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Agroforestry Practices and Climate Change Impact Mitigation in Semi-Urban Umudike Community, Abia State, Nigeria

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Abstract

The survey investigated agroforestry practices and the impact on climate change mitigation in Umudike community, Ikwuano LGA, Abia State, Nigeria. Two hundred completed semi-structured questionnaires used in stratified random sampling techniques to collect data from respondents of three villages, in Umudike. Data collected were analyzed descriptively using SPSS 20. Over half (66.5%) of the respondents are males while farmers constitute the largest occupational group (76%). The most of the people indicated climate change caused heavy flooding and erosion (194 (97%) and led to irregular rainfall (90%) while only 21 respondents (10.5%) *indicated it caused sea level rise. Majority of the people (83.5%) also linked reduced agricultural crop production to climate change. Whereas all the respondents (100%) indicated using agrisilvopastoral practices, the homegarden was the most used system (*92.5%) *supporting several reports of its wide adoption in the southeast, Nigeria. However, a greatest number of respondents (91%) and (83.5%) affirmed that agroforestry practices enhance soil fertility and influence on water management respectively while only few people (28%) indicated its enhanced carbon sequestration. The findings indicated that Umudike community is sensitive to climate change and have adopted agroforestry as a climate smart agricultural practice. Promoting wider spread adoption of agroforestry practices in especially rural and semi-urban agrarian communities in southeastern Nigeria is essential. Agricultural and forestry extension services should be providing farmers in such communities with relevant training and technical support for greater adoption of technologies like agroforestry for climate change mitigation, adaptation and sustainable development.*

Key words: Umudike community, *Agroforestry strategies, Climate change impact, Mitigation and adaptation.*

Introduction: Climate change is a major challenge facing humanity in this 21st century. Many countries in Africa including Nigeria are amongst the most vulnerable to climate change due to large proportions of the human population in these countries living in the rural and sub-urban areas where agriculture, forest resources and water resources which are affected by the climate change are the principal source of livelihood (Nwajiobi, 2018). Climate change refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period typically for decades or longer (IPCC, 2021). For standard, climate change is considered a change or variability in weather of a region over a period of at least two climatic time points consisting of between 30 – 35 years per climatic time point (Nwajiobi, 2018). Largely considered to be caused by anthropogenic activities, climate change is already having severe impacts on every aspect of Nigeria's development (FME, 2011, Nwajiobi, 2013). However, the severity of climate change impact will be reduced by adaptation and mitigation measures, one of which is massive adoption of agroforestry practices against traditional agricultural systems. Although agroforestry practices are usually absent in the lists of potential mitigation measures in most report on management practices to reduce carbon dioxide (Clark *et al.*,2019), it has potentials for enhancing climate resilience in Nigeria which is a predominantly agrarian society.

Agroforestry which describes the integration of trees/shrubs with agricultural crops and/or livestock production on the same land is an age-old land management practice by farmers for its multiple benefits. The practice has been prevalent for many centuries in different parts of the world, especially under subsistence farming conditions (Nair, 2008). It encourages steady supply of food through the year, prevent degradation of soil maintaining soil fertility, diversify and increase income sources on farm, enhance soil nutrient use efficiency and provide regular employment thereby, increasing system resilience (Rao *et al.*, 2017). Agroforestry is now well recognized as a climate-smart agricultural practice. Its strategies encompass a range of innovative practices that enhances productivity in a way that often contributes to climate change mitigation through enhanced carbon sequestration and can also strengthen the system's ability to cope with adverse impacts of changing climate conditions (Clark *et al.*, 2019). It is important to note however, that while agroforestry practice describes an arrangement of components (trees, crops, pastures, livestock, etc.) in space and time, an agroforestry system is a distinctive local example of practice characterized by

environment, plant species, management, and social and economic functioning (Young, 1990). For the immense benefits of agroforestry especially it's role in helping farmers adapt to climate change, improve resilience, and reduce greenhouse gas emissions, several countries now include agroforestry systems and practices in their national policies (Charles *et al.*, 2016).

Regrettably however, even though many rural and suburban communities in Nigeria like Umudike are predominantly agrarian and highly vulnerable to the prevailing climate change, there are no data on the impact of climate change nor on the adoption of climate smart agricultural practices like agroforestry in our communities to inform policies that will promote and enhance resilience. This research investigates the impact of climate change, agroforestry practices and its effect on climate change mitigation in semi-urban Umudike community of Abia State; with the object of creating awareness and generating baseline information for policies to enhance climate resilience in our communities.

