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Taungya Agroforestry program in Dryland of Sudan: Incentives, Challenges and Strategies for Improvement

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Abstract
The Taungya Agroforestry program has been practiced for a long time in different parts of Sudan as one of the strategies implemented by the Forest National corporation to halt deforestation and forest degradation and as means of livelihood improvement for the communities surrounding the forest reserves. In the program, the Forest National Corporation allocated a predetermined area inside the reserved forests and provides the farmers with seedling and technical assistance. Farmers are allowed to grow their subsistence and commercial crops between tree spacing at the early stage of tree establishment. Using a mix of quantitative and qualitative methods, focus group discussions, key informants' interviews, field observation and semi-structured questionnaires among 200 Taungya farmers from nine villages surrounding Nabag Forest Reserve in South Kurdufan State, Sudan. This study attempts to discover the major incentives and challenges associated with Taungya farmers in the study area as well as suggest some strategies for enhancing the program. The study results revealed that the high productivity inside the forest, access to free land, and the highly fertile soil inside the forest were the main incentives for farmers to participate in the program. The study also indicates that the lack of extension services and supervision from Forest National Corporation, overgrazing and crop destruction, land size allocation, and crop species restrictions discourage farmers from participating. The study suggested that: (i) the priority budget allocation be given to the extension services that could empower farmers and guarantee to transfer and deliver the extension services adequately; (ii) Taungya farmers could use the live fences to protect their farms and Forest National Corporation could facilitate this by allowing farmers to use the branches of failed trees during the migration season of pastoralists; and (iii) the Forest National Corporation should reconsider farmers' interest in having intercropping sorghum on their farms by revising tree spacing in the future to overcome these challenges.
Keywords: Taungya Agroforestry, Incentives, Challenges, Sudan
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Introduction

Sudan covers a land area of 1.9 million km^2, of which 29.8 million hectares are classified as forest cover (FAO 2020). Sudan's forest resources play an essential role in providing livelihood needs. Particularly in the rural areas, the majority depend on wood and non-wood forest products as the main sources of income and daily food consumption (Mohamed et al. 2021). Nonetheless, Sudan's forest cover has witnessed massive changes during the last decade. It has substantially declined from 40% to 10.3% with an annual rate of deforestation 1.6% due mainly to agricultural expansion and forest overexploitation (Abdoun 2020). An important remedy to the problem of deforestation and forest degradation caused by anthropogenic activities is the establishment of more forest plantations and enhancement of management practices. In regard, many models, initiatives, and schemes have been applied by the Forest National Corporation (FNC) of Sudan to rehabilitate forest cover and improve the livelihoods of the fringe communities. One of these schemes is the Taungya agroforestry system. Taungya system is one of agroforestry systems, where annual crops are growing alongside forestry trees during the initial stages of forest plantation establishment. (Azeez et al. 2017). The system was originally generated from Myanmar in the early 19th century (Acheampong et al. 2016) and has been widely used in some countries as an effective and inexpensive technology for rehabilitation of the forest cover and livelihood improvement for farmers. In Sudan, however, Taungya system is considered as one of the strategies implemented by the Forest National Cooperation (FNC) to halt deforestation and forest degradation. In the program, the FNC allocated a predetermined area inside the reserved forests and provided the farmers with tree seeds/seedling and technical assistance. The farmers are responsible for planting specific crops allowed by FNC (El Tahir et al. 2015). Taungya agroforestry has been seen as a promising

practice to solve food shortages. It increases crop yields and thus achieve sustainable livelihood for farmers, particularly in African countries where food shortage is of great concern (Wiro and Ansa 2019). In spite, some studies (Oluwadare 2014; Appiah et al. 2020) have analyzed and reported findings indicating a high degree of variation in Taungya agroforestry research, however, little is known about the Taungya agroforestry in dryland of Sudan. Therefore, this research is aimed to explore the major incentives and challenges related to the Taungya agroforestry program implemented by FNC in Nabag Forest Reserve in South Kurdofan State, Sudan.

