**EFFECTS OF LAND FRAGMENTATION ON GRASS SEEDBANKS ADAPTATION INTERVENTION AMONG WOMEN IN KUKU WARD, KAJIADO COUNTY, KENYA.**

**ABSTRACT**

The study was designed to examine the challenges facing the grass seed bank adaptation intervention due to land fragmentation and propose legislative and strategic measures related to sustainable land management and community livelihood resilience practices. This study adopted a descriptive approach as its research design by administering questionnaires and guided focus group discussions to find how land fragmentation has affected the grass seed banks intervention and the benefit of grass seed banks to the women. The quantitative and qualitative data was also used to help in giving insight on the issues surrounding land fragmentation, including its causes and extent. The findings of the research were cleaned, coded and entered into the Statistical Package for Social Sciences (SPSS version 26) in order to generate both descriptive and inferential statistics. Inheritance (98%) and rate of increase in conversion of grazing land to farmland (70%) was identified as the major causes of land fragmentation with odd ratios. Increased income from sale grass seeds was the major benefits accrued from the seed banks with (98%) of the women agreeing while 84% said income from the sale of milk and healthier animals was also an observed benefit. Reduced land for restoration of pasture due to land fragmentation was the popular opinion with 100% of the respondents agreeing. The women perceived that land for establishment of grass seeds banks and preparation and storage was also affected with 80% and 82% noticing reduction of land allocated for duplication of the said activities. The study recommends the implementation of land consolidation programs that can help to reduce the number of small, scattered plots of land and increase land availability for women involved in grass seed banks adaptation intervention.

# **INTRODUCTION**

With over 60% of the world's population predicted to live in urban areas by 2030, land fragmentation is still a major problem and concern among policymakers and economists (Cherotich *et al.,* 2024). According to Linda *et al.,* (2020, rangelands and agricultural lands are majorly affected by population growth, which puts pressure on need for development and fragmentation of land. Declining agricultural output, farm efficiency and ongoing issues with food security, particularly in emerging nations, are the causes of the growing worry ( Food and Agricultural Organization (FAO), 2020).

According to Asiama *et al.,* (2021), land fragmentation in the Sub-Saharan region has always been prevalent and especially in the agricultural system in the recent years. Customary or traditional land tenure system and the agricultural systems has been cited as the major cause of land fragmentation in the Sub-Saharan region. The customary land tenure system is identified as one of the major causes of land fragmentation caused by inheritance and subdivision to current generations. Shifting cultivation, is a predominant agricultural system of customary lands, which causes land fragmentation in the sub-Saharan Africa. Farmers and pastoralists migrate from region to another to allow for natural regeneration of the used land and utilize the new land.

Pastoralists in Kajiado County are known to own very large portions of land that has enabled their way of living for a very long period. The fragmentation of land in Kajiado began with the creation of a few private, individual land holdings allocated to political and community leaders just before independence (Stephen *et al.,* 2019). Large sections of customary land were also appropriated by the government and converted into national parks, reserves, and forests. In 1968, land fragmentation took up a faster pace with the enactment of the group representatives Act. This led to the establishment of group ranches to further strengthen, commercialize livestock production and facilitated the registration of traditional community land as private community property. The security of land tenure has been a major source of conflict on group ranches during the past 25 years, particularly for young people. This has created demand for sub division a process that has now began on these lands and is likely to affect all land uses in the area. Among these are the Maasai pastoral system and wildlife, which rely on the existence of expansive landscapes that support both cattle and wildlife (Fernández-Llamazares, *et al.*, 2020).

Climate change effects have affected animal pastures and led to land degradation affecting the quality local grass seeds in Kajiado. This has led to establishment, evolution, and sustainability of seed banks in many parts of the county. Seed banks play a crucial role in maintaining and preserving plant genetic resources, contributing to the resilience and sustainability of agricultural systems. Wambugu *et al.,* (2023) cited that community grass seed banks, through their effective management, responsiveness to local needs, and facilitation of seed and information flow, make important contributions to local seed security. According to Vernooy *et al.,* (2024), seed banks do not only provide farmers with access to diverse and locally adapted seeds but also serve as knowledge hubs, empowering farmers with the necessary information to enhance agricultural productivity.