Materials and Methods:Study Area: The study was carried out in Umudike community which is within the Umuahia Capital Territory of Abia State, Nigeria. It is a semi-urban settlement in Ikwuano Local Government Area of Abia State. It is located in the tropical lowland rainforest of Nigeria and lies between latitude 05°27'N and 05°32'N and longitude 07°30'E and 07°35'E with an elevation ranging from 100 - 103 m above sea level and a total landmass of 0.135km^2. The climatic regime is characterized by bimodal high rainfall which starts appreciably from April and peaks in June and September with a short spell in August and ends in November. Annual precipitation is an average 2,163mm. Minimum and maximum annual mean temperatures are 21^0 C and 28^0 C, and through the year insolation is high (Nwajiobi *et al.*, 2020). The relative humidity of Umudike ranged from 52.5% in the dry season to 90.3% in the wet season, with a mean annual temperature ranging from 23 to 32 C and the soil temperature is isohyperthermic (28.8^{o}C) (Nwajiobi *et al.*, 2020; Chukwu *et al.*, 2024). The population of Umudike community according to 2015 Population census was 2,687. The main occupation of the people in the region is subsistence farming (Nwajiobi *et al.*, 2020). Only an approximately 2 ha strictly reserved relict of natural rainforest in Michael Okpara University of Agriculture Umudike (MOUAU) is tellwing the story of what used to be the original vegetation of Umudike community.

Methodology: Two hundred and ten (210) semi structured questionnaires were distributed to households in three of the six villages of Umudike community at seventy questionnaires per village, using the stratified random sampling technique. The questionnaire solicited information on socioeconomic characteristics, climate change impacts in the community, agroforestry strategies to mitigate the climate change impacts as well as the effect of the agroforestry practices on climate change impact in the study area. Data from two hundred of the properly completed and returned questionnaires was subjected to descriptive statistical analysis of frequency and percentages using statistical package for social sciences (SPSS) version 20.0.

Results and Discussion: Socioeconomic characteristics of the respondents: The socioeconomic characteristics of the respondents (Table 1) show that majority of the respondents (70%) fall within the 35-50 age group while the least are those within 18-35 years age group (12%). This perhaps is because the age group of 35-50 are the most confident and assertive to make themselves available for the survey. The finding support Odoemelam and Nwachukwu (2012) who also noted that young framers are deemed more willing to take risks and are more open to change. The Farmers constitute the largest occupational group making up 76% of the respondents, followed by civil servants (19.5%) and students (4.5%). This finding corroborates Onyemaobi (2010) and Nwajiobi *et al.* (2020) who noted that agriculture is the major occupation of the people. Ordinarily, a community of predominantly farmers will seem benign except when viewed in the light of established fact that agriculture is a major cause of deforestation and poses a high risk to biodiversity and the environment (FAO, 2010). This is why interest in agroforestry practices in rural and sub-urban community should be sustainably encouraged. The fact that not a single respondent indicated being involved in "other jobs" in the community also corroborated that agriculture is the major occupation of the people. The gender distribution shows that 66.5% of the respondents are male, while 33.5% are female. This observation aligns with the assertion that since data was collected at household level, it was usual for males to speak for households (Odoemelam and Nwachukwu, 2012). Again, the sample population consists mainly of those who have lived long enough in the community to know the information required of them. The largest group of respondents (47.5%) have lived in the area for 10-20 years, followed by 30 years and above (32%). Those who have lived the least number of years 5-10 years made up only 6% of the community. The findings should lend significant credence to data and findings of the study. Almost half of the respondents (47.5%) have a First school leaving certificate, followed by O'level (34.5%), B.Sc. (13%), Masters (3.5%), and Ph.D. (1.5%). Furthermore, a significant portion of the respondents had completed at least a basic education, emphasizing the potential role of education in adopting new technologies (Odoemelam and Nwachukwu, 2012). These demographic and socioeconomic characteristics provide valuable insights into the composition of the Umudike community.

