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## Appraisal of Land Fragmentation and Crop Production in the Western Terai of Nepal

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### Abstract

Land disintegration is a widespread distinctiveness of all farming systems that influences farmland efficiency. The relationship between farm size and productivity in developing countries is one of the oldest issues in the academic literature on agrarian structure. The main objective of this research was to assess the land fragmentation condition and its relation to crop production in the western Terai of Nepal. This study was based on mixed methods that adopted both qualitative and quantitative methods, including primary and secondary sources of information. In addition to field observation, a total of 124 household surveys, 13 key informant interviews, and 6 focus group discussions were conducted for primary data, and census data from the national statistical office and profile data from the municipality were used for secondary information. Apart from these, topographic maps, cadastral maps, and satellite imagery were used for ground verification. It was concluded that land fragmentation triggered the loss in productivity; however, it was noted that the gain in production was tracked by intensive cropping practices. Out of the total, 69.4 percent of respondents identified a loss, and 30.6 percent reported a gain in productivity. It is recommended to utilize systematic land use planning and follow crop diversification, multiple cropping, and intensive farming, which could be an alternative to mitigate farm land fragmentation and increase productivity.

**Keywords:** Agriculture, cropping, land fragmentation, livelihood, productivity

## Introduction

Land is an indispensable resource for farming; changes in land-use patterns significantly affect the environment, including biodiversity and socio-economic impacts (Bacsi et al., 2025). Land results in fragmentation because of unproductive agricultural development procedures and unsuccessful land use planning in East Africa (Mayele et al., 2024). Land disintegration is an unrestricted agricultural singularity in many countries around the globe that is a constraint to efficient crop production and agricultural modernization, which is caused by the implementation of land coalition programs (Laghari et al., 2025). The contributing factors of land fragmentation and its implications on agricultural production are necessary subject matter to pursue and explore for the country where agriculture is the mainstay of the economy (Aslam & Fazal, 2025). The arrangement of the land inheritance system, disorganized housing and urbanization planning, and insecurely prescribed policies are accountable for land fragmentation in Nepal (CRSC, 2012). Land parcels located closer to the homestead are found to be more fragmented than the ones situated farther away in western Nepal (Dhakal & Khanal, 2018). Commandment of inheritance, population increase, land market, and scarcity are four major influences that are accountable for farm fragmentation (Khan & Rehman, 2018). Uncertainty of tenancy and resource rights are the key features for land fragmentation that result from unsuitable agricultural development processes and unproductive land use planning, which caused negative impacts on agricultural productivity (Mayele et al., 2024). Fragmented land with scattered numbers of plots and unmanaged shape and size of parcels created a negative impact on crop production (Ali et al., 2023). Land fragmentation increases the cost of crop production, which decreases household income and increases food insecurity (Phan et al., 2022). Land consolidation and proficient land management are decisive in growing agricultural productivity (Kibisu et al., 2024).

Land fragmentation has a negative influence on dairy production, leading to the development of land consolidation in Spain (Corral et al., 2011). Land fragmentation increases travel time between fields, which in turn reduces labor efficiency and increases transport costs for inputs and outputs (Buller & Bruning, 1979). Increasing farm size and access to credit have increased productivity in Vietnam (Phan et al., 2022). Production efficiency has decreased due to land fragmentation in Nepal (Niraula & Thapa, 2007). Land fragmentation has positive effects on agricultural growth, as evidenced by the adoption of intensive farming in Bihar, India (Singh et al., 2018). Land fragmentation led to the conversion of build-up area to other land-use categories, and the disappearance of agricultural farms forced them to explore alternative activities for their subsistence in the western Tarai of Nepal (Dhakal, 2025).