In kuku ward, organizations are using grass seed bank technology as an adaptation, which is often used in landscapes that are characterized by degrading rangelands to produce grass seeds and hay (Monica, 2021). The organizations often use structured women groups to implement grass seed bank technology. Jusdiggit, (2021), points out that the women practice the grass seed bank intervention as a source of income through the sale of grass seeds and hay. They also store some hay to be used in times of drought to mitigate the effects of climate change. The grass seeds are used for restoration of landscapes with quality pasture reducing the migration of livestock by pastoralist in search of pasture. Grass seed banks provide economic opportunities for local communities while restoring degraded landscapes.

Continuous land fragmentation has affected grass restoration approach affecting the livelihoods of women and their families (Mayele, 2024). Establishment of grass seed banks on different small landholdings can increase transport costs especially when plots are located far from the home, and far from each other. Additionally scattered plots pose challenges in management and supervision. As land fragmentation increases, land plots become more dispersed in space, leading to lower efficiency in the use of agricultural tools and labor input. Fragmentation of land gives leeway for fertile lands and landscapes meant for establishment of seed banks and restoration to be used for other economic activities.

Land ownership systems in Maasai land are commonly favoring men, placing them as decision makers on how the land is utilized (John G. et al., 2010). For group ranches depending on member’s lands, the reliability for permission for use from men who own them threatens the success of the seed banks managed by women.

For this reason, the study sought to examine the drivers of land fragmentation in the study area, and its effects on adoption of grass seed bank technology.

# **2. METHODOLOGY**

## **2.1 Study Area**

The Chyulu Landscape lies within the heart of the Tsavo-Amboseli ecosystem in South West Kenya at the foot of Mount Kilimanjaro and the Chyulu Hills. It covers 110,945 ha, of which the protected of approximately 7,895 ha and the buffer zone 103,050 ha. The grass seed bank projects are located within kuku ward, which is still under group ranch land tenure system, in the chyulu landscape, Kajiado South sub-county in Kajiado County. Kuku Group Ranch covers an area of 1,200 km2 and is inhabited heavily by Maasai community who heavily depend on the land. Additionally, the ranch is an important wildlife corridor between the national parks (Tsavo West, Chyulu Hills and Amboseli National Park) and other protected areas in the region.

## **2.2 Study Design**

This study adopted a descriptive approach research design to assess drivers and effects of land fragmentation on the grass seed banks intervention. The quantitative and qualitative data was also used to help in giving insight on the issues surrounding land fragmentation, including its causes and extent. The research design was based on the use of questionnaires, focus group discussions, and field observation as the data collection instrument.

## **2.3 Target Population**

The target population were made up of women living in the kuku group ranch and practicing grass restoration. 104 women, from the different locations in the area, including Olkaria, Enkusero, Inkisanjani, Enkii, Olorika and Nolasiti, were sampled and interviewed. Additionally, purposive sampling technique was used to select officials from the County Department including Lands and physical planning, Environment and Climate Change, Agriculture and Livestock, water and administration, and officials from the local partners who provided information on land and subdivision, livestock yields, grass seed banks intervention

## **2.7: Data analysis**

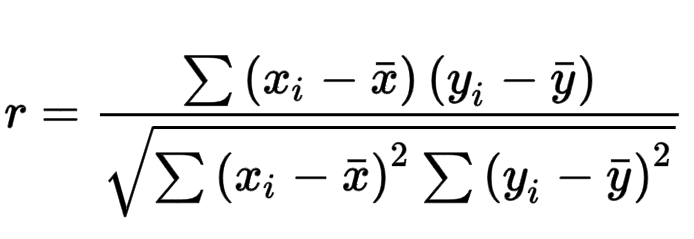
Prior to data analysis, the data obtained from the field using questionnaires was cleaned, coded and entered the Statistical Package for Social Sciences (SPSS) version 26. Data analysis was done by both descriptive and inferential statistics such as ANOVA through use of SPSS software. Multiple linear regression model was used to investigate the significance of the relationship between land fragmentation (as independent variable) and grass seed bank adaptation intervention (as dependent variables) based on data obtained from the questionnaires and observations.

**Y = α + βX + ε**

Y= α +β1X1 +β2X2+β3X3+ε

* Y= Grass seed bank intervention
* α = Constant term; β= Beta Coefficients; X1 = Land fragmentation; X2= Land use; X3= land ownership; ε = Standard Error

**Pearson correlation** coefficient (PCC) was also used to investigate the relationship between different land uses and their impacts on various aspects of land utilization including grass production. The Pearson formulae used was;



To test the hypotheses, the P value threshold of 0.05 was used.

