Population, Incipient Desertification and Prediction of Household Agroforestry Uptake in Tabora Region, Tanzania

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Abstract- Environmental conservation in the world presents a daunting task due to population increase. In Tanzania, environmental degradation has occurred at an alarming rate in specific areas including Tabora. The continued burgeoning of the human population has resulted in changes in land use, increasing demand for resources and excision of forests. This study employed the theory of planned behaviour to predict on-farm tree planting behaviour of farmers. A sample size of 288 farmers drawn from Nzega and Sikonge districts in Tabora region was interviewed to measure standard theory of planned behaviour constructs. The data and hypotheses were examined using structural equation modeling performed in partial least squares algorithms. Results from the maximum likelihood estimation showed that attitudes, subjective norms and perceived behavioural controls were significantly and positively associated with stronger intention and related to farmers' behaviours in farming decisions. Farmers saw hindrance in tree planting operations being a result of cultural beliefs which yielded negative impacts. However, these were outweighed by perceptions of positive impacts. The drivers of these constructs can be harnessed by policy makers by directing farmers' intentions and behaviours toward conserving and sustaining fragile eco-environmentally areas against a threatening population growth in the region through agroforestry uptake programs.

Index Terms- Population growth, Deforestation, Tree planting, Gender, Theory of planned behaviour.

1. Introduction

Population increase, agricultural productivity and environmental degradation have characterised many developing countries including Tanzania. These trends have negatively impacted on the development and natural resources, amidst the increasing demand for resources in the wake of ever increasing population. Environmental degradation in several parts ofTanzania not only affects biodiversity but also has a direct impact on water quantity and quality, livelihood, poverty and development of a nation.

The Tanzanian population grew from about 12 million people in 1967 to 44.9 million in 2012, almost four times. With the annual population growth rate of 2.7 percent, Tanzania's population is projected to go up to 69.1 and 129.1 million in 2025 and 2050 respectively [1]. Population growth, in both rural and urban areas, is the underlying factor behind rapid rates of deforestation in Tanzania. Population growth intensifies the necessities for basic needs such as food, shelter, infrastructure development, fuelwood, furniture, construction materials and other products. In meeting these accumulating demands, deforestation is inevitable. The impact of population growth on deforestation is worsened by the reality that the growing population remains in poverty with limited livelihood strategies and, therefore, compelled to undertake unsustainable economic options including deforestation.

Tanzania is facing an exceptional loss of its forests and other woodlands. Over the last three decades, blocks of forests in Tanzania have been heavily impacted by official forest excisions as well as illegal, irregular and unplanned settlements. Evaluation of vegetation cover change based on time-series satellite images and repeated aerial surveys showed that between 1990 and 2010, the country lost an average of 403,350 ha or 0.97 percent per year and also, between 1990 and 2010 the total loss was estimated to be 19.4 percent (about 8,067,000 ha) of the forest cover [2]. Within this timespan, Tanzania was, among the ten countries that had the largest annual net loss of forest area. A recent report indicates that the country had already lost about 38 percent of its forest cover [3]. According to the report, the rate of loss is 400,000 ha per year and the risk considered to be high as the country's entire forests are likely to be depleted within the next 50 to 80 years if the current trend remains persistent.

Although there are information gaps for some disciplines on a sustained basis, already links have been suggested between population growth, land cover change, land degradation and an acute shortage of water [4]. Among the reasons for desertification caused by population growth are deforestation, overgrazing and over cultivation. Expansion of agriculture, especially the massive clearance of

land for cultivation of cash crops such as cotton and tobacco to increase export earnings has been mentioned as one of the leading causes of deforestation in Tanzania [5].