A large proportion of families in Nepal depend on agriculture for their livelihoods (MoAD, 2012). The number of farm households has increased by 7.8 percent, and the total area under farming has decreased by 12.2 percent (NSO, 2021a). On the other hand, the average number of parcels per holding is decreased from 3.2 to 2.8. Similarly, the average parcel size is also decreased from 0.21 hectares in 2011/12 to 0.19 hectares in 2021/22. Further, the total number of farm holding households has increased by 7.26 percent. At the same time, the size of

landholding is decreased from 2.0 ha to 0.55 ha in the Nawalparasi district. whereas the total number of parcels increased by 60 percent from 1971/72 to 2011/12. However, the average number of parcels decreased from 9.4 to 2.7 during the same period due to population growth in the district. Census report shows that the average parcel size decreased from 0.21 hectares in 2011/12 to 0.19 hectares in 2021/22 at the national level (NSO, 2021a). It shows that large numbers of people rely on a small area of land for their survival, and that land patches are increasing. Highland fragmentation and the rapid conversion of agricultural land are major challenges to food security in Nepal. There is an unclear and a lack of information on the influence of land fragmentation on agricultural development, which could be positive or negative. Empirical studies are necessary to explore the impact of land fragmentation on crop productivity. Therefore, this study aims to fulfill this gap by utilizing plot-level data to assess the relationship between land fragmentation and farm productivity. This finding could serve as a reference document for planners and decision-makers on the sustainable use of agricultural land across Nepal.

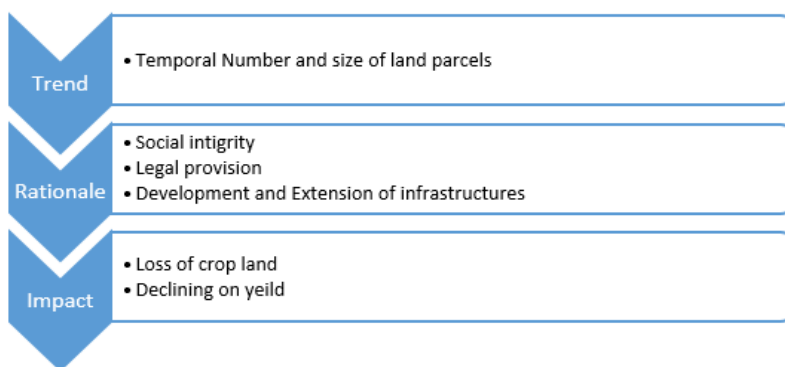
## Methods and Materials

### Conceptual Framework

Initially, the fragmentation in terms of the number and size of parcels was assessed; then the rationale behind that disintegration was identified. Subsequently, the impact of land destruction on crop land loss and the productivity of major crops was evaluated based on the gain or loss in production levels (Figure 1).

**Figure 1**

*Conceptual Framework*



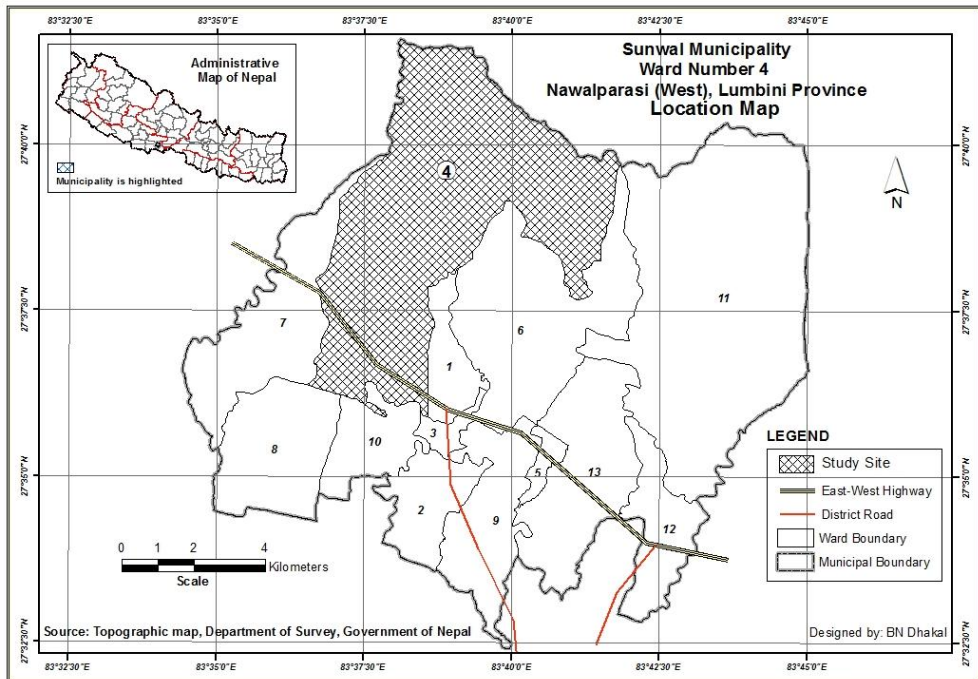
### Study Area

This study was conducted in Sunwal municipality, which is situated in Nawalparasi (Bardaghat-Susta West) district of Lumbini Province in western Nepal. Geographically, it is located between 83°24'26'' to 83°45'05'' east longitude and 27°32'24'' to 27°41'38'' north latitude covering the 139.10 sq km of surface area. There are 72,085 people residing within 17,418 households in the municipality. The population growth rate is very high (3.01 percent) in this

