

Article

Application of Landscape Approach Principles Motivates Forest Fringe Farmers to Reforest Ghana's Degraded Reserves

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Abstract: Research Highlights: Landscape approach principles were developed to address competing claims on resources at local scales. We used the principles to address agricultural expansion in Ghana's forest reserves. Background and Objectives: Agricultural expansion is a major cause of Ghana's forest-cover loss. Cultivation has totally deforested some forest reserves. The situation in Ghana illustrates the trade-off between attaining the Sustainable Development Goals (SDGs). SDG 1—reduction of poverty, and 2—achieving food security, are in conflict with SDG 15—protecting and restoring forests. We examined how farmers in forest fringe communities could be engaged in restoring degraded forests using the landscape approach and whether their livelihoods were improved through the use of this approach. Materials and Methods: The Ongwam II Forest Reserve in the Ashanti region of Ghana is encroached by farmers from two communities adjacent to the reserve. We employed the 10 principles of the landscape approach to engage farmers in restoring the degraded reserve. The flexibility of the landscape approach provided a framework against which to assess farmer behaviour. We encouraged farmers to plant trees on 10 ha of the degraded reserve and to benefit through the cultivation of food crops amongst the trees. Results: Access to fertile forest soils for cultivation was the main motivation for the farmers to participate in the reforestation project. The farmers' access to natural and financial capital increased and they became food secure in the first year of the project's operation. Conclusions: Effective implementation of several small-scale reforestation projects using the landscape approach could together lead to a forest transition, more trees in agricultural systems and better protection of residual natural forests while improving farmers' livelihoods, all combining to achieve the SDGs.

Keywords: forest restoration; multi-functional forest landscapes; landscape approach; rural Ghana; forest-dependent communities; UN Sustainable Development Goals

1. Introduction

The remaining natural forests in the tropics are under intense pressure due to competing land uses. Although conservationists are striving to preserve forests, farmers and extractive industries are encroaching on the forests for their livelihoods [1,2]. Human competition for land and consequent fragmentation of forests is a major cause of forest and biodiversity loss [3–5]. Although some stakeholders are benefiting from deforestation, the socioeconomic and environmental problems resulting from their actions have drawn global attention to the need to restore and sustainably manage forests [6–8].

Protected areas are central to the global strategy for protecting and managing natural resources such as forests, yet many of the world's protected forests are being degraded [9–11]. The rising demand for food due to population growth and the development of commodity fibre and oil crops are placing pressure on protected areas [12]. The world is predicted to need a 70% increase in food production to feed the growing population by 2050 [13,14]. However, agriculture and forests are two competing land uses that will have to co-exist in landscapes, and methods will have to be found in order to reconcile trade-offs. Could foresters adopt landscape approach in their conservation and management strategies in the forest–farm mosaic? Would such an approach benefit farmers who rely on forestlands for crop production? We examined the extent to which farmers in forest fringe communities of Ghana could be involved in reforesting degraded reserves and whether their involvement could help secure their livelihoods using the landscape approach.

Forest landscapes are diverse, with multiple functions and myriad management regimes. For instance, in Southeast Asia, forest governance and zoning have aimed to restrict human access to forests and have encouraged forest-dependent peoples to move to less forest-reliant and involve in more off-farm activities [15–18]. Exploitation of forests in Scandinavia and Europe has been mechanized during the 20th century, and the focus on a few commercial species has led to declines in floral and faunal diversity [19–21]. In some parts of Africa, however, forest patches exist in agricultural landscapes especially where livestock are present [22]. In Southern Ethiopia, participatory forest management has resulted in increased incomes from forest products for community members, and now provides 35%–50% of household income [23]. About 80% of the West African forest area lies in an agriculture-forest mosaic, with biodiversity persistence linked to the livelihoods of local people [24,25]. The diversity of the functions and management of forest landscapes is varied and highly context-specific.

Ghana's forest landscapes are diverse and portray some complex features. Some forest reserves are allocated for timber production whereas others are for nature conservation [26]. Most of these reserves contain legal settlements, and some farmers have legal farms within the reserves [27,28]. Communities surround most of the forest reserves in Ghana [29]. Some residents of the fringe communities have legal and illegal farms within the forests [3,4]. Forest encroachment has been difficult to control in Ghana due to the complexity of activities occurring within the forests [5]. Restoring Ghana's degraded forests requires a multi-stakeholder approach that reconciles the competing interests of stakeholders.

The Sustainable Development Goals (SDGs) 1, 2, and 15 target sustainable forestry and livelihood improvement [30]. Eradicating extreme poverty (goal 1) in farming communities requires that farmers have access to physical, economic, financial, and natural capitals to allow them to produce food and become resilient and less vulnerable. The Forestry Commission of Ghana is responsible for protecting forest reserves from farmers' encroachment. We sought to demonstrate how these farmers could be involved in restoring the already degraded forests and the effect of their engagement on their livelihoods. Access to fertile farmlands could reduce the level of hunger in farming communities and achieve some level of food security among the farmers (goal 2). The Ongwam II forest reserve in the Ashanti region of Ghana has been under the management of the Forestry Department since the 1930s. However, illegal logging followed by illegal farming and fires set by hunters and farmers have degraded more than half of the reserve. The objective of this study was to assess the applicability of the landscape approach in the form of an adapted Taungya system in order to engage farmers in fringe communities of Ongwam II forest reserve in the reforestation of degraded areas for environmental conservation and livelihood improvement.

1.1. Revisiting the Taungya System to Achieve the SDGs Through the Landscape Approach

The Taungya system is a form of agroforestry where farmers combine agricultural crops with woody species during the early years of plantation establishment [31]. The system was developed in Burma (Myanmar) in the 1800s and since then has spread to Southeast Asia and other tropical countries [32,33]. The British introduced the Taungya system to Ghana in the 1930s in response to deforestation and shortage of farmlands in farming communities fringing forest reserves [34]. Under

this system, participating farmers received portions of degraded forest reserves to plant trees amidst their food crops but were required to maintain the trees until canopy closure at which time food crop cultivation is no longer possible. This system initially improved household food security and led to forest restoration. Eventually the system ceased to function. Failure was attributed to insecure land tenure, lack of farmers' participation in decisions about forest management, lack of supervision and abuse of power by forest and public officials, and the fact that farmers did not benefit from the planted trees [34,35].

The Taungya system was officially stopped in 1987 but re-introduced in 2002 as the Modified Taungya System (MTS) [35,36]. The difference between the old and the new system is that with the MTS (a) farmers are not evicted from the land after 3 years because they have to maintain the trees until maturity, and (b) farmers have a 40% share of the value of planted trees when harvested [37]. The MTS however has some challenges. First, farmers do not get income from the MTS between canopy closure and harvest. Growing food crops is no longer possible after canopy closure but farmers have to continue maintaining the trees until harvest. Second, farmers are not paid for tree planting and maintenance activities. Third, there is delay in signing MTS agreements and absence of a clear mechanism for sharing the 40% timber benefit among individual farmers [37]. These challenges make the farmers insecure about future timber benefits because they have no personal planting records that will specify how to share benefits. The recommendations from the assessment of the MTS made us adopt the landscape approach in our restoration project so that the farmers were fully engaged and had more decision making power in all the activities they undertake in implementing the project.