While data for various land vegetation in Tanzania from 1990 to 2010 displays a declining trend for forests and other wooded lands, subsistence agriculture alone is accountable for 48 percent of deforestation while commercial agriculture contributes 32 percent [6]. In Tanzania, the impact of agriculture on deforestation (see figure 1) is affected by a number of factors including human population growth, poverty and unfavourable government policies. Human population increase translates into the expansion of land under agriculture in forest areas in order to meet the growing demand for food and income. As pointed out earlier, poverty is linked to incapability to afford the agricultural inputs for bumper crop production. As a consequence, people are forced to leave the existing farms and clear virgin forests for new farms, the practice commonly known as shifting cultivation. To farmers, virgin lands have a number of advantages, making it less laborious. Virgin forest soils are easy to work with; fresh farms have fewer weeds for about two seasons. Therefore, weeding is very much lessened; new farms are less infested by pests; fresh forest soils are well drained and require minimum tillage before planting [7].

With reference to the 2002-2012 intercensal period, Tabora region's 2.9 percent average annual population growth rate was the 9th highest in the country [8]. It was also the 24th most densely populated region with 30 people per square kilometre. Census data for the last two decades indicate a dramatic population increase in Tabora region. The projections show that population growth rate will increase from 3.8 percent in 2003 (with a population of 1,777,437) to 3.9 percent in 2025 (with a population of 4,181,327) [9]. The rapid population increase since 1980 has occurred mainly due to the influx of farmers, attracted by fertile forest soils and improving infrastructure. The demand for water and other natural resources to serve basic needs is growing steadily as the population continues to increase. This is putting tremendous pressure on what are already scarce and highly vulnerable natural resources. Tabora region's land converted from natural vegetation to cultivated land (see figure 1) between 1984 and 1995 was 4.7 percent compared to 11.2 percent that was converted between 1995 and 2000 [10]. There is a total of 33 Forest Reserves which have a total area of 3,422,500 hectares out of which about 119,691 hectares are catchment forests, and as of now, about 201,017 hectares have disappeared through encroachment [11]. As a result of the high deforestation rate and subsequent fire-based agricultural land preparation with little or no fertiliser input, soil fertility has declined tremendously in the area. Natural secondary succession in the left bushlands and grasslands is also prevented by a constant annual recurrence of fire.

Fig 1. Miombo woodland invasion in Mitowo Village, Sikonge District, Tabora region
Source: Author, December, 2016

Agroforestry and reforestation practices, when appropriately directed toward biophysical and socio-economic conditions, have the potential to solve some of the problems of poverty, food insecurity and environmental degradation. Tree planting is essential to reduce the pressure on natural forests. It has been demonstrated that agroforestry and reforestation of public lands can augment the ability of farmers to face the effects of climate change [12], improve soil fertility and boost crop yields [13]. In Tanzania, several studies have

reported increased yields in agroforestry systems compared to monoculture crops [14]. Bumper crop yields coupled with the sale of tree products such as fruits, firewood and poles can increase income, as has been demonstrated in Tanzania, Nigeria and Zambia [15, 16, 17] respectively.

Although it is anticipated that recognition of the importance of forests is likely to increase tree planting, this has not always been the case with reference to Nzega and Sikonge districts of Tabora region. There are other factors which intervene and discourage farmers from planting trees within and surrounding their farms and compounds. Despite the multiple benefits associated with tree planting activities, it has been argued that agroforestry uptake has lagged behind [18]. The need to look for alternative approaches to reduce deforestation in Tabora region is widely acknowledged [19, 20]. However, there have been serious constraints in tree establishment on farmers' fields or on marginal lands because of various reasons.

Several studies have examined the challenges facing the uptake of agroforestry, yet conventional adoption studies have had a tendency to look at personal, social and economic variables when explaining agroforestry adoption [21, 22, 23, 24, 25].

Cultural beliefs, particularly in the Tanzanian context, have a strong influence on tree planting adoption. It is not easy to generalise about cultural norms and customary rulings because they differ from different people in various areas. In western Kenya, for example, tree planting activities are dominated by men and the concept of tree owners has been effectively sustained through well manipulated cultural practices (taboos) resulting in fewer women than men participating in tree activities [26, 27]. Cultural taboos observable in western Kenya are gender-bound such that a woman is feared to become barren or her husband is more likely to die if she dares planting a tree [28].