municipality, compared with the district level of 1.44 and the national average of 0.93, between the 2011 and 2021 censuses (NSO, 2021b). The population density of the municipality is also increasing from 398 to 518 persons/sq km during the same period, which is also higher than the national level of 198 persons/sq km.

## Figure 2

### Location Map of Study Area



## Research Design

The study was conducted in three different phases. Initially, a comprehensive literature review was conducted across various reports and documents to identify the research objectives and guide subsequent activities. Furthermore, various materials, including topographic and cadastral maps and satellite images of the study area, were collected, compiled, and assessed to delineate the research area. Thereafter, a field survey was conducted to gather the required information using a quantitative method with a household questionnaire, and a qualitative method was adopted through observation, Focus Group Discussion (FGD), and Key Informant Interview (KII). Formerly, in the post-survey phase, the collected data were processed, compiled, analyzed, and tabulated, and a final research paper was prepared.

## Tools of Data Collection

This study used both qualitative and quantitative methods, drawing on primary and secondary sources of data and information. The main sources of

primary data were used through a household-based face-to-face questionnaire survey, key informant interviews, focus group discussions, and field observations. The main sources of secondary data/information were included reports, documents, maps/images, journals, books, etc., published by various institutions and organizations.

### **Sampling Techniques**

Initially, the purposive sampling survey technique was used with farm households. Then, list or names of people having the farm land/farmers/land owners with more than 10 Kattha (338.623 sq. meters) (1 Bigha = 20 Kattha = 6772.63 sq. meters) with multiple number of parcels were collected from the consultation with 13 Key Informants (Ward member, school teachers and senior citizens) then field work was conducted through household survey with covering 124 farmers. (There are altogether 1853 households in ward number 4 of Sunwal Municipality as per NSO, 2021b). Among them, 1240 households were identified as farmers with farmland, of whom only 806 had more than 10 Kattha of farmland. Out of these 124 households (covering 15 percent), a sample size was taken. However, maximum attempts were made to follow the absolute ethics of research throughout the research period. Based on the determined sampled households (124), direct interviews with farm owners and farmers were carried out by using structured questionnaires in the selected ward, followed by direct observation and key informant interviews with thirteen respondents and six focus group discussions among different characters, including small or landless farmers, subsistence farmers, and commercial or large farmers.

### **Data Analysis**

At the beginning, data processing, verification, and discrepancies preparation were carried out on the information that resulted from the household questionnaire survey, FGD, and KII, which included field observation. Then local units (Pathi, Muri, Kattha, Bigha) were transformed into SI units. The notes and field-level discussions were categorized by issues and coded to summarize the findings. Spatial, qualitative, and quantitative methods were adopted to analyze derived information in this study with the application of GIS, MS Excel, and SPSS computer software in the form of maps, tables, charts, and diagrams for the demonstration of the findings.

## **Results and Discussions**

### **Distribution of Farmland and Crop Production**

Land and crop management are the crucial efforts for the proper utilization of land resources and agricultural development in any area. This study found an uneven and irregular distribution of farm lands among the farmers in the study area. There were single parcels to more than five parcels (up to 17 parcels) recorded during the field study. Similarly, farm area also extended from 13 Kattha (small farmer, land less or near landless categories#) to 1105 Kattha (larger or commercial farmer#). It reveals that the highest number of respondents owned three parcels extending within the average distance of 915 meters from home, where they grew various crops like

paddy, wheat, potato, oilseeds, vegetables, and also raised livestock, did horticulture, bee-keeping, and fish farming in different plots of land. It was observed that three respondents owned more than five parcels, covering farm land of 1187 Kattha, with parcels separated by up to 1235 meters (Table 1).