* Beta coefficients with P values above 0.05 resulted in the hypotheses being rejected; while beta coefficients with P values below 0.05 will result in the hypotheses not being rejected.

# **RESULTS AND DISCUSSIONS**

## **Drivers of Land Fragmentation**

Results in figure 1 indicate that there has been general increase in subdivision of land. Land inheritance, Conversion of grassland to farming, and informal sale of land were mentioned by most of the women (93%, 70% and 57%) respectively as the leading causes of land fragmentation. Other factors studied as the main causes of land fragmentation with most women indicating that they had been increasing in the past 15 years, however, for sub division of ranches, women indicated that ranches had experienced no changes in the size (55%) yet since allocation of land and formal documents of the land subdivided into individual parcel of land have not yet been issued.

Figure 1: Causes of land fragmentation

Table 1: Drivers of Land Fragmentation

|  |  |  |  |
| --- | --- | --- | --- |
| **Land Use** | **Mean** | **Std. Deviation** | **Rank** |
| Inheritance | 1.22 | 0.76 | Increased |
| Sub division of group ranches | 3.11 | 1.22 | Neutral |
| Infrastructure development  Conversion of grass land to farming | 2.46  1.21 | 1.22  0.88 | Decreased  Increases |
| Sale of land to individuals | 2.02 | 1.35 | Decreased |
| Other uses | 1.98 | 1.16 | Decreased |

Results presented in table 1 illustrated more on the how different factors had resulted to more land being fragmented in the past 15 years generated from the Likert scale. The ranking scale used to assess the impact of different variables on land fragmentation ranges from 1-1.75, indicating an increase in fragmentation, 1.76-2.5 implying a decrease, 2.6-3.25 suggesting no change, and 3.26-4 indicating no significant change.

Conversion of grassland to farming had a mean scale of 1.21, with a standard deviation of 0.88 indicating increase in land fragmentation due to the land use shift. 82.4% of the respondents who indicated that the land has been fragmented also indicated that this land use shift was increasing. Kajiado being a pastoralist county, large lands are under grasslands for grazing. Over exploitation of grass lands by agricultural activities often lead to subdivision of the land to smaller plots for crop farming. The conversion of grasslands to croplands converts the ecosystem into a net carbon emitter, especially when management practices are insufficient to retain the sequestered carbon in soil (Zhang *et al.,* 2021).

Inheritance had a mean scale of 1.22, with a standard deviation of 0.76, an implication that inheritance has increased land fragmentation based on the respondent’s perception. This suggests that the process of dividing land among heirs, often leading to smaller, less efficient land parcels, is a significant factor in the fragmentation observed.

Amongst the drivers, infrastructure Development was not a key driver to land fragmentation, with only 37.36% attributing that land fragmentation has increased due to infrastructural developments. Infrastructural development was associated with construction of roads, bridges, and other infrastructure projects may lead to the fragmentation of land, possibly due to the need to access or develop new areas (Gallent, 2019). Subdivision of Group Ranches was neither increasing nor decreasing land fragmentation at mean scale of 3.11 and a standard deviation of 1.22, considered as neutral in terms of its impact on land fragmentation.

**Table 2: Multi-linear regression of Causes of land fragmentation**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
| B | Std. Error | Beta |
| Yes | (Constant) | .721 | .065 |  | 11.061 | .000\*\* |
| Inheritance | .241 | .023 | .714 | 10.678 | .000\*\* |
| Sub division of group ranches | .014 | .014 | .067 | 1.003 | .319 |
| Infrastructure development | -.007 | .014 | -.031 | -.471 | .638 |
| Conversion of grasslands to farmlands  Sale of land to individuals | .256  .021 | .021  .013 | .699  .109 | 6.975  1.647 | .001  .103 |
| Other causes | .037 | .015 | .167 | 2.474 | .015 |
| a. Dependent Variable: Land Fragmentation | | | | | | |

The results of the multiple linear regression analysis in Table 2 reveal that several predictor variables have a statistically significant effect on Land Fragmentation. The coefficients for Inheritance, Subdivision of group ranches, conversion of grass lands to farm lands, Sale of land to individuals, and other causes are positive, indicating that an increase in these variables is associated with an increase in Land Fragmentation.