The landscape approach is a context-specific tool that is most effective for small-scale natural resource conservation and management projects and yet flexible enough to be applied to large-scale projects. Unlike the old conservation systems that are usually top-down, the landscape approach is a collaborative process that brings together different stakeholders with diverse interests and aims to achieve a balance between multiple and sometimes conflicting objectives in a landscape [38]. This approach attempts to make long-term improvements to conservation and livelihoods by engaging and empowering the stakeholders to maintain a sustained relationship between themselves and the landscape [39–42]. Learning, flexibility, adaptation, and the need for a holistic view of outcomes and impacts in a constantly changing landscape are key concerns of the landscape approach [43]. The landscape approach features most principles of the rights-based approach [42]. For instance, principle 5 emphasizes recognition of multiple stakeholders and the need for equity. Principle 7 focuses on the clarification of rights and responsibilities and principle 8 emphasizes monitoring and the right to access information by all stakeholders. The principles of both approaches (landscape approach and rights-based approach) work towards effective human-centred conservation of natural resources. When human rights are not recognized, conservation activities can generate negative impacts and minimal local benefits [44,45].

The application of the landscape approach in this research aligns with actions towards the achievement of the SDGs 1—end poverty in all its forms everywhere; 2—end hunger, achieve food security and improved nutrition, and promote sustainable agriculture; and 15—protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse land degradation, and halt biodiversity loss. Each of these goals has specific targets related to this study (see Table A1). The main stakeholders that have direct influence on forests in Ghana are the foresters, fringe communities, and timber companies. Farmers in forest fringe communities require fertile lands for food crop cultivation and may be in conflict with foresters working towards sustainable management of the forests. Involving these farmers in forest restoration projects could help reduce poverty and hunger while re-establishing the degraded forest. Sayer et al. [14] have proposed 10 principles of the landscape approach for applications in multi-functional landscapes. We assessed how these principles could reconcile forest restoration and livelihood development goals of farmers in forest fringe communities of Ghana.

2. Materials and Methods

Application of the landscape approach to the Taungya system to restore degraded forest requires convening different stakeholders with varied objectives to make use of the land for different purposes in a complementary way. Four stakeholders were involved in this research project: forest managers (from the Forestry Commission of Ghana and Forest Services Division), forest technical officers (forest ranger, forest cartographer, both from the Forest Services Division), project team (research assistant—Environmental Conservation and Management Foundation (Ecomafghana), forest ranger—Forest Services Division at Mampong-Ashanti, forest guard—Forest Services Division at Mampong-Ashanti, field manager—experienced farmer and field assistant from Ecomafghana, and the lead author), and farmers. A research assistant from the Environmental Conservation and Management Foundation (Ecomafghana), a local not-for-profit Non-Governmental Organization (NGO), and the lead author consulted the district manager of the Forest Services Division at Mampong-Ashanti to advise which forest reserve required such an action-research approach. We chose Ongwam II Forest Reserve, where logging and agricultural encroachment has deforested almost half of the reserve. Illegal farmers are moving into accessible areas. According to the district manager, there is high biodiversity loss due to the degradation of the reserve.

We surveyed some degraded portions of the reserve with a forest technical officer, forest guard, and a cartographer. We then selected an area of 49 ha with very few trees and a thick cover of elephant grass (*Pennisetum purpureum*) (Figures A1,A2). This area is close to two fringe communities, Hwidiem and Kruwi. We visited the leaders of these two communities to make our intention known to them. The leaders showed their interest and we announced our intentions to the community members through information centres. After the announcement, farmers were able to register their interest in the project with their leaders. We presented a report and official proposal to the district manager expressing our interest in initiating a forest recovery project in the reserve. After the manager's approval, we carried out a farmer household survey to identify the farmers that were willing to participate in the project. Thirty-one farmers expressed interest, 16 from Hwidiem and 15 from Kruwi. These farmers were either heads of their households or members of their households.

The district manager forwarded the proposal to the Forestry Commission of Ghana for approval. The Forestry Commission reviewed the project plan and issued a letter approving the project. The first phase of the project started in December 2017 and ended in November 2018. The farmers gave their verbal informed consent before they participated in the survey. The Human Research Ethics Committee of James Cook University, Australia, approved the study's ethical protocol (application ID: H7199). First, we collected data on the farmers' age, farm size, ownership of farmland, land tenure system, location of farm, farming experience, and motivation to participate in the project. These data were analysed to identify the factors that motivated the farmers, as well as their capacity to participate in the project. We then assessed the farmers' commitment to the project's implementation using the principles of the landscape approach [14]. Finally, we collected data on the quantity of produce the farmers harvested from both the project land and their other farmlands. We used the data to assess whether the livelihoods of the farmers improved through their involvement in the reforestation project and whether or not the project has contributed to the achievement of the SDGs.

3. Results and Discussion

3.1. Brief Background of the Farmers

The youngest farmer was 28 years old whereas the oldest was 69. Almost a third (32%) of the farmers were between the ages of 31 and 40 years old, and 26% were between 41 and 50 years old. More than half (55%) of the farmers had over 10 years of farming experience, and 29% had between 5 and 10 years of experience. No farmer had less than 2 years of experience. Almost two-thirds (61%) of the farmers had no other job aside from farming, whereas the rest had one or two other irregular income earning activities. The ages, years of farming, and farming as a main activity (Tables A2–A4)

implied that the participants were experienced farmers, and hence were capable of assisting in the reforestation project.

3.2. Farmers' Motivation to Participate in the Reforestation Project

Access to fertile land to plant food crops was the main motivation for 48% of the farmers to participate in the project. An additional 36% indicated this same rationale, but also included the idea of the benefit that the community would get from the restored forest. One farmer stated, "The community will benefit from the dense forest again. We will also get land to farm on now that all our farmlands are infertile". Another farmer added, "I want to participate so that I will get land to farm and also help reforest the reserve for future generations". The farmers engaged in restoration in exchange for access to the forestland for farming, a phenomenon that is evident elsewhere [46–48].

The survey found that 29% of the farmers had inherited farmlands, whereas 71% had insecure tenure under sharecropping arrangements or had encroached on the forest. However, 77% of the farmers had land that was infertile, a reason for them to join the project. Secure tenure and ability to cultivate crops are the main priorities of farmers in forest frontiers [49,50]. Willingness to participate in a reforestation project depends on the benefits attained. Farmers in forest fringes of Ghana would not participate in any forest recovery intervention that would not positively affect their livelihoods [28,47].