**Table 1**

*Distribution of Farm Lands and Crop Production*

Number of parcels*	Area (in Kattha)	Distance (in meters) from Home to Farm (Average)	Crops
1(1)	13.0	-	Paddy, wheat, potato, oilseeds
2 (42)	1089.5	350	Paddy, wheat, maize, potato, oilseeds, vegetables +(livestock)
3 (63)	1357.0	915	Paddy, wheat, potato, oilseeds, vegetables, + (livestock, horticulture, bee-keeping, fish farming)
4-5 (15)	568.5	1052	Paddy, wheat, potato, oilseeds, vegetables, (bee-keeping, poultry farming)
More than 5(3)	1187.0	1235	Paddy, wheat, potato, oilseeds + (livestock, horticulture, bee-keeping, poultry farming, sugarcane)

Source: Field survey, 2081

Note: \*Figures in parentheses indicate the total number of HHs having a particular number of parcels.

# indicates farmer category according to ADS (2015-2035) based on the National Agricultural Census, 2011. These categories farm size, having less than 15 Kattha (landless or near landless farmer), having area 15-30 Kattha (subsistence farmer), 30-150 Kattha (small commercial farmer), and having more than 150 Kattha, have been classified under large or commercial farmers.

### **Distribution of Parcels by Numbers**

There were a number of parcels unevenly distributed in the study area. During the field study, single parcels, more than five parcels, and even up to 17 on average, were reported. A total of 50.8 percent of the respondents owned three parcels. Similarly, 33.9 percent among them maintained two parcels outside the homestead.

**Table 2***Distribution of Number of Parcels by Respondents*

SN	Categories and Number of Parcels	No of HHs	Percentage
1	More than 5 (3)	3	2.4
2	4-5(42)	15	12.1
3	3 (63)	63	50.8
4	2 (15)	42	33.9
5	1 (1)	1	0.8
Total	362	124	100.0

Source: Field survey, 2081

Accordingly, 12.1 percent of them owned 4 to 5 parcels, whereas 2.4 percent (3 respondents) owned more than five parcels (Table 2).

**Trend of Land Fragmentation**

Table 3 shows the historical developments of the fragmentation procedure. Regarding the settlement history of the study area, the total period was divided in to five-time period with equal years of interval. However, it was predominantly influenced by in-migration and population growth. Out of the total respondents, 44.4 percent of them started their land fragmentation during the 2041 BS to 2060 BS period. Similarly, in recent years, this trend has been increasing rapidly around the country, not only in the study area. The table below reflects that 21.8 percent of the respondents' farmland was fragmented after 2060 BS to the present day. Keeping in view that this trend was started before 2020 BS by 8.9 percent of the total respondents. Most of the parcels were not identified on the cadastral map, and some of the respondents hesitated to share their actual parcel numbers.

**Table 3***Trend of Land Fragmentation*

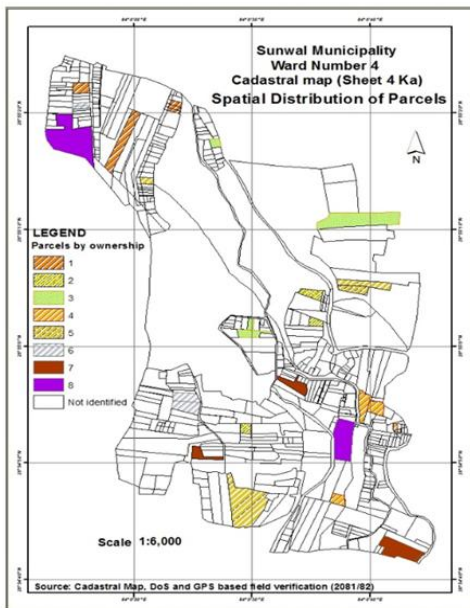
SN	Fragmentation period	No of HHs	No of parcels		%
			Before fragmentation	After fragmentation	
1	Before 2020 BS*	11	17	36	8.9
2	2021-2040 BS	26	31	74	21.0
3	2041-2060 BS	55	72	203	44.4
4	2061 BS to till	27	36	89	21.8
4	No	5	13	13	4.0
	Total	124	169	415	100.0