Methodology

Nabag forest reserve is located in EL Dilling district, South Kordofan State between the latitude 12° 30' 0" N and 12° 36' 0" N and the longitude 29° 36' 0" E to 29° 58' 0" E. It was reserved in 1961 as a state forest and is managed by FNC. It covers an area of 4174.2 hectares. The dominant tree species is *Acacia senegal*. Species including *Azadirachta indica*, *Balanites aegyptiaca*, *Sclerocarya birrea*, are also present.

Data collection was done using both primary and secondary means. Primary data was collected based on face-to-face interview using a semi-structured questionnaire. This was complemented and validated through focus group discussions, key informant interviews, and direct field observations. Prior to the formal interview, the questionnaire was rigorously pre-tested with a cohort of 10 farmers to observe its reliability and validity. Before starting the interviews, each respondent was informed about the purpose of the research, questionnaire protocol, and timelines. Respondents were given the full right to respond to the interview or to refuse it. This ethical issue was important to build confidence between enumerators and respondents and to connote voluntary participation. The interview period lasted between 20-45 minutes and was carried out mainly in Sheikh (village leader) houses, village markets, and farming. The secondary data was collected from a wide range of documents, archival records, reports by FNC, available literature (articles, books, policy briefs), and internet sources.

Results and Discussions

Socioeconomic Context and Demographic Factors of Respondents

The study findings on the socioeconomic characteristics of the farmers, as summarized in Fig. 1 showed that Taungya practice was dominated by male farmers, they represent 77% of respondents. The high proportion of males could be attributed to the fact that in a natural African setting, men are usually the head of the households and are in charge of making decisions. The study further showed that most of the farmers have attained different levels of education, ranging from Khalwa 23%, primary 34.5, secondary 16.5%, and university 5%, while 21% were illiterate. It is obvious that most of the farmers in the study area have attained at least formal or informal education, meaning that they are more likely to easily understand the extension programs and have access to up-to-date agricultural technologies compared to illiterate farmers. The study also revealed that 57.7% of the farmers fell within the age range of 36–55 years, with an average age of 40.96 years as shown in Fig. 1. These findings suggest that most of the farmers were above youthful age but still considered within an economically active age range. Regarding Taungya experience, the findings in Fig. 1 showed 57.5% had Taungya experience ranging between 1–5 years, while the others, 23%, 15.5%, and 4% had an experience of between 6–10 years, 11–15 years, and more than 15 years, respectively (Figure 1). This implies that Taungya practice is well accepted by the farmers and the number of adopters is increasing, at the same time, farmers in the study area have enough experience in practicing Taungya agroforestry.