The standardized coefficient (Beta) for Inheritance is 0.714, indicating that for every one-standard-deviation increase in Inheritance, Land Fragmentation is expected to increase by 0.714 standard deviations. The t-statistic for Inheritance is 10.678, and the p-value is 0.000, indicating that the coefficient for Inheritance is statistically significant at the 0.05 level. The standardized coefficient for Conversion of grass land to farmlands is 0.699, indicating a positive relationship to land fragmentation. The t-statistic for conversion of grassland to farmland is 6.975, and the p-value is 0.001, indicating that the coefficient for Conversion for grassland to farmlands is statistically significant at the 0.05 level.

The coefficient for Sale of land to individuals and Sub division of group ranches was 0.021 and 0.014, indicating a positive relationship between Sale of land to individuals and sub division of group ranches and Land Fragmentation. However, these associations were not statistically significant the 0.05 significance level. This may be due to the process of settlement of families and processing of land ownership documents (title deeds) not yet concluded in the region. However, the respondents expressed their concerns on the variables bringing a significant effect after completion of subdivision.

Statistically significant positive relationship was also observed between other causes with a p-value of 0.015 and Land Fragmentation at the 0.05 level. The coefficient for other causes of land fragmentation is 0.037, indicating a positive relationship between them and Land Fragmentation. Infrastructure development was the only factors that was negatively association with land fragmentation with a negative coefficient of -0.007 although it is not statistically significant. The results align to the respondents’ perceptions presented in table 3 that’s infrastructure development did not results to any land fragmentation.

Comparing these findings with other studies, such as those analyzing landscape fragmentation metrics in watersheds with diverse land uses in Iran (Alaei *et al.,* 2022) or the spatio-temporal characteristics of cultivated land fragmentation in rapidly developing regions like Guangdong Province, China (Wu, 2021), reveals a common theme of land fragmentation being influenced by a variety of factors, including inheritance, infrastructure development, and changes in land use. These studies underscore the complexity of land fragmentation and its multifaceted causes, emphasizing the need for comprehensive approaches to manage and mitigate its effects.

## Effects on land fragmentation on requirements of developing seed banks

Objective 3 was aimed to investigate the impacts of land fragmentation on the development and sustainability of seed banks. To achieve this, respondents were presented with a range of scenarios illustrating the different effects of land fragmentation on the requirements for the success of grass seed banks and were asked to indicate their level of agreement with the statements related to these effects. The results were then presented in percentages as in figure 2.

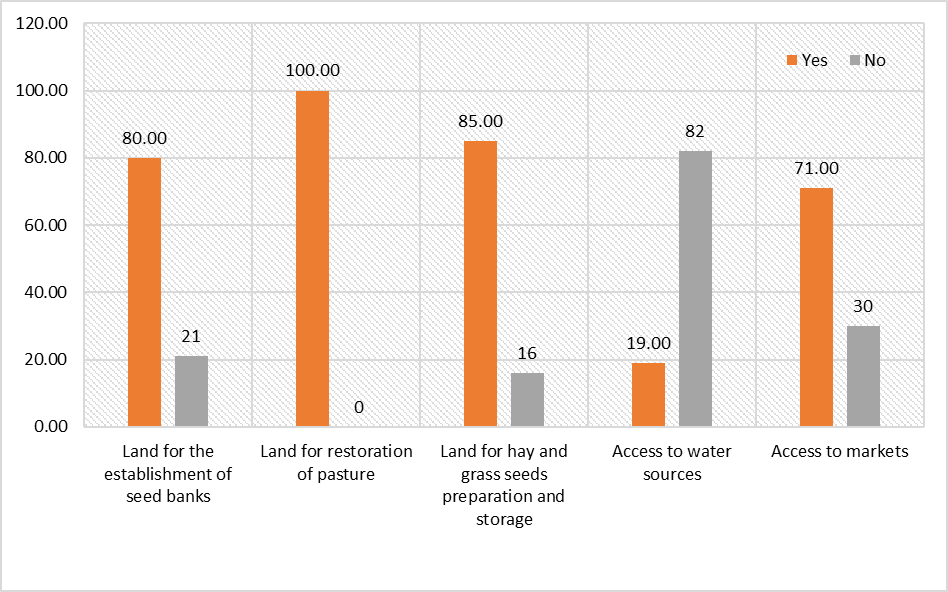


Figure 2: Effects on land Fragmentation on requirements of developing seed banks

Results from (Figure 2) indicate that’s the respondents agree that land fragmentation affect land required for establishment of seed banks, preparation, storage, restoration efforts and access to markets. 100% of women agreed that land fragmentation affect land required for restoration of pasture especially in rangelands. However, 82% of the respondents disagreed that land fragmentation affects access to water. They explained that the growing of seeds in the seed banks and reseeding of rangeland for restoration rain fed thus no irrigation needed.