Climate Change Impact in Umudike Community: Fig. 1 shows that the greatest number of respondents [180 respondents (90%)] identified irregular rainfall patterns, heavy flooding and erosion [194 (97%)] and poor agricultural crop production [167 (83.5%)] as impact of climate change in Umudike. Irregular rainfall can have adverse effects on agriculture, water resources, and overall livelihood of people (Nwajiobi *et al*., 2013). The fact that "heavy flooding and erosion" is the most indicated climate change impact in Umudike [194 (97%)], should generate serious concerns because it can lead to property

damage/loss, displacement of residents, poor agricultural production and environmental degradation. Obidike-Ugwu *et al.* (2018) reported that flood is already having severe impact on cities and that the effects of climate change include flooding disaster, loss of income, contamination of water sources, emotional disorder, loss of properties such as houses, farmlands, business premises and death of both human and animals. This may explain why poor agricultural crop production was associated with climate change by large number of respondents (83.5%). Notwithstanding, only about half of the respondents [99 (49.5%)] indicated "disruptions to the local ecosystem" as climate change impact while the least number of respondents [21(10.5%)] indicated "sea level rise" due to climate change in Umudike. The findings clearly show that climate change is having obvious impacts in Umudike community. it supported Nwajiobi *et al.* (2013) who reported that climate change will have wide ranging impacts on the environment, natural and human systems including agriculture, water resources, biodiversity and human health; and are likely to lead to severe water shortages and or flooding. The poor number of respondents who indicated sea level rise as impact of climate change in the community is understandable since Umudike is not a coastal community and has only two streams.

Agroforestry strategies to minimize the risk and maximize the opportunities associated with climate change in Umudike: The results on Table 2 indicated that Umudike community adopted several agroforestry strategies at varying extents to minimize the risk and maximize the opportunities associated with climate change. While agrosilvopastoral practice is the most widely adopted [200 (100%)], agrisilvicultural practice is the least adopted [117 (58.5%)]. However, amongst specific agroforestry systems, it is the homegarden system that is most widely adopted in the study area [185 (92.5%)] and the least used system is the Hedgerow intercropping (alley cropping) [34 (29%)]. The findings supported several reports on the popularity of the homegarden practice in southeastern Nigeria (Okafor and Fernandez, 1986). It also agrees with Amonum *et al.* (2009) supporting the perception of the term Agroforestry by social scientists a combination and interrelationships between people, domestic animals, crops and trees, designed to rehabilitate land or to sustain and increase production of certain desired social benefits. However, it is notable that some strategies, such as multipurpose trees and shrubs on farmlands (MPTS), was not indicated to be in use in the community [0 (0%)] thereby highlighting potential areas for intervention and education. This supports Nair (2008) assertion that a vast majority of MPTs have not been domesticated let alone exploited commercially thereby making domesticating, improving, and exploiting the multitude of these indigenous MPTs a major challenge and an opportunity in agroforestry. The adoption of these wide range of agroforestry strategies in the community however reflects efforts to enhance food production and environmental sustainability as well as resilience to challenges posed by climate change.

Effects of the agroforestry strategies on climate change impacts in the study area: The result of impact of agroforestry strategies on climate change in the study area (Fig 2.) revealed that the community identifies with positive impacts of agroforestry practices in climate change impact mitigation and adaptation but their perception of these positive impacts, such as carbon sequestration, livelihood improvement, enhanced soil fertility, biodiversity conservation, and flood control/soil conservation varied. These findings align with well recognized benefits of agroforestry in enhancing ecosystem services and building resilience to climate change (Nair, 2008, Amonum *et al.*, 2009). The least perceived benefit of the agroforestry practices in the community is carbon sequestration [56 (28%)] while most recognized benefits are enhancement of soil fertility [182 (91%)] and flood control/soil conservation [179 (89.5%)]. It is possible that because declining soil fertility is one of the most disturbing of the impact of climate change in the predominant agrarian southeastern Nigeria (Nwajiobi *et al.*, 2020), the people are more sensitive to the impact of the agroforestry practices on their soil fertility and conservation more than its other listed benefits. However, the findings supported several reports of the role of agroforestry in soil fertility enhancement and conservation as well as improved crop productivity (Young, 1990., Nair, 2008, Amonum *et al.*, 2009, Jose, 2019). This may have been corroborated by the fact that a greater majority of respondents acknowledged that agroforestry strategies have a positive impact on water management [167 (83.5%)] and livelihood improvement (65.5%). Indeed, Agroforestry practices can regulate water flow, reduce erosion, and improve water quality which is crucial for sustainable land use and agriculture to enhance income and food security, contributing to improved livelihoods for individuals and communities and should be promoted. Although they may have not been well recognized in Umudike, the role of agroforestry systems in biodiversity conservation and carbon sequestration are no less important than the well indicated benefits in this global climate change regime.

