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A Comparative Study on Agroecological Benefits of Nine Seeded Holes Technology and Traditional Farming in Singida Rural District, Tanzania

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Abstract: **A mixed method research consisted of quantitative and qualitative carried out using descriptive and experiemental research design aimed to compare agroecological benefit of nine seeded holes and traditional farming on maize production in Singida rural district, Tanzania. A total of 50 respondents with the experience of using nine seeded holes and traditional farming for more than three cropping season and aged 18 years and above were included in the study. The sample size was calculated using kothari 2004. Data was collected using questionnaire survey, key informant interviews, focus group discussion and pairwise ranking whereby field experimental data was collected using observation and keeping record of changes. All data collected was subjected to quantitative and qualitative analysis. Quantitative analysis was analysed through SPSS-26 and Rstudio. Whereas qualitative material was analyzed by using NVivo-12 software and chi-squire and anova test was used to test the level of significance. The study discovered that nine seeded holes technology is much more productive than traditional farming system and has more agroecological profit and benefits compared to traditional farming in maize production in semi arid area.**

Keywords: **comparative agroecological, profit, benefit, nine seeded holes technology, traditional farming.**

1. INTRODUCTION

Agroecology is a major part of the global responses to the impact of climate change offering a unique approach to meet vital increases in our food needs of the future[1].Globally the rise in maize yield per hectare is vividly slower as compared to rate of increasing population [2]. The current reports show that up to the year 2100 there will be decline in the production of maize yields by 20%-45% [2]. Whereas other reports recognized that maize production would have decreased not less than 10% globally and equal to 50% in some regions of the world as a results of climate change [3].

Tanzania is among the thirteen highly affected countries in the world by the effects of climate change [4]. Large number of populations in rural area who mostly depend on maize production for their livelihoods are affected by decreased availability of water as a result of change in rainfall patterns or increased temperature [4]. Rural inhabitants are mostly exposed to food insecurity than urban inhabitants whereas food shortages are mainly reported by households located in drought area[5]. This is due to poor temporal and uneven poor spatial distribution of short rain combined with a late start and early stop in some area [6]. Other factors include poor soil fertility, water retention, limited household stocks, and overdependence of maize as a staple food and poor maize yields caused by degraded soils [7] .Therefore increasing maize production is a vital challenge for them [6].

Water as a vital aspect that enable maize growth needs to be constant in the soil to improve maize growth [8]. In order to harvest rainwater, restore soil to the sufficient level of fertility and to increase yield agroecological micro catchment rainwater harvesting technology are promoted by NGOs and ministry of agriculture in semi-arid area of Tanzania [9].

Nine seeded holes is an agroecological technology for rainwater harvest and soil fertility management categorized as native micro-catchment rainwater harvesting technology[10]. It intended at improving food productivity, food security and farmers income due to the variability of rainfall and acute drought [4]. It is created to collect runoff water from smaller catchment area inside the farm borders in range of 10-500m^2 [10]. Runoff water is generally directed into types of penetration improvement structure and used directly by the plants or crop [11]. It enhancing water availability and soil fertility, in this support restore the productivity of the semi-arid soil [12].

Nine seeded hole refers to digging planting hole of about 60cm deep by 60cm wide and 60cm lining space and placing about 36 to 40 kilograms of farm yard manure or compost in each hole mixing with 30cm top soil in order to capture most of the runoff water and planting nine seeds of maize [13]. It intended to harvest the inadequate rainwater and advance its infiltration in the originally sealed soil [13]. It is used to rehabilitate degraded drylands and restore soil fertility[14]. The sum of organic matter biological soil activities raised up allowing the growing environment for nine seeds of maize to be put inside the hole [13]. The technique have proven concrete management option in semi-arid area allowing the improvement of unproductive soil and leading to a unique increase of maize yield [8]. Despite its known benefits and demonstrated success in much semi-arid area of Tanzania its profit and other agroecological benefits compare to traditional farming is still not well documented. It is on the desirable that this study aimed to fill these knowledge gaps.