The data collected from the respondents were then subjected to analysis that focused on calculating the mean of the respondents' opinions on each statement, in order to identify areas of consensus and divergence. The results of this analysis are presented in (Table 3), which provides a detailed breakdown of the respondents' views on the impacts of land fragmentation on seed bank development.

**Table 3: Effects on land Fragmentation on requirements of developing seed banks**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Land Fragmentation on development of seedbanks** | **N** | **Mean** | **SD** | **Value** |
| Reduced land for the establishment of seed banks | 101 | 3.88 | 1.227 | Agree |
| Reduced land for restoration of pasture | 101 | 4.68 | 0.468 | Strongly Agree |
| Reduced land for hay and grass seeds preparation and storage | 101 | 3.94 | 0 | Agree |
| Reduced access to water sources | 101 | 2.41 | 0 | Disagree |
| Improved access to markets | 101 | 4.16 | 0 | Neutral |
| Improved modern technology for intensive farming | 101 | 4.19 | 0 | Neutral |

The study found out that data collected from 101 women in kuku ward, assessing the impact of land fragmentation on the development of seed banks, reveals several key findings as indicated in (Table 3). The ranking scale used to evaluate the statements ranges from 1-1.8 for strong disagreement, 1.9-2.6 for disagreement, 2.7-3.4 for neutral, 3.5-4.2 for agreement, and 4.3-5 for strong agreement.

The mean score of 3.88, with a standard deviation of 1.227, indicates a strong agreement that land fragmentation has reduced the land available for establishing seed banks. This suggests that fragmentation of land into smaller parcels has limited the space available for creating and maintaining seed banks, which are crucial for the conservation of seed banks and the restoration of ecosystems. The women indicated that land restoration for pasture was the main requirements for establishing grass seed banks, with 100% (n=101) of the women agreeing so.

Reduced land for restoration of pasture: With a mean score of 4.68 and a standard deviation of 0.468, the women strongly agreed that land fragmentation has reduced land available for restoring pastures. This indicates that the fragmentation of land into smaller, less efficient parcels has hindered efforts to rangeland restoration and rehabilitation through re-seeding and in turn grass seed banks that provide seeds for the same. These rangelands are essential for maintaining biodiversity and supporting livelihoods.

Reduced land for hay and grass seeds preparation and storage: The mean score of 3.94, with a standard deviation of 0, indicates a strong agreement that land fragmentation has reduced the land available for preparing and storing hay and grass seeds. This finding underscores the impact of land fragmentation on agricultural practices, particularly those related to the conservation and restoration of natural resources.

Reduced access to water sources: The mean score of 2.41, with a standard deviation of 0, indicates a disagreement with the statement that land fragmentation has reduced access to water sources. The results agree further with finding indicated in figure 4. that access to water sources as a requirement was the list of the requirements need to establish seed banks with only 18.8% of the respondents suggesting it as requirements. This suggests that while land fragmentation may have other negative impacts, its direct effect on water access is not as significant or is not perceived as such by the respondents.

With a mean score of 4.16, the women were neutral on the statement that land fragmentation has improved access to markets. This indicates that the fragmentation of land does not have a clear positive or negative impact on market access, suggesting that other factors may be more influential in determining market access.

Improved modern technology for intensive farming: The mean score of 4.19, with a standard deviation of 0, indicates a neutral stance on the statement that land fragmentation has improved access to modern technology for intensive farming. This suggests that the impact of land fragmentation on the adoption of modern farming technologies is not perceived as significant by the respondents.

Comparative analysis reveals that while the negative impacts of land fragmentation on seed banks, pastures, and resource storage are consistent across different contexts, its influence on water access, markets, and technology varies significantly. These differences underscore the importance of local context in shaping the outcomes of land fragmentation. The findings from the Chyulu landscape align with broader concerns highlighted by the Food and Agriculture Organization (FAO), which emphasizes the need for integrated land-use planning to address the multifaceted challenges of fragmentation.