Some of the farmers (16%) admitted that they farm illegally in the forest, and to avoid eviction they had to participate in the project. An illegal farmer stated, "This idea has come before but I could not take part because I was sick. Now that I have the strength and I farm in the forest, I have to grow the trees as my contribution to the project". Another illegal farmer said, "I have been planting the trees since 2008 although it was illegal for me to farm in the forest. Now that you have come for us to do the work, why will I not get involved?" Further enquiry revealed that all the farmers except two had farms within the forest reserve. However, they did not mention those farms as their main farms because they were illegal. Participating in the project was therefore an opportunity for them to farm legally on fertile forestland. The project initiators and the farmers had different short-term priorities but the long-term outcome for both parties was the same. The landscape approach brings stakeholders with different interests together to achieve a common goal [38]. The farmers were cultivating illegally in the forest reserve. Although some claim they were growing trees, their main interest was food crop production. The project initiators were interested in growing trees to restore the degraded forest. The implementation of the project would mean that the farmers would have to be evicted from the land and be deprived of their source of livelihood from the land. To prevent this negative impact on the farmers, we used the landscape approach to engage the farmers in the reforestation activity to ensure that both parties (the farmers and the project initiators) achieve their objectives. The farmers get the land for farming and the project initiators get the land planted with trees.

3.3. Assessing Farmers' Commitment with the Principles of the Landscape Approach

3.3.1. Continual Learning and Adaptive Management

This principle states that progressive learning should be a characteristic of all stakeholders involved in making decisions towards a common objective. We assessed the application of this principle by engaging the farmers in establishing the nursery for the project. The project team organized a meeting to demonstrate the following nursery procedures to the farmers: making the beds, tending the seeds, and watering the plants. All the farmers were involved in preparing the nursery (Figure 1). The project team tasked one educated farmer to prepare a duty roster for watering the plants.



Figure 1. Farmers preparing beds to nurse tree seeds for the reforestation project. Source: authors' field survey, 2017.

The seeds started germinating after 3 weeks but were surrounded by weeds. The farmers could not differentiate between the tiny seedlings and the weeds. The expertise of the foresters became useful at this point. These experts assisted the farmers in removing all the weeds from the nursery beds. From then, the farmers maintained the seedlings until the time for transplanting. The farmers' willingness to learn new skills and their ability to adapt to new strategies on the basis of changing circumstances led to the success of the nursery. Continual learning and adaptive management is fundamental to the success of every multi-stakeholder activity [43]. We paid attention to the establishment of the nursery because the process entailed learning and adaptive management from the beginning to the end. Making the nursery beds for the tree seeds involved some techniques that the farmers would not have known without the advice of foresters. Weed removal from the newly germinated seeds was tedious. The establishment of the nursery served as a measure of the commitment of the farmers to the project.

3.3.2. Common Concern Entry Point

According to this principle, project managers should not neglect the values, beliefs, and objectives of different stakeholders in the process of achieving the common objective for the landscape. All the farmers had one reason to participate in the project—to get fertile land to farm. Each farmer had their preferred crops—plantain, cocoyam, yam, and maize, among others. The project team had one objective—to reforest the treeless portions of the forest. The forest managers of the Forestry Commission of Ghana and Forest Services Division at Mampong-Ashanti had one vision—to reconcile conflicting claims on the land. These diverse objectives provided a shared goal of restoring the forest through collective action. To achieve the common goal, the project team took the farmers to the project site to prepare the land for cultivation.

The first phase of the project used 10 ha and involved 16 farmers who were ready to start their farms. The other farmers were already cultivating illegally at other locations within the same forest but not on the project land. These farmers were encouraged to plant some trees on their already cultivated forestlands. The project team placed the 16 farmers at specific locations to weed to plant the seedlings. The farmers achieved their common goal—access to fertile land for cultivation. The project team achieved its objective of getting the land prepared for planting. The common concern entry point was therefore achieved.

3.3.3. Multiple Scales

Operational processes at different scales can shape the outcomes of projects at other scales through lessons learned from feedback, flows, and interactions. The foresters in the project team were involved in a Taungya system before the initiation of this project and were aware of the challenges involved in engaging farmers in forest restoration. The foresters advised the project team on how to motivate the farmers to ensure their total commitment to the project. The farmers were therefore given allowances (minimum of USD 5 per farmer for each day of work) for any activity they undertook that did not contribute directly to their livelihood, for example, maintaining the nursery, cutting pegs, and planting the seedlings. These allowances served as additional income for the farmers and motivated them to participate actively in the project's implementation. Lack of motivational packages has been one of the challenges of the MTS [28,37,47]. Lessons from previous projects helped resolve such challenges.

3.3.4. Multi-Functionality

Most landscapes provide multiple functions to diverse stakeholders. Trade-offs are inevitable in the attempt to reconcile the values accruing to the various stakeholders with the aim to achieving their goals [51]. According to the foresters, cassava is one potential crop that hampers the growth of young tree seedlings, and hence cannot be grown on the project's land. However, cassava is a major cash crop for most farmers. Disallowing its growth on the project's land would not favour the farmers but would be the best solution to ensure the survival of the tree seedlings. The project team held a meeting with the farmers and agreed through consensus that cassava cannot be the main crop on the land. It can, however, be grown on the boundaries of the land for household consumption. The farmers accepted this idea because they had other options for cash crops.

Farmers use herbicides to control weed growth on their farms. Herbicides are not allowed in Ghana's forests because they kill some young tree species. Excluding herbicide use by the farmers would reduce the area that they are able to cultivate. Again, the farmers accepted this condition because they needed fertile land to farm. Effective reconciliation of conflicting issues in a multi-functional forest landscape strengthens stakeholders' commitment to forest restoration and conservation [39–41]. Farmers' active participation in reforestation declines when authorities fail to achieve consensus around grievances [28,47].

3.3.5. Multiple Stakeholders

The reforestation project involved multiple stakeholders with different roles. The farmers were the main actors. They cleared the land, established the nursery, cut pegs, pegged the land, planted the seedlings, and nurtured the young trees while maintaining their farms. The project team facilitated the entire process. Figure 2 shows some of the pegs the farmers cut and the nursery they established at two sites for the project.



Figure 2. Pegs cut from bamboo (bottom right) and nursery raised at two sites by the farmers.
Source: authors' field survey, 2018.

The district manager and the plantations manager of the Forest Services Division at Mampong-Ashanti indirectly participated in the project. The district manager oversees all activities in the Forest Services Division. He oversaw all the administrative works related to the project and gave advice where necessary. The plantations manager oversees all activities relating to plantations establishment in their catchment areas. He supported the project team with technical advice on tree species and planting techniques. Although these managers are foresters, the implementation stage of the project was carried out with the forest ranger and forest guard in the project team. The project team reported to the forest managers periodically and sought assistance when confronted with unforeseen obstacles. One such obstacle occurred when the farmers finished cutting the pegs and needed to transport them to the project site. There was no route through the forest to the site. The project team consulted the forest managers on the most convenient location to create a path. Another instance of the forest managers' participation concerned the type of trees to grow. Through their long years of experience in forestry and examination of the depth and nature of the soil, they recommended teak as the main tree to grow together with other indigenous tree species. In all, four stakeholders—farmers, forest technical experts, forest managers, and the project team—worked together to implement the project.