Traditionally, farmers in Tabora region do not grow trees because until recently, wood was regarded as plentiful and because they lacked information on tree planting and germplasm [29]. Therefore, farmer's knowledge on planting and management of trees in the region is limited. Even after the introduction of communal woodlots in the region, earliest efforts were not successful owing to among other things, farmers disliking the species (e.g. eucalyptus). Of more importance, farmers were unwilling to cooperate in the establishment of communal woodlots because of the perceived and actual implications of woodlots planting. As of recent (see figure 2), these woodlots have slowly been found to be economically and ecologically and socially sound in Tabora region [30].

Fig 2. Agroforestry in Ngwatu Village, Nzega District, Tabora region
Source: Author, December, 2016

More recent studies have also looked at socio-psychological factors, such as perceptions and attitudes, to explain adoption behaviour in relation to farm level tree planting [31, 32, 33, 13, and 25]. [34] for example studied the perceptions and attitudes of farmers in Pakistan and found that willingness to grow trees on the farms was a function of their attitudes towards the benefits and challenges of growing trees. [35] looked at the role of self-efficacy in the decision-making process of agroforestry adoption in Brazil and concluded that perceived behavioural control, attitudes about conservation and available labour contributed significantly to the intention to adopt

or maintain agroforestry and reforestation. Likewise, [36] claimed that socio-psychological factors of farmers need to be taken into consideration when planning socially acceptable agroforestry programs in the Western Himalayas.

Overall, these studies demonstrate that socio-psychological factors such as perceptions and attitudes can explain the incidence and extent of tree planting activities; however, many existing analyses have not taken into account the perspectives harnessed from local farmers [37, 38]. Specifically, relatively few studies have looked at the role of socio-psychological factors in explaining agroforestry and reforestation adoption. Owing to the methodological difficulties related to studying tree planting behaviour, it is unclear whether socio-psychological factors such as beliefs, norms, attitudes, and intentions are responsible for tree planting behaviour in Tabora region and Tanzania in general. The general objective of this study was to identify and evaluate the influential factors on attitudes toward participation in tree planting among households in selected community sub-samples drawn from the two districts of Tabora region, Tanzania. The specific objectives of this study were threefold. First to identify and analyse the factors that underlie farmers' decisions to engage in farm forestry. Secondly, to examine the gender differences in tree planting between farmers in the northern and southern districts of Tabora region and thirdly, to assess the utility and efficacy of the Theory of Planned Behaviour (TPB) (see figure 4) to explain farmers' intention to adopt agroforestry as an aid to the provision of practical information which may lead to curtailing deforestation and poverty.

Theoretical Framework and Research Hypotheses

Theory of Planned Behavior (TPB)

A modified TPB [39] was used in this study to predict and analyse farmers' socio-psychological factors toward tree planting. [39] TPB presents a theoretical framework for analysing in an orderly manner the behaviour concerning tree planting. In accordance with the theory, a person's behaviour is based on his or her preparedness to execute that behaviour (i.e. intention). This intention is primarily anchored on three antecedent determinants: (1) attitude (A), which is purely a personal positive or negative perception of executing a behaviour. An attitude is defined as "a person's favourable or unfavourable evaluation of the behaviour and is formed by the beliefs about the likely outcomes of the behaviour (salient beliefs) and the evaluations of these outcomes" [40]. (2) Subjective norm (SN), which is the individual's perception of social pressure to engage or not in a behaviour and is constructed by beliefs about the perceived behavioural control which reflects the extent to which the individual feels he or she can actually carry out the behaviour (normative beliefs) and the motivation to comply with these expectations. It refers to a person's understanding of other people's social pressure to execute or not to execute the behaviour [40]. Influence may stem from social referents like peers and (3) perceived behavioural control (PCB), which is a personal understanding of his or her ability to execute a given behaviour. It refers to the individual's perception of the fact that there exists personal and situational impediments to the performance of the behaviour. It reflects the extent to which the individual feels he or she can actually carry out the behaviour, which is based on beliefs and the perceived power of these factors [39]. In sum, the combination of the attitude toward the behaviour, the subjective norm, and the perception of behavioural control leads to the establishment of a behavioural intention, which consequently leads to the execution of the behaviour [39]. The TPB has been used to study the attitudes, intentions and behaviour in relation to farm-level tree planting and has been found to be a suitable model to understand such attitudes and behaviour [35] and [34].