**Table 4: Multilinear regression (Coefficientsa** **for effects of Land Fragmentation on the Development of Seed Banks**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
| B | Std. Error | Beta |
| 1 | (Constant) | .978 | .054 |  | 18.217 | .000 |
| Inheritance | -.052 | .019 | -.283 | -2.816 | .003\*\* |
| Sub division of group ranches | -.012 | .012 | -.107 | -1.059 | .292 |
| Conversion of grass lands to farmlands  Infrastructure development | -.045  .007 | .016  .011 | -.190  .060 | -2.456  .601 | .004\*\*  .549 |
| Sale of land to individuals | .017 | .010 | .165 | 1.658 | .101 |
| Other causes | .004 | .012 | .036 | .355 | .723 |
| a. Dependent Variable: grass seed bank adaptation intervention | | | | | | |

The results suggest that inheritance and conversion of grass land to farmlands has statistically significant effect on the grass seed bank adaptation intervention, with a negative coefficient (-0.052 and -0.45) indicating that an increase in inheritance and conversion of grazing lands to farmlands is associated with a decrease in the intervention. The standardized coefficients (Beta) indicate that for every one-standard-deviation increase in inheritance and conversion of grass lands to farm lands, the grass seed bank adaptation intervention is expected to decrease by 0.283 and -0.190 standard deviations. The t-statistic for Inheritance is -2.816, and the p-value is 0.003, and the t-statistics for conversion of grasslands to farmlands is -2.456, and the p-value is 0.004 indicating that the coefficient for Inheritance and conversion of grasslands to farmlands is statistically significant at the 0.05 level.

Sub division of group ranches had negative relationship with adoption of grass seed banks with Coefficient of is -0.107 (Beta), which means that for every one-standard-deviation increase subdivision of ranches, the Grass seed bank adaptation intervention is expected to decrease by the coefficient values. However, sub division of group ranches do not have a statistically significant effect on the dependent variable with a significance of 0.292. Inheritance of land by women gives them more freedom and rights to made decisions on how to utilize land.

Three out of the 6 causes of land fragmentation studies had positive standardized coefficient (Beta) towards grass seed bank adoption. Sale of land to individuals, Infrastructure development and other courses had coefficients of (0.165, 0.060 and 0.036) receptively, which implied that for every one-standard-deviation increase in sale of land or infrastructure development and other uses of land not studied the grass bank intervention is likely to increase by the values indicated in table 4.

Comparing these findings with other studies, such as Gouranga *et al.,* (2023), who examined the effects of land fragmentation on biodiversity and ecosystem services in different regions reveals a common theme of land fragmentation having a multifaceted impact on ecosystems and human well-being. These studies highlight the importance of considering the specific context and local perceptions when assessing the impacts of land fragmentation, as well as the need for comprehensive strategies to mitigate its negative effects and leverage its potential benefits.

* 1. Challenges affecting development of seedbanks.

Grass seed banks, while valuable for landscape restoration, face other challenges apart from diminishing land and degradation. These challenges may include drought, invasive species, livestock and wildlife invasion, social challenges such as farmer’s knowledge, experience, finances, and access to technical expertise. The study investigated these challenges since they complement the issue of land fragmentation and may act as enablers for the failure of the seed banks. Respondents were given an opportunity to highlight other challenges that they are facing alongside land fragmentation. The results are presented in figure 3.

Figure 3: Challenges facing the development of seed banks

In figure 3, the women highlighted several challenges that they are experiencing while practicing the intervention including. The women involved in the grass seed banks face a multitude of challenges that hinder their success. Firstly, 100% of the women agree that frequent droughts are a significant challenge to the grass seed banks, which are entirely dependent on rainfall. When rains fail, and droughts are harsh, most seed banks fail to produce substantial yields, affecting their income since they have to reinvest what little they earn back into the banks.

Furthermore, 87% of the respondents agree that over-reliance on rainfall, with no access to irrigation, is also a threat to the grass seed banks if the climate continues to change. The long seasons between harvests pose an additional challenge for the women who have no alternative sources of livelihood. Land ownership is another significant challenge, with 75% of the respondents agreeing that the current land ownership system hinders the success of grass seed banks. In the community, men own the land, and the group ranch has men as the legal owners, disadvantaging women from ownership. The women's groups have to go through the group ranch to be allocated land for establishing the seed banks, and in case of any substantiated reasons, the seed banks can be reallocated to different areas, paving the way for other activities by the group ranch. Moreover, 76% of the respondents attribute the failure of grass seed banks to land sizes, as individuals and groups with large lands are more likely to produce more yields.