Source: Field survey, 2081

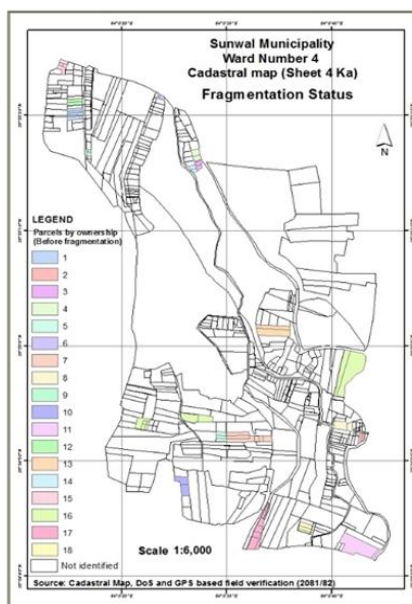
Note: BS\* = Bikram Sambat. Some of the identified parcels were plotted on available

cadastral maps below (Figures 3 and 4).

**Figure 3**  
*Spatial Distribution of Parcels*



**Figure 4**  
*Fragmentation Status of Parcels*



**Rationale of Land Fragmentation**

Based on the perception and certainty of the respondent, the rationales behind the land fragmentation were evaluated in the study area. Among them, 49.2 percent of the respondents agreed that the buying and selling of their farm land was the main cause behind the fragmentation. Whereas, 29 percent of the respondents claimed that population growth and legacy privilege had forced them to divide their land into a number of plots. In addition to these, 12.1 percent of their farm land was due to the extension of roads and the construction of an irrigation canal along the agricultural farm land.

**Table 4**

*Rationale of Land Fragmentation*

SN	Causes	No of HHs	Percentage
1	Population growth and legacy privilege	36	29.0
2	Selling or buying and migration	61	49.2
3	Construction of a road and a canal along farmland	15	12.1
4	Detachment by flood and erosion	7	5.6
4	Land plotting and land use change	5	4.0
	Total	124	100.0

Source: Field survey, 2081

Additionally, 5.6 percent of respondents' farmland was noticed to be detached due to flooding and erosion in the riverside area. Likewise, 4 percent of the respondents reported that their farmland was separated due to land use change and land plotting (Table 4). Regarding the various factors for land fragmentation as mentioned above, inheritance property rights and division among the family members are common in our country, which is given by law.

### Production Trend by Major Crops and Area

This study found a decrease in the cropping area coverage by all major food and cash crops due to land fragmentation. However, production and productivity were observed in both increasing and decreasing conditions. Based on the respondents' observations, a large area was decreasing in specific crop cultivation due to fragmentation and land use change; however, some of them showed positive results of productivity even in small patches of desecrated parcels. With their intensive inputs in farming, the production has increased compared to two decades ago.

**Table 5**

*Production Trend by Major Crops and Area (Area in Kattha and Productivity in kg/Kattha)*

Crops	Area (now)	Area (before*)	Productivity (now)	Productivity (before*)	Remarks
Paddy	3550	3418	240	320	Decreased
	475	610	425	320	Increased
Wheat	1413	1975	125	200	Decreased
	302	634	220	200	Increased
Maize	434	1380	100	150	Decreased
	208	650	125	100	Increased
Potato	660	1058	370	450	Decreased
	312	497	450	340	Increased
Pulses	1223	1650	40	60	Decreased
	556	815	72	60	Increased
Oilseeds	1670	2401	40	55	Decreased
	646	709	75	60	Increased
Vegetables*	345	654	300	350	Decreased
	304	382	500	325	Increased

Source: Field survey, 2081

Note: \*before indicates 20-25 years back, based on the recalled data recorded by respondents.

\*vegetables cover in average products of cauliflower, cabbage, beans, brinjal, lady fingers, bitter gourd, etc.