2. MATERIAL AND METHODS

A study employed mixed methodology that consisted of quantitative and qualitative methods. This study was carried out using descriptive and experiemental research design [15]. This design allowed a researcher to strengthen the validity and credibility of the study. It was carried out in Singida rural district in Singida region in central Tanzania. The district has a total population of 225,521 and it is administratively divided into 3 divisions and 21wards[16]. It is characterized by a semi-arid climatic condition with two seasons, the dry season which is the longest starting from April to November and the rainy season starting from December to March with the average rainfall between 600-700mm per year whereas the temperature ranges from 15C to 30C [16].

Farmers in this area practiced nine seeded holes and agriculture is mostly rainfed and maize is grown in this area as well the soils are fragile and prone to decline infertility attributable to erosion risks due to poor natural and human adapted vegetative cover and low land value per unit area. The primary target population of this study was 400 farmers' adopters of nine seeded holes and user of both nine nine seeded holes and traditional farming with the experience of more than three cropping season. The key informants in this study were the extension officers from government and field staffs from local organization within the district.

A sample size was calculated using Kothari, 2004. The formula is $\mathbf{n=Z^2pqN/e^2(N-1)+Z^2pq.}$ "n" is the sample size, "N" is the total population, "p" is population reliability, where "p" is 0.5 which is taken for all developing countries population and p + q= 1, "e" margin of error to be considered is 13% for this study. "Z α /2" normal reduced variable at 0.05 level of significance z is 1.96. Rendering to the above formula the sample size enrolled in this study was 50 participants. Among 21 wards, 10 wards were adopters of nine seeded holes and users of both nine seeded holes and traditional farming with the experiences of more than three cropping seasons. Therefore among 10 wards, 5 wards were selected randomly in this study and in each of the 5 wards, 10 farmers were selected randomly to yield 50 respondents. The selection of participants was on the basis of willingness to participate in the comparisons.

Experiements were conducted under rain fed farming situation for one cropping season in order to gain experiences of nine seeded holes yield in comparison to traditional farming. The test crop was maize and the same variety was used by all farmers. The selected 50 farmers each prepared two plots before the rain season, 1 acre for nine seeded holes and 1 acre for traditional farming. Nine seeded holes were dug of about 60cm deep by 60cm wide and 60cm lining space and placing about 36 kilograms of farm yard manure in each hole mixing with 30cm top soil. The mixture was refilled in the holes and a space like a basin was left at the top. For traditional farming farmers applied, farm yard manure which was broadcasted before farm cultivation then farmers cultivated first round and the second-round cows draw the ox plow and the sower dropped maize seeds in the raws by following the line drawn by the plow whereas planting for the nine seeded holes and traditional practice done at the same time.

Data collection in both nine seeded holes and traditional farming was commenced at germination and continue to be collected with critical interval of twice per month. The type of data collected was yield and germination. Data from respondents was collected using questionnaire survey, interview, focus group discussion and pairwise ranking whereby

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field experimental layout was collected twice per month. All data collected was subjected to quantitative and qualitative analysis. Quantitative analysis was analysed through SPSS-26 and Rstudio. Whereas qualitative material was analyzed by using NVivo-12 software and chi-squire and anova test was used to test the level of significance and the results was presented in frequence table, percentage and figure.

3. RESULTS

3.1 Demographic and Social Economic Characteristic of Respondents

Demographic findings show that there is statistical significance between female 31(62%) and male 19(38%) respondents ($p<0.001$). It noticed the number of households aged 46-55 years 21(42%) has a significantly higher number farmers who adopted nine seeded holes compared to younger household heads ($p<0.001$). As regards to size of households the results verified that there is a statistical significance between size of household 6-8(60%) and the adoption of nine seeded holes ($p<0.001$). it revealed that most of the adopters of nine seeded holes are married this is due to the fact that most of the farmers who received nine seeded holes training were married. Interms of education level the results indicated that there is a statistical difference between adopter of nine seeded holes who attended primary school 48(96%) and who not attended school ($p<0.001$).