3.3.6. Negotiated and Transparent Change Logic

Transparency is the basis of trust and it is achieved through a mutually understood and negotiated processes of change. Good governance results in consensus on general goals, challenges, and concerns [14]. All stakeholders need to know why a course of action has been taken and the risks and uncertainties ahead. The project was managed by the project team. Management procedures included planning for uncertainties such as drought and continuous rainfall, organizing project activities in a participatory manner with the farmers, directing what is supposed to be done in cases where the farmers had no or little knowledge about an activity such as cutting pegs, and controlling the entire process of implementation. The governance of the project was based on two-way communication. Although the project team conveyed information to the farmers on the composition of the various stages of the project, the farmers provided feedback, inputs, and suggestions to the project team for refinement of actions towards the implementation of the project. The farmers were aware of any decision that was taken, and no change was imposed on them. The project team

negotiated with the farmers on the use of chemicals and the planting of cassava. Days and times of communal work were agreed upon with the farmers. Transparency was key in the operations of the reforestation project.

3.3.7. Clarification of Rights and Responsibilities

Stipulation of rights and responsibilities are key components in adopting the landscape approach [14] and achieving effective landscape governance [42]. Each stakeholder had rights to exercise and responsibilities to perform towards the reforestation project. The farmers had the right to grow food crops on their allotted plots until the trees form a canopy. They were required to maintain the trees while cultivating the land. The farmers carried out their duties as expected, and grew their crops as they wanted (Figure 3).



Figure 3. Farms on the project's land with young teak trees shown in lines beside the pegs. Source: authors' field survey, 2018.

The project team had the right to expel any farmer who violated conditions, for example, by applying herbicides or not maintaining the trees. Although it was the responsibility of the farmers to replant dead seedlings, the project team had to conduct survival surveys to check on the number of seedlings that did not survive in each farm and supply additional seedlings to the farmers. Finally, the Forestry Commission of Ghana had the right to withdraw the permit to carry out the project if conditions were violated. The Commission, on the other hand, had the duty to provide technical support to the project implementers.

Each stakeholder knew the rights and responsibilities attached to the project. As a result, there was no instance that a stakeholder violated their duties or impinged on another stakeholder's rights. Minor conflicts arose, but they were resolved through consensus. One instance was the replanting of dead seedlings, which the farmer had to do immediately when the seedlings arrived. However, there were some instances when the farmer was not present. When this happened, the project team placed the seedlings in the soil in a shady place so that they remained in good condition until the farmer arrived. This strategy worked for all the affected farmers.

3.3.8. Participatory and User-Friendly Monitoring

This principle emphasizes that there should be all-inclusive and participatory monitoring. No single person has sole access to any information. Trust is built when all stakeholders are involved in monitoring the operations of a project [14]. Because the farmers and the project team agreed on a common outcome, they all participated in monitoring the project. The project team monitored each field periodically. The farmers also reported unexpected developments to the project team wherever and whenever they occurred. This brought transparency and accountability throughout the execution of the project.

3.3.9. Resilience

Stakeholders should recognise that threats and vulnerabilities are bound to occur due to changing patterns and external events. Learning how to be resistant to threats is one means of building the capacity of stakeholders [14,52]. The main threat to the project was fire, which occurs during the dry season from December to February. The project team trained the farmers on how to create fire belts to prevent accidental fire outbreaks on the project's land. The farmers weeded 5-meter wide strips at the boundaries of the project as fire belts. Each farmer used their section of the fire belt to grow vegetables before the dry season.

By the end of November, the fire belt was void of weeds and needed no major weeding. Through this, the farmers were able to respond to fire threats. The project team did not impose this idea on the farmers. The team and the farmers developed this idea through consensus. The objective of the project was to reforest the degraded reserve while providing livelihood to the farmers. Any portion of the landscape the farmers cleared should contribute to this objective, and hence the fire belts were cleared in the rainy season and were cultivated until the onset of the dry season.

3.3.10. Strengthening Stakeholder Capacity

The first phase of the project required stakeholder capacity building, mainly focusing on the farmers. The farmers, the main actors of the project, were trained in all the activities involved in the project's implementation. The willingness of the farmers to undergo the training showed their commitment to the project. Environmental conditions kept changing. There were instances when the soils became dry due to continuous sunshine without rain and other instances where the soils became waterlogged due to continuous rainfall. The farmers were equipped with the knowledge of the right time to plant seedlings and replace those that died. The progress of the project was driven by climatic and environmental conditions of the area. This enabled the building of the farmers' capacity. They improved their skills as the project progressed.

3.4. *Lessons from the Application of the Landscape Approach Principles*

The 10 principles of the landscape approach were adapted and applied to the reforestation project. The use of these principles enabled stakeholders to achieve their varied objectives without any significant conflicts. We did, however, experience challenges. First, despite disallowing the use of herbicides on the project land, one farmer sprayed about half a hectare of his maize with a herbicide that does not kill maize, thinking that the young teak plants would survive the chemical. Almost 300 plants died due to the farmer's ignorance, but he replanted them in the next rainy season. This reduced our success rate. Second, another farmer accidentally burned almost 200 young trees after harvesting watermelons and while trying to prepare the land quickly to grow maize. Third, a farmer, after harvesting his beans and okra crops, left the land and never came back. We learned his intention of stopping farming when we asked him, at which time the weeds had already grown about half meter tall around the young trees. A new farmer, however, took over his land.

Because human behaviour is unpredictable, some challenges and failures in the application of any principles for conservation and restoration projects are inevitable. However, adoption of flexible strategies and learning from experience did improve the success rate of our restoration project. Our adoption of the landscape principles helped achieve greater success than the Taungya and Modified

Taungya systems because the farmers were part of all decision making and they were motivated in cash to carry out any extra activity that did not directly enhance their livelihoods. The Taungya systems failed because there was no motivation, transparency, and accountability, and the farmers were not sufficiently involved in forest management decisions. The farmers were the recipients of instructions and not participants in decision-making.

3.5. The Contribution of the Reforestation Project to the Livelihoods of the Farmers

Of the 31 farmers who were involved in the first phase of the project, 16 cultivated their crops from the beginning of the project. Priority was given to the farmers who had small or no existing plots. We delayed involvement of the rest of the farmers to the next phase of the project because they had lands ready for cultivation. The land sizes apportioned to the 16 farmers constituted 50% to 100% of their entire farmlands and 38% of the farmers cultivated solely on the project's land. The project served as a source of land for the landless farmers and added to the holdings of the farmers who already had land.

