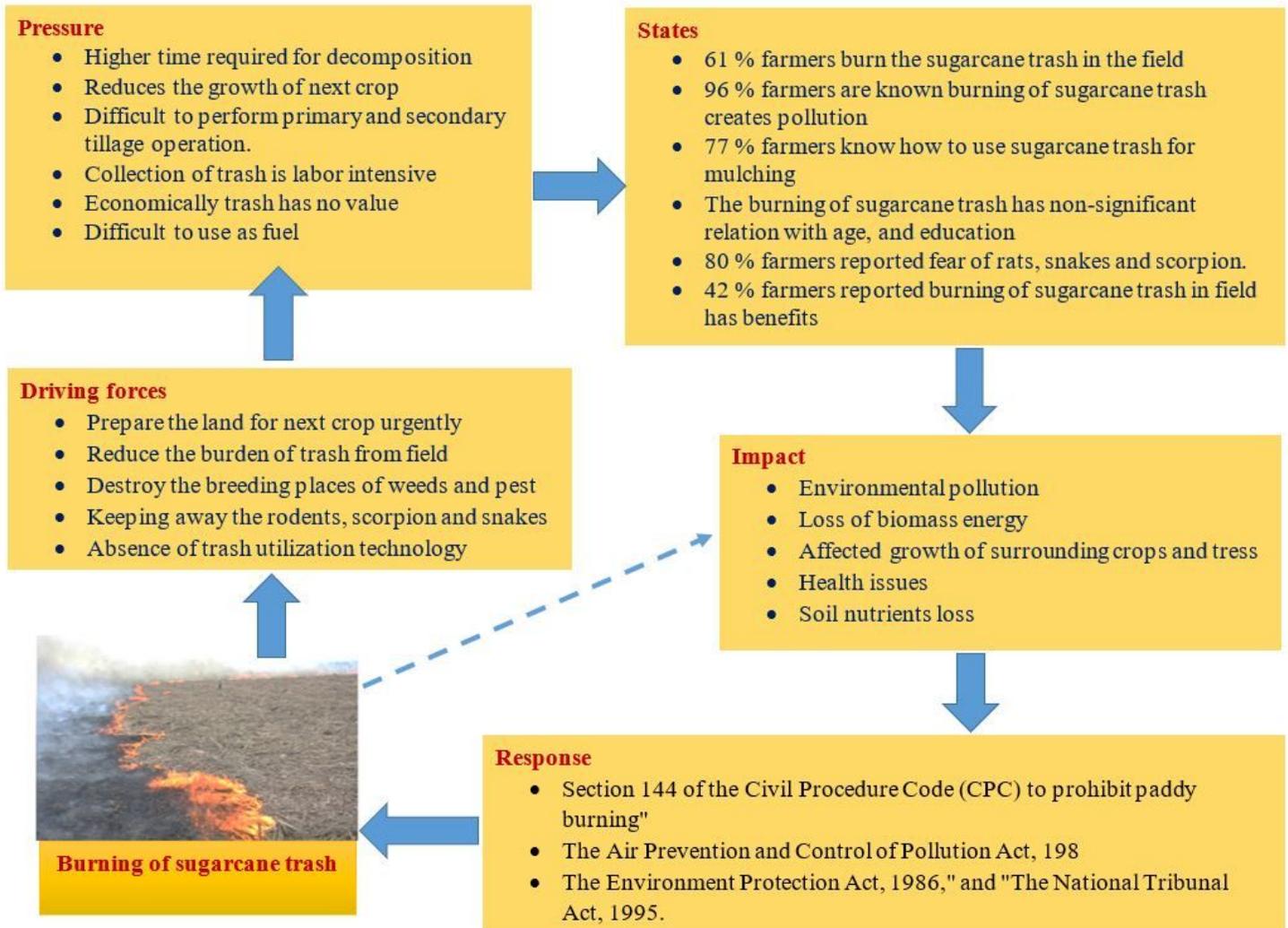
Figure 1

Location of study area (kolhapur District, Maharashtra State, India)