3.2 Agroecological Profit and Benefit of Nine Seeded Holes Compared to Traditional Farming

The results from pairwise ranking noticed nine seeded holes farming has more agroecological profit and benefit compared to traditional farming in terms of trapping runoff water, to enable more water penetration, to hold soil moisture, to combine nutrients and water management, to reduce manure and nutrients competitions, to improve soil structure and restore soil fertility, to restore soil erosion and degraded land, to reduce vegetative loss and preserve biodiversity, to combat desertification, to support germination of maize, to protect seeds and organic matter being washed away, to generate more beneficial insects, to reduce weed, to reduce pest and diseases, better in low rainfall and high rainfall season, good uses of manure and high maize productivity.

During focus group discussion and interviews with key informants the study identified that traditional farming involved slash, burning, cutting down tree which create the possibilities of reducing the organic matter from the soil and leads to the situation of deforestation and the most roots of maize firmly hold the soils to get eroded by the weathering forces like rain, wind and storms which cause the loss of top soil fertility, increase soil erosion and degraded land, increase vegetative loss and biodiversity, increase desertification, make seed and organic matter being washed away, dencrease beneficial insects, increase pest and diseases hence leads to low yield of maize.

Variables	Traditional (%)	Nine seeded (%)
Trap runoff water well	-	50(100%)
Enable more water penetration	-	50(100%)
Better in low rainfall and high rainfall season	-	50(100%)
Hold soil moisture	-	50(100%)
Combine nutrients and water management	-	50(100%)
Good uses of manure	-	50(100%)
Reduce manure and nutrients competitions	-	50(100%)
Improvement in soil structure and restore soil fertility	-	50(100%)
Restore soil erosion and degraded land	-	50(100%)
Reduce vegetative loss and preserve biodiversity	-	50(100%)
Combat desertification	-	50(100%)
Support germination of maize	-	50(100%)
Protect seeds and organic matter being washed away	-	50(100%)
High maize productivity	-	50(100%)
More beneficial insects	-	50(100%)
Less weed	-	50(100%)
Pest by weeds is highly reduced	-	50(100%)
Diseases by weeds are highly reduced	-	50(100%)

Table 1: Results of Pairwise Ranking of Agroecological profit and Benefit of Nine Seeded Holes Compared to Traditional Farming

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In experiemental layout a study found there was a significant difference in yields between nine-seeded-holes and traditional farming ($p>0.001$). In all 5 wards nine seeded holes was much more productive than traditional farming. It performed on average of 5769.85126kg/acre compared to traditional farming that performed on average of 704.49348kg/acre in all wards (Figure 1 see, the effect of nine-seeded-holes versus traditional farming on yield of maize).