The 16 farmers planted their crops on the project's land and the other 15 farmers cultivated their non-project farmlands. Assessment of the harvested outputs from both sets of farmers indicated that the project's farmers harvested more produce than those who farmed on the non-project land. Although 81% of the project's farmers harvested between USD 500 and USD 3000 worth of produce within the first six months of cultivation, none of the non-project farmers harvested more than USD 500 worth of produce (Figure 4, Table A5). The reason was that, first, the existing farmlands of the non-project farmers were infertile. Second, although these farmers had other illegal farms in the forest, they feared arrest by forest guards. Consequently, they could not spend enough time maintaining their crops and weeds, and therein pests and diseases took over their farms. According to the farmers, weeds were competing with the crops for nutrients. Pests were feeding on the crops, causing damage and destruction to crops such as maize, tomatoes, and beans, and diseases were infecting the crops due to poor farm maintenance. This delayed the maturity and affected the health of the crops. As a result, 54% of the non-project farmers could not harvest anything at the time all the other farmers were harvesting their crops. Insecure land tenure thus affects farm productivity [49].

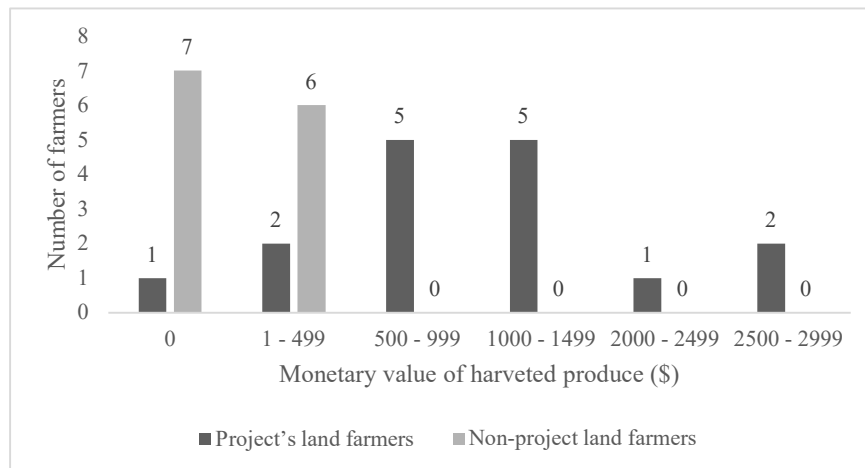


Figure 4. Monetary values of outputs harvested on the project's land and non-project land. Note: 29 farmers cultivated in the forest, 16 on the project's land, and 13 illegally elsewhere in the reserve. Two participating farmers did not farm in the reserve. Source: authors' field survey, 2018.

Aside from land tenure security, soil fertility determines the quantity of produce a farmer harvests [53–55]. A total of 44% of the project's farmers harvested 85% to 100% of their produce from the project's land (Table A6), although their other farm plots were bigger than the plots they obtained from the project. The other farmers harvested up to half of their produce from the project's land. These results confirm the rationale behind the farmers' participation in the reforestation project.

Other studies in Ghana and some developing countries have stated similar reasons for farmers' participation in forest management [28,46,48]. The first priority of farmers is a secure livelihood, and they participate in interventions that place high importance on their livelihoods.

One indicator of a farmer's improved livelihood is being food secure [56–58]. Selling excess produce for income contributes to improved livelihoods. Four-fifths (81%) of the farmers sold between 80% and 99% of their harvested produce. All the sales of 25% of these farmers were from the project's land, whereas 19% had between 85% and 96% of their market produce from the project's land. Few farmers sold less of their produce harvested from the project's land (Figure 5). The outcome of the project contributed to the financial assets of the farmers.

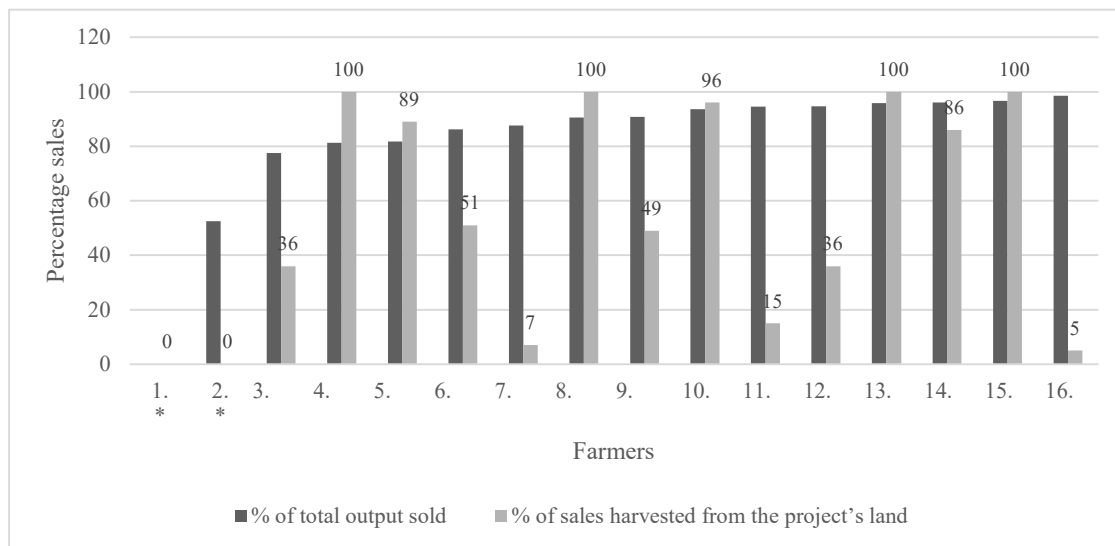


Figure 5. Output sold and proportion harvested from the project's land. *Farmers 1 and 2 grew banana and plantain on the land they obtained. These crops had not matured at the time this survey was taken, and hence this is the reason for 0% sale. How to interpret the graph: Farmer 3 sold 77.4% of the produce harvested from all his/her farmlands, and this included 36% from the project's land. Farmer 4 sold 81.2% of produce harvested from all his/her farmlands, and this included 100% from the project's land, etc. The data labels indicate the percentages of the harvests from the project land that were sold. Source: authors' field survey, 2018.

The project's farmers sold more than half of their harvested produce because they had enough to meet their domestic needs. These farmers utilised the project's land (additional natural capital) to obtain more financial assets while depending on their other land for food security. Over half (56%) of the project's farmers derived 90% to 100% of their food consumption from the project's land. Overall, the implementation of the reforestation project enhanced the livelihoods of the farmers through access to fertile land, additional income through sales of produce, and providing food security.