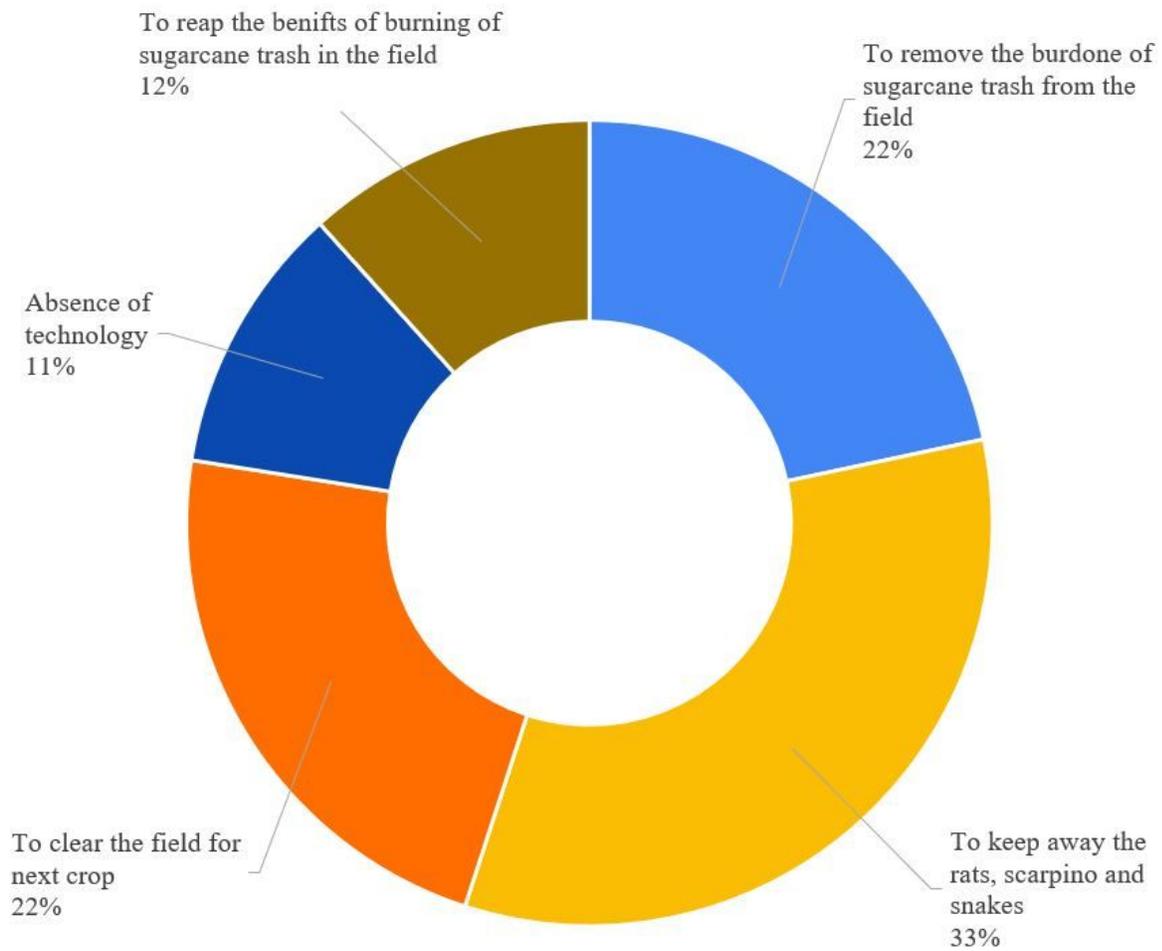
**Figure 2**

CCA biplot of farmers' knowledge, behaviour and backgrounds of interviewee towards use of sugarcane trash under CCA as constructed according to data collected.



**Figure 3**

Drivers, Pressures, State, Impact, Response (DPSIR) model for sugarcane trash utilization towards health and environmental issues in western Maharashtra.



**Figure 4**

Share of different reasons for burning of sugarcane trash in open field.