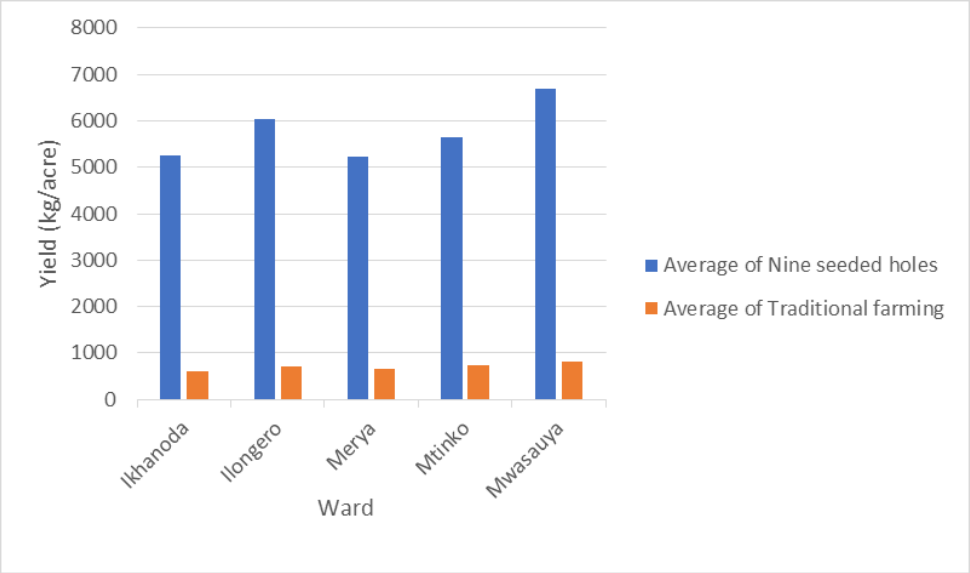

Figure 1: Effect of Nine-Seeded-Holes versus Traditional Farming on Yield of Maize.

A study revealed that there was yield variation among wards. There are farms that got relatively high yields than other farms using the traditional and nine-seeded-holes (Figure2, see the distinctively divided farms in the scatterplot – those is the left and right). The findings show that nine seeded holes yields in Mwasauya ward are higher and less variable than other wards whereby it revealed that Ikhanonda and Merya wards seem to have lower average yields than other wards (figure1). This is due to the differences in rainfall patern among wards and differences in the individual farms by each farmer in native soil fertility and types of organic manure in terms of feed, liter and age of animal.

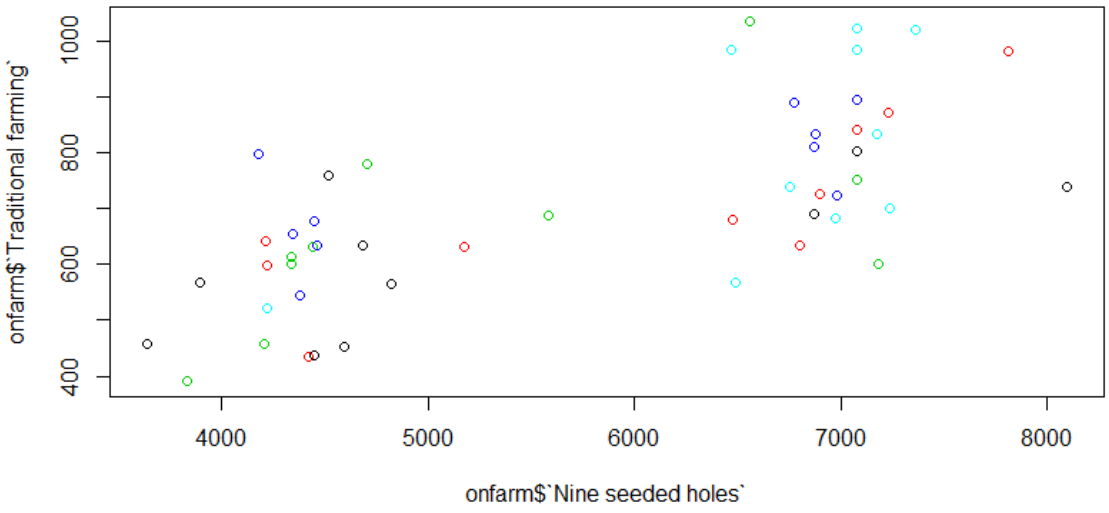

Figure 2: A scatter Plot Shows Variation of Nine Seeded Holes and Traditional Farming on Maize Yield in Different Wards

4. DISCUSSION

The study aimed to compare agroecological profit and benefits of nine seeded holes and traditional farming on maize production in semi-arid area. Agroecology is recognized as the way forward for maize cultivation capable of declining productivity well without affecting the environment and nature. The findings revealed that nine seeded holes farming has more agroecological profit and benefits compared to traditional farming. The agroecological profit and benefits discovered in this study from maize cultivation using nine seeded holes as an agroecological practices includes the relationship between agriculture production system and ecological process.