3.6. The Contribution of the Reforestation Project to the Achievement of the SDGs

The reforestation project using the landscape approach contributed to the SDGs 1, 2, and 15. The government of Ghana has been investing in restoration of degraded forests but with little success [59] because the farmers who contribute to deforestation are usually excluded from reforestation projects and forest management decisions. Our reforestation project contributed to SDG 15 in two ways. First, we engaged the farmers, thereby preventing them from clearing other areas of the forest, preserving life on land. Second, we (with the farmers) planted a degraded portion of the forest, and this activity will continue, gradually restoring the forest and its biodiversity. Farming is the predominant employment in forest fringe communities of Ghana, but scarcity of fertile farmlands makes some farmers degrade forest reserves [3,4,60]. The government could adopt this economically efficient

farmer-centred landscape approach to restore degraded forest reserves in Ghana. This could gradually create a pathway to a forest transition and regeneration of ecosystem services while benefiting the participating farmers.

Engaging farmers in forest restoration after they have contributed to its degradation leads to long-term land rights for the farmers and gradual poverty reduction—key foci of SDGs 1 and 2. Most farmers in forest fringes of Ghana are poor and landless, living on less than USD 1.25 a day [29,30,61]. Meanwhile, the project's farmers had a minimum of USD 2.8 income a day from the sale of the farm produce in the first 6 months of the project's implementation. This value excludes the produce harvested for consumption. Having free fertile lands to farm could break the extreme poverty cycle of these farmers and increase their natural and financial assets. Access to fertile farmland could boost agricultural production and eliminate hunger in farm households [53–55]. Excess harvest could be sold and the income used for other household expenses.

The reforestation project has demonstrated the effectiveness of applying a human-centred landscape approach to environmental conservation and livelihood improvement. All the participating farmers will have secure lands to farm through future cycles of forest harvesting and reforestation for the indefinite future, a big benefit especially for the landless farmers. All except two farmers harvested produce to sell in markets as well as for household consumption. The landscape approach, therefore, is an all-inclusive and flexible mechanism that could be adopted alongside other strategies to achieve the SDGs.

3.7. The Reforestation Project and Other Restoration Actions: the Nexus

Tropical forest restoration occurs through either natural regeneration or establishment of native or exotic tree plantations [62–64]. Tree species diversity is one objective of forest restoration projects, and plantations of native tree species mostly show greater species diversity than plantations of exotics [65–67]. We started our reforestation project with exotic tree species because, first, this was the first time most of the farmers were involved in a reforestation project, and maintenance of most exotic species such as teak (*Tectona grandis*) is easier than native tree species. Second, some exotic tree species promote regeneration of native species and can withstand harsh weather conditions in their early stages of planting, at which time they need maximum care and maintenance [68]. We made provisions for natural regeneration of native species through 3 meter spacing for the planted trees, although the project team and the farmers agreed to interplant the existing plantation with some known native tree species.

Our reforestation project is similar to the Taungya system, an agroforestry system whereby tree plantation establishment is mixed with food crops cultivation as a livelihood mechanism for participating communities [31,69,70]. The Taungya system started in Ghana in the 1930s, collapsed in 1987 due to various shortcomings including top-down decision making and abuse of power, but was reintroduced as the Modified Taungya system (MTS) in 2002 [34–36]. The MTS continued to witness almost the same challenges as the old system—top-down decision-making, neglecting the concerns of the participating farmers in relation to incentives for planting and maintenance, and poor supervision [37]. The MTS ceased to function in 2009, and since then the Forestry Commission of Ghana has been collaborating with private enterprises in the restoration of Ghana's degraded forests [71,72]. Our reforestation project has achieved some successes because the weaknesses of the MTS were considered in implementing the project. Participatory decision-making processes with the farmers, resolving issues through consensus and negotiations, respecting the rights and responsibilities of all stakeholders, and incentivizing the farmers for planting and other activities related to the project were of much concern to the project team, and all these are key principles of the landscape approach.

Forest restoration projects in most developing countries combine forest recovery objectives with livelihood improvement of forest-dependent communities. There are mixed levels of evidence of successes and failures. For instance, in the Edo State of Nigeria, natural regeneration of endemic tree species was more successful in fallowed deforested areas than deforested areas under agroforestry practice due to continuous cultivation [69]. Contrarily, in eastern Panama, inter-planting young trees

with food crops was found to be an important silvicultural practice that facilitated forest restoration [73]. However, the assumption for most tropical forest restoration projects is that once the tree canopy closes, the remaining flora and fauna will regenerate naturally [74], although there are some exceptions [75–77]. The project team and the farmers however decided to interplant the existing plantation with various native tree species before canopy closure, one step ahead of natural regeneration. This is made possible because of the trust built between the project team and the participating farmers, as well as the benefits accrued to the farmers through the project, which are also evident elsewhere [73].

4. Conclusions

The Ongwam II forest reserve has been managed by the state since its establishment in the 1930s, yet illegal logging, fire, and illegal farming have left more than half of the reserve with few trees. We found that some farmers in two fringe communities of the reserve were willing to participate in restoring the degraded portions of the forest to obtain fertile land to farm. We held a stakeholder meeting with forestry officials and the farmers in order to build consensus on the processes for restoring the degraded forest reserve and improving the livelihoods of the farmers. Ten principles of the landscape approach were adopted to assess the extent to which they could be applied in the forest restoration process. The human-centred attributes of the principles resulted in their effective application to reforest the degraded reserve. The farmers, supervised by the project team, were able to plant teak seedlings on 10 ha of the degraded reserve within six months of the project's initiation. The progressive implementation of this project in the next 5 to 10 years will result in significant portions of the degraded forest being restored. A meeting held with the farmers in late 2019 brought about a decision to interplant the existing teak plantation with native tree species. The participants (foresters, the project team, and the farmers) chose to plant mahogany (*Khaya anthotheca*), wawa (*Triplochiton scleroxylon*), ofram (*Terminalia superba*), and sapele (*Entandrophragma cylindricum*), amongst other species. These and other locally valuable species will be planted in 2020 to restore the forest and its biodiversity to a condition nearer to its original state. We will also introduce other non-timber forest products with potential to bring the long-term benefit for the farmers.

The farmers that cultivated on the project land benefited from participating in the forest restoration project more than the farmers that cultivated on their non-project land. In the first 6 months of the project's implementation, the farmers improved their livelihoods financially through the sale of the excess crops they harvested from the project's land. The farmers became food secure because they had surpluses to sell for extra income. Although the farmers are assisting in reforesting the reserve in the following years, their poverty levels will gradually reduce. Nutritional levels of the farmers' households will improve because they will have extra income to purchase other foods to supplement those that they harvest from their farms. This will contribute to the achievement of SDGs 1 (eradication of extreme poverty) and 2 (ending hunger and achieving food security). The application of the landscape approach in several similar reforestation projects in Ghana could lead to forest transition and a gradual reduction in rural poverty.