Table 5 shows that the paddy cropping area was 96 percent of the total land area occupied by the total respondents in the study area before two decades, among them 81 percent paddy cultivation area users were reported to 84 percent last year that means area increased by 3 percent and they were reported in decreasing the productivity from 320 kg/Kattha to 240 kg/Kattha. However, those involved in

producing paddy in 15 percent of the total land two decades ago have now reduced to 11.3 percent of the total paddy cultivation area, and productivity has grown from 320 kg/Kattha then to 425 kg/Kattha now. Similarly, 26.5 percent of the total area was under vegetable farming over the past two decades, which decreased to 15.4 percent last year. However, the productivity scenario was reflected differently among them. Those farmers who were cultivated vegetables in the 15.5 percent of total area in past reduced the land within only 8.2 percent and reported the loss in productivity also from 350 kg/Kattha to 300 kg/Kattha whereas 9.1 percent area users in the past have reduced their land area coverage only to 7.2 percent but productivity was increased from 325 kg/Kattha then to more than 500 kg/Kattha now (Table 5). It means there were both types of implications that occurred due to land fragmentation in the study area.

### **Consequences of land fragmentation**

The researcher discussed the positive and negative influences of land fragmentation in the study area. Out of the total respondents, 81.5 percent reported that they were facing increasing costs in input uses that caused difficulties in farming. They were agreed that the input cost was increased due to the scattered, small-sized, and irregular plots, with an average distance of 300 to 1500 meters between the parcels and farmhouses. They noticed that the labor movement, transportation of seeds, fertilizers, and manure, plants, as well as land management and harvesting of products, had become expensive. Uses of machinery are almost impossible due to the small size and irregular shape of plots. Out of the total, 69.4 percent of respondents agreed on the problem of the decreasing trend in their product. However, some of the respondents (30.6 percent of them) shared the positive impact of the fragmentation by increased production in their farmland through intensive farming practices. Furthermore, they added that they were able to work and use input intensively, even manually, to increase production and support for the sustainable livelihood. Additionally, 10.5 percent of the respondents decided to change their farming activities to others like livestock, fish farming, poultry farming, bee-keeping, and so on (Table 6).

**Table 6**

#### *Impact of Land Fragmentation*

SN	Perceptions*	No of HHs	Percentage
1	Loss of farm land	79	63.7
2	Increasing cost in input use	101	81.5
3	Declining production trend	86	69.4
4	Increasing production due to intensive farming	38	30.6
5	Crop and activities diversification	13	10.5

Source: Field survey, 2081

\* Note: Multiple respondents were accepted so the total percentage increased

## Conclusions

This study found the uneven and irregular distribution of farm lands among the farmers in the study area. They owned single parcels or more than five parcels (up to 17 parcels also). Similarly, farm area was also extended from 13 to 1105 Kattha. It was found that the highest number of respondents owned three parcels extending within the average distance of 915 meters from home. They grow various crops like paddy, wheat, potato, oilseeds, and vegetables. In addition to these, respondents were involved in livestock, horticulture, beekeeping, and fish farming in different plots of land.

This study also found a decrease in the coverage of cropping area by all major food and cash crops due to land fragmentation. However, production and productivity were observed in both increasing and decreasing conditions. The fragmentation trend was increasing rapidly around the country, not only in the study area. Among them, 64.2 percent of respondents reported their land fragmentation beginning after 2040 BS. Increasing population and legacy property, selling and buying of land parcels, migration, road and canal development along farm lands, flood and erosion disasters, land use change, and land plotting were the main determinants reported behind the land fragmentation in the study area. Among them, 49.2 percent of the respondents and their farmland were fragmented due to the buying and selling of their land. Whereas, 29 percent of the respondents claimed that the increasing population and the right of inheritance property forced them to divide their land into a number of plots.

Input cost was increasing due to the scattered and small sizes of plots. The labor movement uses machinery, transportation of seeds, manure/fertilizers, plants, and harvesting costs are becoming high. 69.4 percent of the total respondents reported the problem of a decreasing trend in their product. However, 30.6 percent of them shared the positive impact of the fragmentation that increased production in their farmland with intensive farming practice; they were able to work and use input intensively, even manually, to increase production and support for the sustainable livelihood. Additionally, 10.5 percent of the respondents decided to change their farming activities to others like livestock, fish farming, poultry farming, beekeeping, and so on. It is recommended to coordinate among the different stakeholders to utilize systematic land use planning and follow crop diversification, multiple cropping, and intensive farming to mitigate farm land fragmentation and increase productivity.

**Declarations:** The author declares that there is no area of conflict.

**Ethical approval for the research:** Not applicable

Consent for publication: Not applicable

**Conflict of interest:** The author does not have any conflict of interest with any institutions concerning this research

**Ethical conduct of research:** This paper is written ethically

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