Nine seeded holes is an agroecological techniques that allowed agriculture practices to be more respectful of the environment and its ecological specificities. Nine seeded holes helps to minimize the pressure of the environment and preserve the renewal capacity of the ecosystem services. After digging nine seeded holes they are filled with manure which led to increased microbial activities which in return increase the rate of water infiltration during the rain seasons. This creates a micro-environment that increase drought resistance and improve maize yield.

Nine seeded hole is most appropriate in area where infertile, encrusted soil receive low and often highly in reliable rainfall causing the small holders farmers face continuous challenges. The study observed that through digging nine seeded holes degraded hand pan soils that are impossible to plough can be made productive rather than being abandoned. Nine seeded holes plays significant roles in controlling runoff since the rainwater is trapped on them, continually close to the root of maize this playing a major role in water harvesting. Nine seeded holes act as a micro catchment that collect water and sediments. The soil placed downhill from each hole enhances their water harvesting function. The added organic material improves infiltration and retention of water in the soil. Nine seeded holes concentrates fertility near the maize root's zones, wind or run off driven debris. Nine seeded holes activities contribute significantly to the decomposition of organic matter and nutrients recycling in the soils. Nine seeded holes guarantees that competition for moisture, manure and pesticides by weed are highly reduced. This is because the maize is grown in artificial environment which is controlled and thus weeds and pesticides are disadvantages.

Most of the farmers felt strongly that the design of nine seeded holes as an agroecological practices enable trapping runoff water, water penetration, hold soil moisture, combine nutrients, reduce manure and nutrients competitions, improve soil structure and restore soil fertility, restore soil erosion and degraded land, reduce vegetative loss and preserve biodiversity, combat desertification, protect seeds and organic matter being washed away, generate more beneficial insects, reduce weed, pest and diseases hence helped to concentrate water and nutrients for the maize and reduce maize failure due to the impact of climate change. This is in agreement with findings that water harvesting technologies improve food security and increase resilience and adoption to climate changes by insuring more efficient use of scarce water resources Kiggundu, Nicholas et al. (2018). The findings illustrated that nine seeded holes helped to increase maize yield than traditional farming this is reliable with Nkatha, Koome Dorcas (2017), who reported that water harvesting technology conserve water hence reduce the risk of crop failure compare to traditional farming. Traditional farming use the primitive styles of farming like slash and burning which reduce the organic matter from the soil and within the short period of time the nutrients content of the soil taken up by maize, the slash and burn required massive cutting down of tree which leads to the situation of deforestation and the deforestation exposed the soil to get eroded by the rain and wind which cause the loss of top fertile soil and this was the main reasons for low yield of maize when using traditional farming.

Most of the farmers continue to use traditional farming because it is a primitive style of farming and it is simple to apply compared to nine seeded holes technology even if they know side effects of using traditional farming on ecology, soil and how nine seeded holes is more productive than traditional farming. Nine seeded holes as an agroecological practices use small area to harvest more maize and is useful to farmers who are attempting to grow maize in semi-arid area.

The approaches used in nine seeded holes technology in combination with production techniques allowed farmers to increase the soil organic matter and other assets that provide greater system resilience. Farmers can use the same holes for more than three cropping seasons to plant maize which allowed them to save cost compared to traditional farming.

5. CONCLUSION

The study revealed that nine seeded holes technology is much more productive than traditional farming and has more agroecological profit and benefits than traditional farming in maize production particularly in semi arid area. Nine seeded holes applied agroecological principles to build soil fertility, to trap runoff water and to hold soil moisture and to manage pests. Thefore, by using erosion control, manure, compost and other methods farmers can intensify maize production

without relying on cost or unavailable inputs. Farmers should be encouraged to adopt nine seeded holes technology which is much more productive than traditional farming.

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REFERENCES

[1] A. Mdee, A. Wostry, A. Coulson, and J. Maro, "A pathway to inclusive sustainable intensification in agriculture? Assessing evidence on the application of agroecology in Tanzania," *Agroecol. Sustain. Food Syst.*, vol. 43, no. 2, pp. 201–227, 2019.