The lack of modern farming technologies is also a significant hindrance, with 67% of the women pointing out that it may hinder the attainment of the objective of the grass seed banks. The work in the grass seed banks is intensive, starting from planting, weeding, and harvesting, and most groups do this manually. Considering that many group members are elderly or disabled, the work becomes tiresome for the remaining members. Farm tools are also inadequate, and some are broken. Additionally, pastoralism as a way of life is a significant hindrance to the intervention, as it took a while for the community to adopt the grass seed banks initiative since they were used to migrating from one place to another during drought seasons. Some households still practice pastoralism and have not adapted the technology of reseeding and buying hay for their livestock.

Access to adequate information is another challenge, with 71% of the respondents explaining that low financial and marketing literacy, coupled with access to inadequate information, has hindered them from marketing their produce and achieving full commercialization. Furthermore, 98% of the women interviewed have no access to credit facilities, which they attribute to inadequate finances in savings with the credit providers since most of them live from hand to mouth.

On the other hand, 80% of the respondents disagree that access to agricultural extension services is a hindrance to the success of grass seed banks, attributing their opinion to the availability of extension services especially from the local organization personnel supporting them. However, 20% of them agree that it might be a challenge, attributing it to the unavailability of sustainable government extension services that they may need in the absence of the supporting organization.

Lastly, 81% of the respondents disagree that farm experience is a hindrance to the success of grass seed banks, attributing this to the frequent farm technical training provided by the supporting organization.

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# **4. SUMMARY, CONCLUSION AND RECOMMENDATIONS**

## **4.1: Summary of the findings**

### **4.1.1: Demographic characteristics**

The study achieved 89.51% (111) successful responses of the targeted respondent’s including101 women who are involved in the GSB and 10 KII. The survey on women collected demographic characteristics of the respondents including age, education level, income level, main occupation, land size, land ownership and land use, to provide a comprehensive understanding of the study population. The women interviewed had stayed in the study area for averagely 24.26 years with older respondent, having stayed in the area longer (averagely 32.06 years) than the young respondents. The data also suggests a potential positive relationship between education level and household income. The main occupation practiced by women was livestock keeping with 71% of the total respondents. 70% of the respondents keep goats as the predominant or most abundant type of livestock with 12% keeping cattle and 10% keeping sheep as the most preferred livestock. Despite crop production being the lowest activities performed by the women; it emerged as the highest earning sector with a mean annual income of 11537.50 while income from livestock being at 6166.67 annually. Women with primary level education were the most dominant group at 43.2% practicing livestock keeping. Married individuals having the largest mean household size, followed by widowed individuals, and then single individuals. Livestock keeping was the largest land use, implying that most of the land by owned respondents was designated for livestock’s as pasture land. Out of the total land size (995 ha) livestock keeping occupied 68.54%.

### **5.1.2: Drivers of land fragmentation**

Inheritance (98%) and rate of increase in conversion of grazing land to farmland (70%) was identified as the major causes of land fragmentation with odd ratios. There was also a positive relationship between Sale of land to individuals and sub division of group ranches and Land Fragmentation indicating that an increase of the two will lead to an increase on land fragmentation. However, these associations were not statistically significant to the 0.05 significance level. This may be due to the process of settlement of families and processing of land ownership documents (title deeds) not yet concluded in the region. However, the respondents expressed their concerns on the variables bringing a significant effect after completion of subdivision. Infrastructure development was the only factors that was negatively association with land fragmentation indicating that it did not results to any land fragmentation although it is not statistically significant.

### **5.1.3: Benefits of grass seed banks to women**

Increased income from sale grass seeds was the major benefits accrued from the seed banks with 98% of the women agreeing while 84% said income from the sale of milk and healthier animals was also an observed benefit. With a minimum of 10 acres of land for the sed banks, the women accrue an annual benefit of approximately eight hundred thousand shillings (Ksh 800,000) from each sale of hay or grass seeds. The respondents also agree that the grass seed banks initiative has improved Survival of livestock using hay from the seed banks project groups as fodder during drought seasons. This has maintained their prices and milk production, sustaining their livelihood. They also agree that grass seeds from the banks promotes restoration efforts and support sustainable grazing of livestock in rehabilitated grazing fields due to the availability of pasture and water. From practicing the grass seed banks intervention, women also incorporate other alternative activities to increase income i.e. beekeeping.