Predicting the state of multifunctional forest landscapes in the future will not always be possible. It is, however, possible to maintain the building blocks—the species, ecosystems, knowledge, cultures and institutions—needed to retain resilience and maximise future options for the landscape [52]. Collaboration among all stakeholders is key to sustainable conservation and management of forest landscapes. Excluding any stakeholder, especially farmers in forest fringe communities, could lead to conservation failures. Building the capacity of these farmers to champion a conservation agenda is key to sustainable management and restoration of forest landscapes.

The landscape approach principles were originally conceived to address problems at larger scales and with more stakeholder conflicts. We have used them successfully at a micro-scale. We now have a community of farmers, key members of the local forestry administration, and a research assistant from a local not-for-profit Non-Governmental Organization (NGO) (Ecomafghana) who have experience in the use of the principles and have built up a level of trust and experience, and who see the value of these principles. Landscape approaches have struggled to achieve traction in

other parts of the world, but we postulate that beginning at a small scale to establish the credibility of the approach may be an essential first step in moving to broader application of the principles. We hope to use this community of practitioners to lead the development of more ambitious, larger scale landscape initiatives extending beyond the boundaries of the Forest Reserve to address the urgent issue of land competition in the broader landscape.

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Appendix A

Table A1. Sustainable Development Goals (SDGs) and targets related to the study.

Goal 1. End poverty in all its forms everywhere	
Target 1.1	By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than USD 1.25 a day.
Target 1.4	By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services; ownership; and control over land and other forms of property, inheritance, natural resources, appropriate new technology, and financial services, including microfinance.
Goal 2. End hunger, achieve food security, improve nutrition, and promote sustainable agriculture	
Target 2.3	By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists, and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition, and non-farm employment.
Target 2.4	By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production that help maintain ecosystems, and which strengthen capacity for adaptation to climate change, extreme weather, drought, flooding, and other disasters and that progressively improve land and soil quality.
Goal 15. Protect, restore, and promote sustainable use of terrestrial ecosystems; sustainably manage forests; combat desertification; halt and reverse land degradation; and halt biodiversity loss	
Target 15.2	By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests, and substantially increase afforestation and reforestation globally.

Source: United Nations General Assembly, 2015.

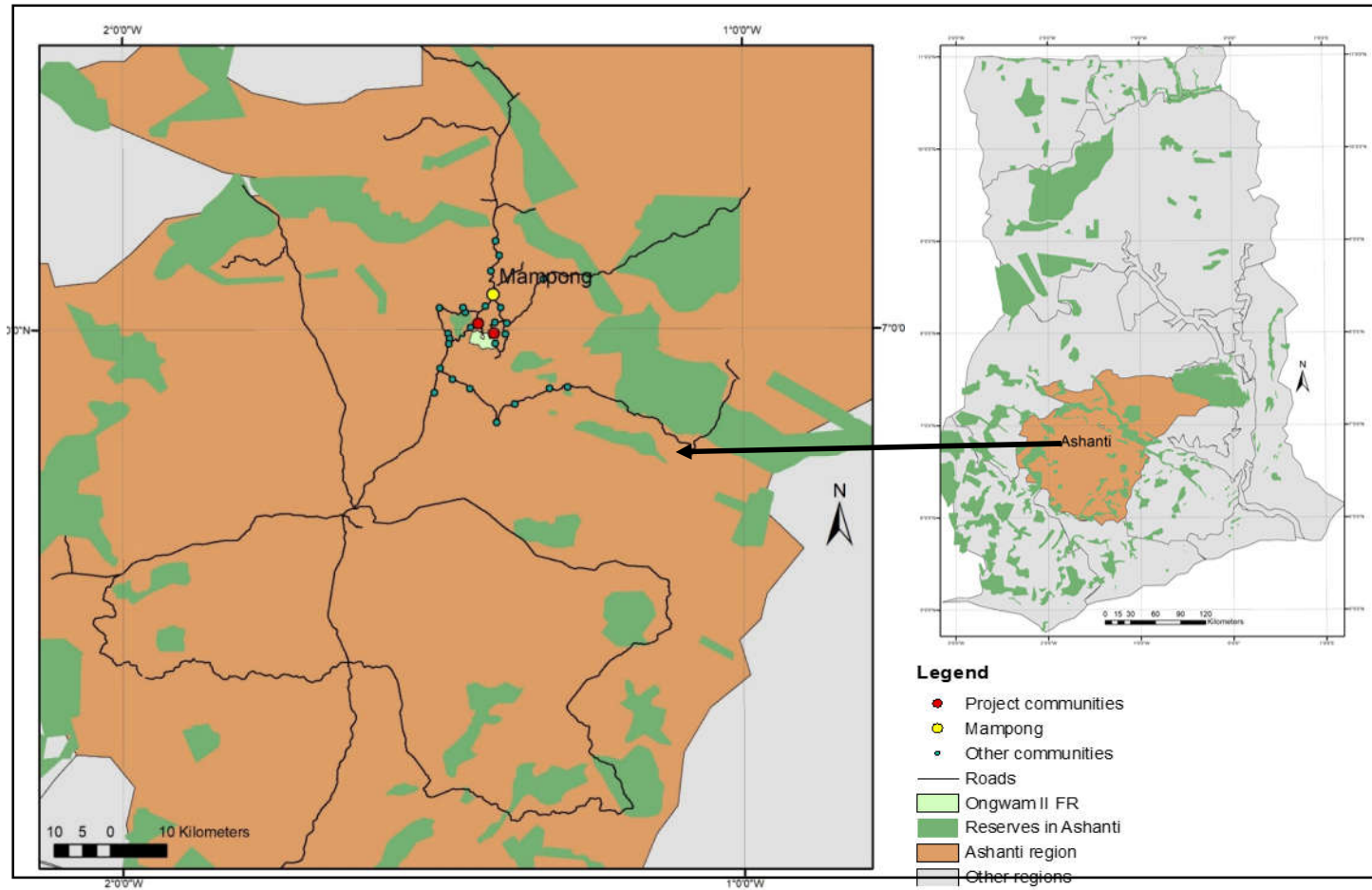


Figure A1. The Ashanti region of Ghana showing the study reserve and project communities. Source: Resource Management Support Center, Kumasi (RMSC), 2016.