[2] N. K. Arora, "Impact of climate change on agriculture production and its sustainable solutions," Environ. Sustain. vol. 2, no. 2, pp. 95–96, 2019, doi: 10.1007/s42398-019-00078-w.

[3] C. Francis, "The carbon farming solution: a global toolkit of perennial crops and regenerative agriculture practices for climate change mitigation and food security, by Eric Toensmeier," Agroecol. Sustain. Food Syst., vol. 40, no. 9, pp. 1039–1040, 2016, doi: 10.1080/21683565.2016.1214861.

[4] M. Mkonda, M. Y. Mkonda, and X. He, "Production Trends of Food Crops: Opportunities, Challenges and Prospects to Improve Tanzanian Rural Livelihoods Environmental Engineering View project Building resilient and profitable grain cropping systems through improved knowledge of soil organic carb," Nat. Resour. Conserv. vol. 4, no. 4, pp. 51–59, 2016, doi: 10.13189/nrc.2016.040402.

[5] "Climate change and food security in Tanzania: analysis of current knowledge and research gaps," Tanzania J. Agric. Sci., vol. 14, no. 1, pp. 21–33, 2015.

[6] K. Reincke, E. Vilvert, A. Fasse, F. Graef, S. Sieber, and M. A. Lana, "Key factors influencing food security of smallholder farmers in Tanzania and the role of cassava as a strategic crop," Food Secur., vol. 10, no. 4, pp. 911–924, 2018, doi: 10.1007/s12571-018-0814-3.

[7] F. Ojija, S. Abihudi, B. Mwendwa, C. M. Leweri, and K. Chisanga, "The Impact of Climate Change on Agriculture and Health Sectors in Tanzania: A review," Int. J. Environ. Agric. Biotechnol., vol. 2, no. 4, pp. 1758–1766, 2017, doi: 10.22161/ijeab/2.4.37.

[8] M.N. Danjuma* and S. Mohammed, "Zai Pits System: A Catalyst for Restoration in the Dry Lands\n," IOSR J. Agric. Vet. Sci., vol. 8, no. 2, pp. 01–04, 2015, doi: 10.9790/2380-08210104.

[9] ASDS II, "Agricultural Sector Development Strategy-II 2015/2016-2024/2025," United Repub. Tanzania, p. 95, 2016, [Online]. Available: http://extwprlegs1.fao.org/docs/pdf/tan160643.pdf.

[10] J. De Trincheria, D. Dawit, and W. L. Filho, "Fostering the use of rainwater for small-scale irrigation in sub-Saharan Africa Call for papers: 21st century skills, individual competences and personal capabilities for sustainability: a management and education perspective. View project IMPALA View pro," no. September, 2016, doi: 10.13140/RG.2.2.11049.39522.

[11] F. O. Danquah, M. A. Twumasi, and I. Asare, "Factors Influencing Zai Pit Technology Adaptation : The Case of Smallholder Farmers in the Upper East Region of Ghana," Agric. Res. Technol., vol. 21, no. 1, 2019, doi: 10.19080/ARTOAJ.2019.21.556150.

[12] N. Kiggundu et al., "Rainwater harvesting knowledge and practice for agricultural production in a changing climate: A review from Uganda's perspective," Agric. Eng. Int. CIGR J., vol. 20, no. 2, pp. 19–36, 2018.

[13] K. D. Nkatha, "Factors Influencing the Adoption of ' Zai ' Pit Farming Technology To Enhance Food Security : the Case of Makueni County , Kenya By," 2017.

[14] M. Miriam, "Factors Affecting Smallholder Farmers" Adoption of Integrated Soil Fertility and Water Management Practices in Machakos Count," pp. 1–114, 2017.

[15] A. Shorten and J. Smith, "Mixed methods research: Expanding the evidence base," Evid. Based. Nurs. vol. 20, no. 3, pp. 74–75, 2017, doi: 10.1136/eb-2017-102699.

[16] URT, "The United Republic of Tanzania, Singida socio-economic profile, 2015," 2017.