Conclusion: The study provides insights into climate change impact, agroforestry practices and the effect of the agroforestry strategies on climate change mitigation in sub-urban Umudike community of Abia State, Nigeria. The findings underscore the potential of agroforestry practices to enhance community resilience and sustainable development. It also highlighted ignorance of the agroforestry system of multipurpose trees and shrubs on farmlands which should be promoted to enhance the range of beneficial agroforestry strategies at the community's disposal. It further highlighted the importance of promoting agroforestry practices, improving education and awareness to foster sustainable resource utilization while also addressing climate change and environmental challenges in the community. As the prevailing climate change continues to threating communities around the world, embracing climate-smart agricultural practices such as agroforestry by agrarian communities becomes increasingly necessary. Ultimately,

the study serves as a valuable resource to enhancing sustainable agriculture and promoting climate resilience in Umudike and other climate change vulnerable communities. **Recommendations:** The following recommendations are relevant. Policymakers, local authorities, and agricultural extension services can use the insights here-from to develop targeted interventions to enhance community resilience, and contribute to the broader goals of mitigating climate change impacts.; Local agricultural extension services should be strengthened to provide farmers in Umudike with training and technical assistance on various agroforestry systems including the multipurpose trees and shrubs on farmlands (MPTS); Explore avenues for providing support like grants, low-interest loans, free or subsidized tree seedlings and improved crops to farmers interested in adopting agroforestry practices; Similar surveys in other communities of southeast and other regions of Nigeria to provide a broader data base for administration of agroforestry programmes in the country; Government policies that incentivize adoption of agroforestry practices such as tax incentives for farmers engaged in agroforestry, subsidies for agroforestry inputs, and the integration of agroforestry into national climate change adaptation and mitigation strategies.

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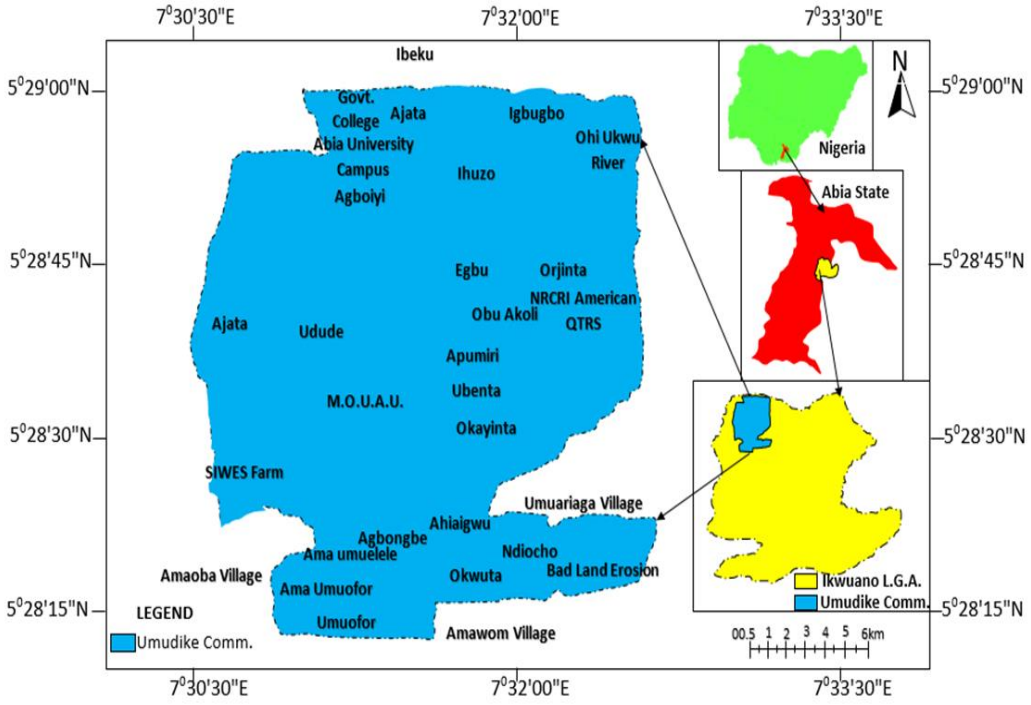