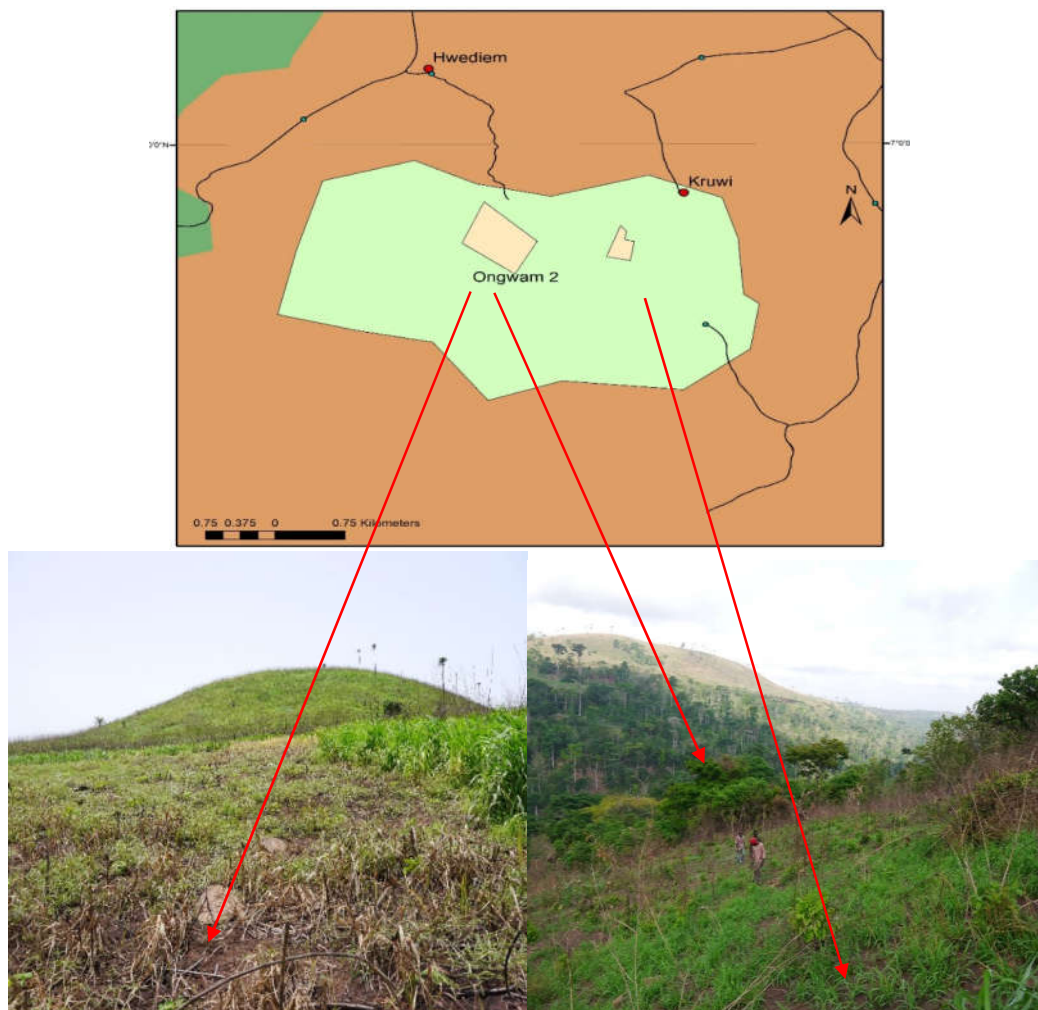


Figure A2. State of the project site in Ongwam II Forest Reserve as of 2017. Source: field survey, 2017.

Table A2. Ages of the farmers.

Age	Number of Farmers	Percentage
28	1	3.2
31	1	3.2
32	2	6.5
33	2	6.5
35	1	3.2
36	1	3.2
37	2	6.5
39	1	3.2
43	4	12.9
44	1	3.2
45	2	6.5
46	1	3.2
51	2	6.5
52	2	6.5
53	1	3.2
55	2	6.5
63	1	3.2
65	2	6.5
66	1	3.2
69	1	3.2
Total	31	100.0

Source: authors' field survey, 2017.

Table A3. Farmers' experience in farming on the basis of years of farming.

Years of Farming	Number of Farmers	Percentage
2	2	6.5
3	1	3.2
5	2	6.5
6	2	6.5
8	3	9.7
10	4	12.9
12	2	6.5
13	1	3.2
18	1	3.2
20	2	6.5
22	1	3.2
25	1	3.2
30	3	9.7
31	1	3.2
34	1	3.2
35	1	3.2
40	1	3.2
44	2	6.5
Total	31	100.0

Source: authors' field survey, 2017.

Table A4. Occupations of the farmers.

Occupation	Number of Farmers	Percentage
Farmer	19	61.3
Farmer, block molder	2	6.5
Farmer, food vendor	1	3.2
Farmer, mason	1	3.2
Farmer, mason, labourer	2	6.5
Farmer, trader	4	12.9
Farmer, trader, labourer	1	3.2
Farmer, welder	1	3.2
Total	31	100.0

Source: authors' field survey, 2017.

Table A5. Monetary values of all outputs harvested on both project and non-project land.

Worth of Harvested Produce (USD)	Farms in the Forest and on the Project's Land (Number of Farmers)		
	Yes	No	Total*
0	1	7	8
72.0	0	1	1
236.0	0	1	1
280.0	0	1	1
384.0	1	0	1
432.0	0	1	1
452.0	1	0	1
460.0	0	1	1
476.0	0	1	1
532.0	1	0	1
784.0	1	0	1
808.0	1	0	1
928.0	1	0	1
954.0	1	0	1
1,064.0	1	0	1
1,244.0	1	0	1
1,308.0	1	0	1
1,396.0	1	0	1
1,490.0	1	0	1
2,384.0	1	0	1
2,740.0	1	0	1
2,820.0	1	0	1
Total	16	13	29

Simple Statistics for Monetary Values of All Outputs Harvested

	Project's Farmers	Non-Project Farmers	Total Farmers
Mean value (USD)	1205.5	130.4	
Standard deviation	821.6	190.7	
Minimum value (USD)	0.0	0.0	
Maximum value (USD)	2820.0	476.0	
Total famers	16	13	29

Source: authors' field survey, 2018.

*All the 29 farmers farm in the forest. A total of 16 farmers farmed on the project's land and 13 farmers illegally farmed elsewhere in the forest reserve. Two farmers did not farm in the forest reserve. Note: The table is in two parts, the second (lower) part presents the mean, standard deviation, and minimum and maximum monetary values of the outputs harvested by the 29 farmers.

Table A6. Proportion of produce harvested from the project's land.

Percentage of Harvested Produce from Project Land	Farms in the Forest and on the Project's Land (Number of Farmers)					
	Yes	%	No	%	Total	%
0	1	6.3	13	100.0	14	48.4
8.00	2	12.5	0	0.0	2	7.0
14.00	1	6.3	0	0.0	1	3.4
36.00	2	12.5	0	0.0	2	7.0
40.00	1	6.3	0	0.0	1	3.4
44.00	1	6.3	0	0.0	1	3.4
45.00	1	6.3	0	0.0	1	3.4
86.00	1	6.3	0	0.0	1	3.4
96.00	1	6.3	0	0.0	1	3.4
97.00	1	6.3	0	0.0	1	3.4
100.00	4	25.0	0	0.0	4	13.8
Total	16	100.0	13	100.0	29	100.0

Source: authors' field survey, 2018.

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