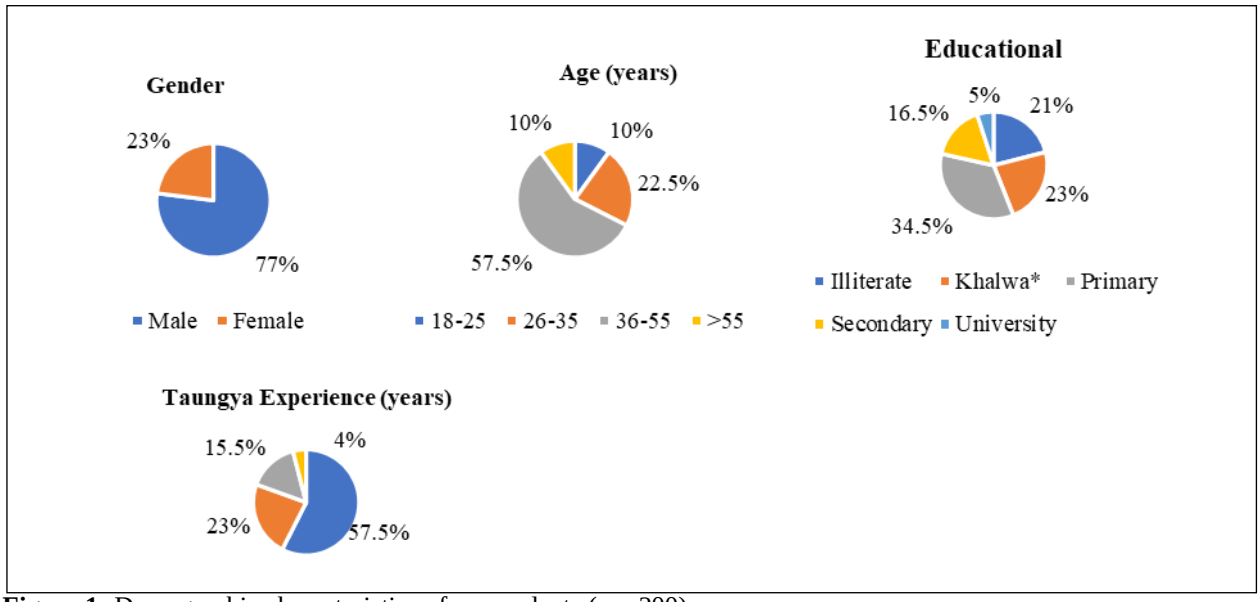

Figure 1: Demographic characteristics of respondents (n = 200)

Major Incentives and Challenges Associated with Taungya Farmers

The study findings expressed in Figure 2 explored several incentives and challenges associated with Taungya farmers in the study area. According to the interview and FGDs, farmers highlighted having three main incentives or motivations to participate in Taungya program. These included the high productivity inside a forest in comparison to an open area, which was mentioned by 69% of the farmers. Other motivations were the access to free land and the fertile soil inside a forest, as mentioned by 27% and 4% respectively (Figure 2). However, it is worth mentioning that land tenure is considered the main obstacle confronting farmers in the study area. Meaza et al. (2016) have noted that farmers surrounding the reserves prioritize secure land tenure and crop cultivation as the main motivation, while their willingness to join such rehabilitation programs is determined by the benefits attained. The study results (Figure 2) further uncovered four main challenges confronting Taungya farmers in the study area. More than half 52.5% of farmers indicated that a lack of extension services and supervision from FNC are the main challenges. This is followed by overgrazing and crop destruction, as claimed by 33%, while land allocation constraints within the forest and crop species restrictions by FNC were asserted by 8% and 6.5% respectively (Figure 2). Farmers expressed their concerns about the extension services and training provided by FNC through FGDs and KIIs. They indicated that the main services provided by FNC officers were allocation of land inside the forest and providing them with seedlings of *Acacia senegal* trees for planting. There was no additional subsequent technical support. To overcome this challenge, study suggests that the priority budget allocation should be given to the extension services that could empower farmers and guarantee the transfer and delivery of the extension services adequately.

Overgrazing and crop destruction were the second challenges claimed by Taungya framers in the study area. It was obvious through DFOs that overgrazing has been severe in NFR. This could be attributed to the location of the NFR as a seasonal grazing route followed by nomadic pastoralists as well as due to the degradation of rangeland in the study area, which directs the nomads' attention towards the NFR for feeding their livestock. This has created continuous destruction of crops and tree regeneration and hence exacerbated the land use conflicts between farmers and nomads. However, to address this issue, Taungya farmers could use the live fences to protect their farms, and FNC could facilitate this by allowing farmers to use the branches of failed trees during the migration season of pastoralists. Adoption of cut and carry as a proper grazing system for fodder could also be examined. Furthermore, the land use policy in Sudan should be revised to provide pastoralists with rangeland.