Fig. 1. Map of Umudike

Table 1. Socioeconomic characteristics of the respondents

Socio economic and demographic characteristics	Frequency (F)	Percentage (%)
Age		
18-35	24	12
35-50	140	70
50 – above	36	18
Total	**200**	**100**
Occupation		
Student	9	4.5
Farmer	152	76
Civil servant	39	19.5
other jobs	-	
Total	**200**	**100**
Gender		
Male	133	66.5
Female	67	33.5
Total	**200**	**100**
Residency		
5-10yrs	12	6
10-20yrs	95	47.5
20-30yrs	29	14.5
30 and above	64	32
Total	**200**	**100**
Educational Qualification		
First school leaving certificate	95	47.5

O'level	69	34.5
B.Sc.	26	13
Masters	7	3.5
Ph.D	3	**1.5**
Total	**200**	**100**

Source: Field Survey

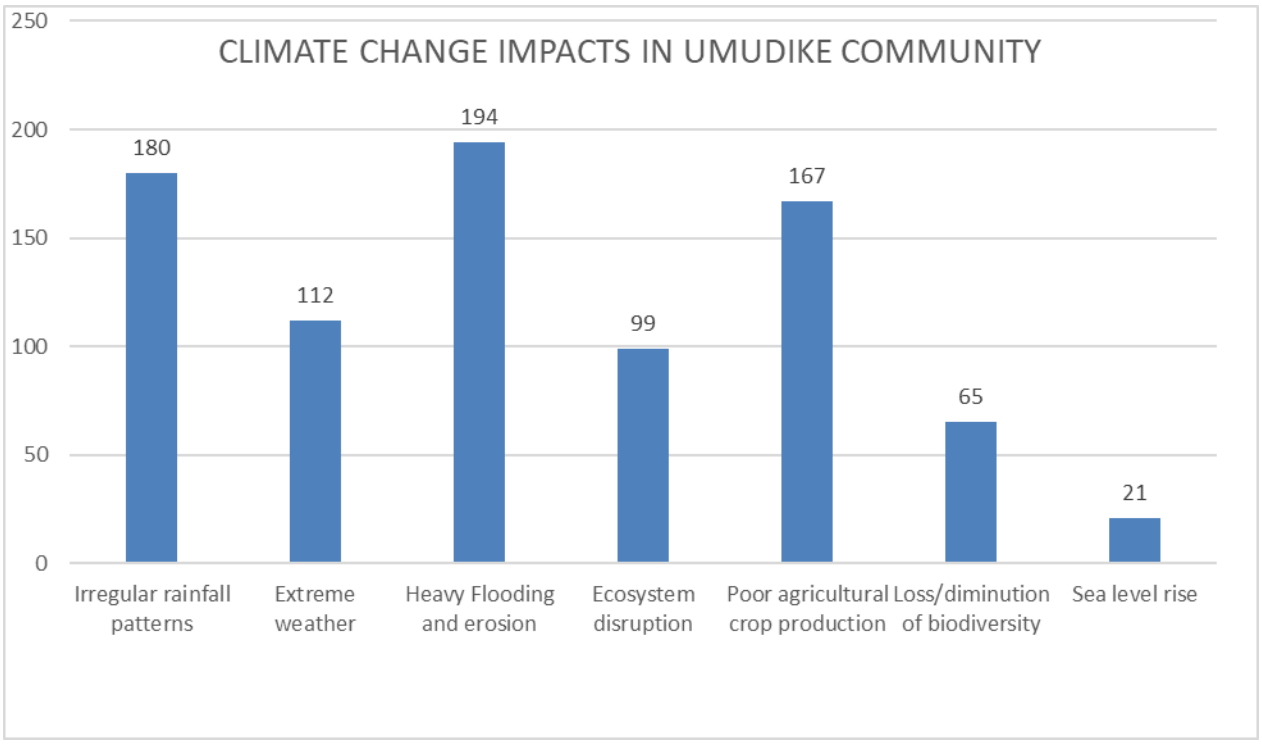

Fig. 2: Climate Change Impacts in Umudike Community

Table 2. Agroforestry strategies to minimize the risk and maximize the opportunities associated with the climate change in Umudike