### **5.1.4: Effects of land fragmentation on grass seed banks**

Reduced land for restoration of pasture due to land fragmentation was the popular opinion with 100% of the respondents agreeing. The women perceived that land for establishment of grass seeds banks and preparation and storage was also affected with 80% and 82% noticing reduction of land allocated for duplication of the said activities. This suggests that the fragmentation of land into smaller parcels has limited the space available for creating and maintaining seed banks, which are crucial for the establishment of seed banks and the restoration efforts to rangeland through re-seeding. These rangelands are essential for maintaining biodiversity and supporting livelihoods. However, respondents indicated that land fragmentation effect on water access was not as significant. The women were also neutral on the statement that land fragmentation has improved access to markets and improved modern technology for intensive farming. This indicates that the fragmentation of land does not have a clear positive or negative impact on market access or on the adoption of modern farming technologies.

## **4.2: Conclusions**

Common challenges for maintaining and up scaling community seed banks in the Kuku ward include improving the mechanisms of controlling land fragmentation and mechanisms that contribute to a more secure and diversified supply of high-quality seeds adapted to local conditions and developing incentives for farmers, particularly women and younger generations, to continue their seed-banks efforts. This can be achieved through strengthening of grass seed banks community ownership, financial power, the introduction of more efficient and effective systems to acquire and exchange seeds, better seed conservation and multiplication practices for a broad range of grass and training in grass improvement practices. Women in the grass seeds are benefiting a lot from the grass seed banks and especially from income and hay for their livestock. Community seed banks would benefit from targeted technical and financial support from government, organisations and private sectors and solve the issues of livestock loss due to drought.

The analysis of factors contributing to land fragmentation in Kajiado reveals that the conversion of grassland to farming and inheritance are the primary drivers. The significant mean scales of 1.21 and 1.22, respectively, highlight the critical role these factors play in exacerbating fragmentation, with a substantial portion of respondents acknowledging their impact. The shift from grasslands to croplands not only leads to the subdivision of larger plots but also poses ecological risks by transforming the ecosystem into a net carbon emitter. In contrast, infrastructure development appears to have a limited effect on land fragmentation, as indicated by the low percentage of respondents attributing fragmentation to this factor. Furthermore, the neutral impact of subdivision of group ranches suggests that this process does not significantly influence fragmentation dynamics. These findings underscore the complexity of land use changes.

The grass seed banks initiative has proven to be a transformative program for the women in the community, significantly enhancing livestock survival and improving household incomes. The ability to store and utilize hay as fodder during droughts has played a crucial role in preventing livestock losses, while increased milk production from improved feeding practices has contributed to better nutrition and financial stability for families. Moreover, the initiative supports environmental sustainability through the promotion of quality grass seeds, which aid in rangeland restoration and help mitigate human-wildlife conflicts. The diversification of income-generating activities, such as beekeeping and poultry farming, further strengthens the resilience of these women against the challenges posed by drought.

Beyond economic and environmental benefits, the initiative has fostered a sense of community among the women, allowing them to share experiences and provide mutual support on various social issues. Overall, the grass seed banks initiative not only enhances agricultural productivity but also empowers women, contributing to their families' well-being and fostering a collaborative community spirit.

The findings from the assessment of the impact of land fragmentation on seed banks in kuku ward reveal significant concerns regarding the availability of land for conservation efforts. The strong agreement (mean score of 3.88) that fragmentation has reduced the land available for establishing seed banks highlights a critical challenge in maintaining the GSB programs. The unanimous agreement among respondents on the necessity of land restoration for pasture further emphasizes the need for larger, contiguous land areas to effectively establish grass seed banks. This indicates a clear recognition of the relationship between land size and the capacity for continuity of GSB.

Additionally, the strong agreement regarding reduced land for preparing and storing hay and grass seeds (mean score of 3.94) underscores the negative impact of fragmentation on agricultural practices essential for conservation. Conversely, the disagreement regarding the impact of fragmentation on water access, coupled with the low percentage of respondents considering water access a requirement for seed banks, suggests that while fragmentation presents various challenges, its effect on water resources is perceived as less critical. The neutral scores related to market access and access to modern farming technologies indicate that respondents believe other factors may be more influential in these areas, suggesting a complex interplay of influences beyond land fragmentation.

## **4.3 Recommendations**

1. The study strongly recommends the development of a comprehensive land use plan that takes into account the needs and perspectives of women involved in grass seed banks adaptation intervention.
2. To address the issue of land fragmentation, the study recommends the implementation of land consolidation programs that can help to reduce the number of small, scattered plots of land and increase land availability for women involved in grass seed banks adaptation intervention.
3. The study emphasizes the need for capacity-building programs that focus on skills development, entrepreneurship, and leadership for women involved in grass seed banks adaptation intervention.

**COMPETING INTERESTS DISCLAIMER:**

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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