Land size allocation and crop species restrictions have been recognized as additional barriers for Taungya farmers. Discussions with forestry officials in the study area indicated that the limited allocation of land plots to farmers is due to the nature of the rehabilitation program, which focuses on specific degraded plots within the NFR, which was less than the number of motivated farmers who expressed an interest in participating. So, to solve this problem and make sure farmers had equal access to land, an average of 1– 4 hectares was given to each farmer. Regarding crop species restrictions, while the FNC officials restricted farmers from growing specific crops in the Taungya system, the farmers had their own preference for crops. For instance, some of the interviewed farmers expressed a preference to planting the sorghum crop due to its importance as daily food consumption for their livelihood. On the other hand, FNC authorities argue that intercropping *Acacia senegal* trees with sorghum have a major impact on seedling survival and growth during the early stages of tree establishment. To address this issue, FNC in collaboration with the extension division could find an appropriate way to provide farmers with intercropping sorghum, such as by allocating them to some degraded plots under young or mature trees. In this respect it is recommended to pursue further study to investigate appropriate tree spacing that allow existence of farmers throughout and avoidance of canopy closure. This way, farmers would be able to have a steady supply of food and thus achieve the win-win outcomes of the Taungya program.

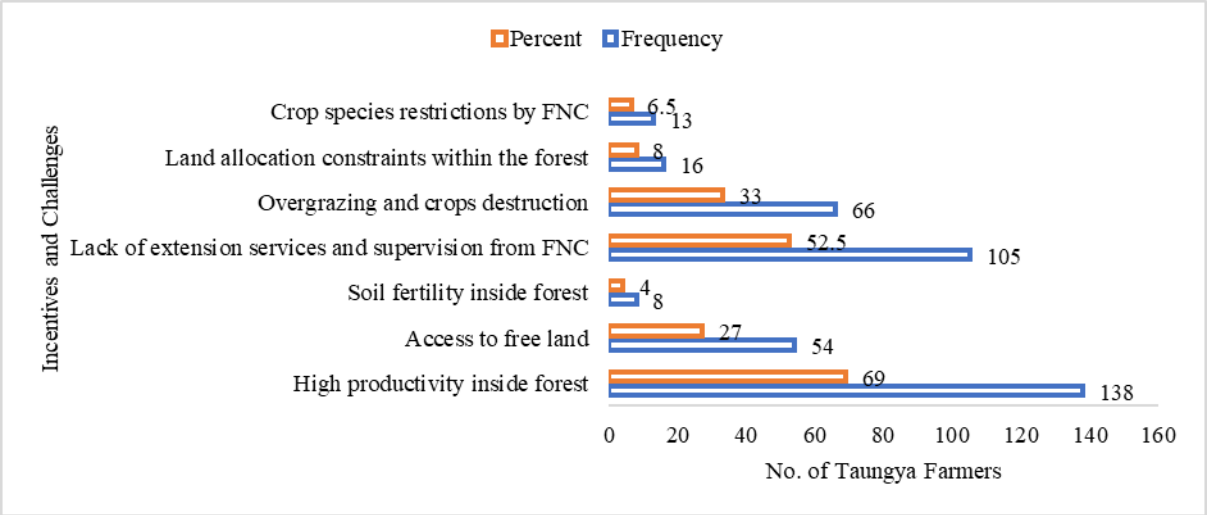

Figure 2: Incentives and challenges associated with respondents

Conclusions and Outlook

This research showed that the main incentives for farmers to participate in the Taungya program were the high productivity inside the forest, access to free land, and the highly fertile soil inside the forest, while the major constraints were the lack of extension services and supervision from FNC, overgrazing and crop destruction, land size allocation, and crop species restrictions. Recommendations to overcome these challenges include: (1) the priority budget allocation be given to the extension services that could empower farmers and guarantee to transfer and deliver the extension services adequately; (2) Taungya farmers could use the live fences to protect their farms and FNC could facilitate this by allowing farmers to use the branches of failed trees during the migration season of pastoralists; and (3) the FNC should reconsider farmers interest to have intercropping sorghum on their farms by revising tree spacing in the future. Alternatively, new degraded plots could be allocated to farmers for sorghum production to improve their livelihood.

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