Strategies	**Yes F (%)**	**No F (%)**
Agrisilvicultural	**117 (58.5)**	**83 (41.5)**
Improved fallows in shifting cultivation areas	58 (49.5)	59 (50.5)
Hedgerow intercropping (alley cropping)	34 (29)	83 (71)
Multipurpose trees and shrubs MPTS on farmlands	0 (0)	117 (100)
Silvopastoral system	**142 (71)**	**58 (29)**
Protein bank	15 (10.5)	127 (89.5)
living fence of for trees and hedges	107 (75.4)	35 (24.6)
Trees and shrubs on pastures	92 (64.7)	50 (35.3)
Agrosilvopastoral	**200 (100)**	**0 (0)**
Home garden	185 (92.5)	15 (7.5)
Woody hedges	126 (63)	74 (37)
Various forms of shifting cultivation and the bush fallow system	**124 (62)**	**76 (38)**

Source: Field Survey

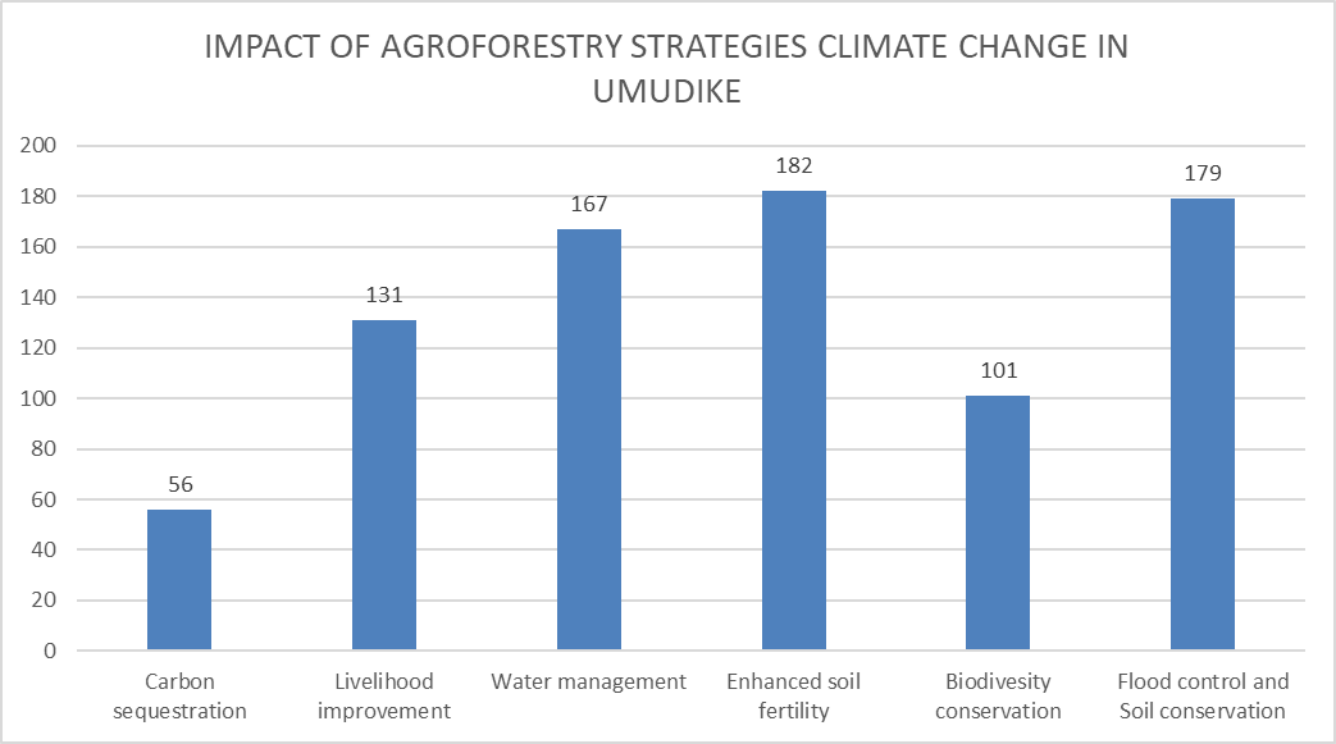

Fig. 3. Impact of agroforestry strategies on climate change in the study area