Within the context of the TPB, more concentration is given to the identification of the underlying factors that influence separation behaviours. Several studies have recommended for additional variables to improve the predicting validity of the theory. A supportive example is drawn from Sao Paulo where moral obligation had a meaningful influence on the prevention behaviours among households [41]. Davis proposed that situational factors should also be added as a variable in the model [42]. This variable could be measured by evaluating the extent to which the respondents understand situational factors as impediments to performing tree planting behaviour. Ramayah put environmental knowledge as an additional variable to his model [43]. This particular study added situational factors in the model.

Research Hypotheses

The specific hypotheses tested by this study on the uptake of tree planting are stated below.

HI: Socio-demographic variables significantly and positively influence the TPB constructs which differ by gender and geographic locations.

H2: Farmers' attitudes toward tree planting significantly and positively influence their intentions to adopt on-farm tree planting.

H3: Farmers' subjective norms significantly and positively influence their intentions to adopt on-farm tree planting.

H4: Farmers' perceived behavioural control over tree planting significantly and positively influence their intentions to adopt on-farm tree planting.

H5: Farmers' intentions toward tree planting have a positive effect on on-farm tree planting behaviour.

H6: Situational factors have a significant influence on on-farm tree planting behaviour.

II. MATERIALS AND METHODS

Study area

Tabora Region is located in mid-western Tanzania on the central plateau, between latitudes 4°- 7°south and longitudes 31°- 34°east (Figure 3). The region covers an area of 76,150 km^2, representing 9 percent of mainland Tanzania, and lies at an altitude of between 1000 and 1800 metres above mean sea level. The area is bounded to the north by the Manonga Valley, to the east by Wembere River, to the south by the Ugalla River and the west by the Malagarasi swamps. Tabora region is located on an east-west trending regional watershed.

This study focused on two study sites in Tabora Region: the northern district Nzega and the southern district Sikonge. Nzega District is one of the seven districts of the Tabora region of Tanzania. It is bordered to the north by Shinyanga region, to the south and south-west by the Uyui District and to the east by the Igunga District. Its coordinates are 4°19'60" N and 33°4'60" E in degrees, minutes and seconds, [44]. Nzega district has a total land area of 6,961 square kilometres. Of these, 4,296 square kilometres are either forest reserves or natural forest. Its headquarters is in Nzega township. According to the 2002 Tanzania National Population and Housing Census, the population of the Nzega district was 417,097 and again according to the 2012 Tanzania Population and Housing Census, the population had increased to 502,252. The district of Sikonge, on the other hand, has its administrative seat in Sikonge township. The district, with geographical coordinates of 50 38' 0" S and 320 46' 0" N has an area of 27, 873 km^2 but 26,834 km^2 of it is occupied by forest and game reserves. It is bordered to the northwest by Urambo district, to the north by Uyui district, to the east by Manyoni district of Singida region, to the south by Chunya district of Mbeya region, and to the south-west by Mlele district of Katavi region. The population of Sikonge district was 133, 388 by 2002 and by 2012, it had risen to 179, 883 [45]. Sikonge District is characterised by relatively high levels of forest cover and low population densities. In contrast, most forests have disappeared in Nzega District, where population densities are high.

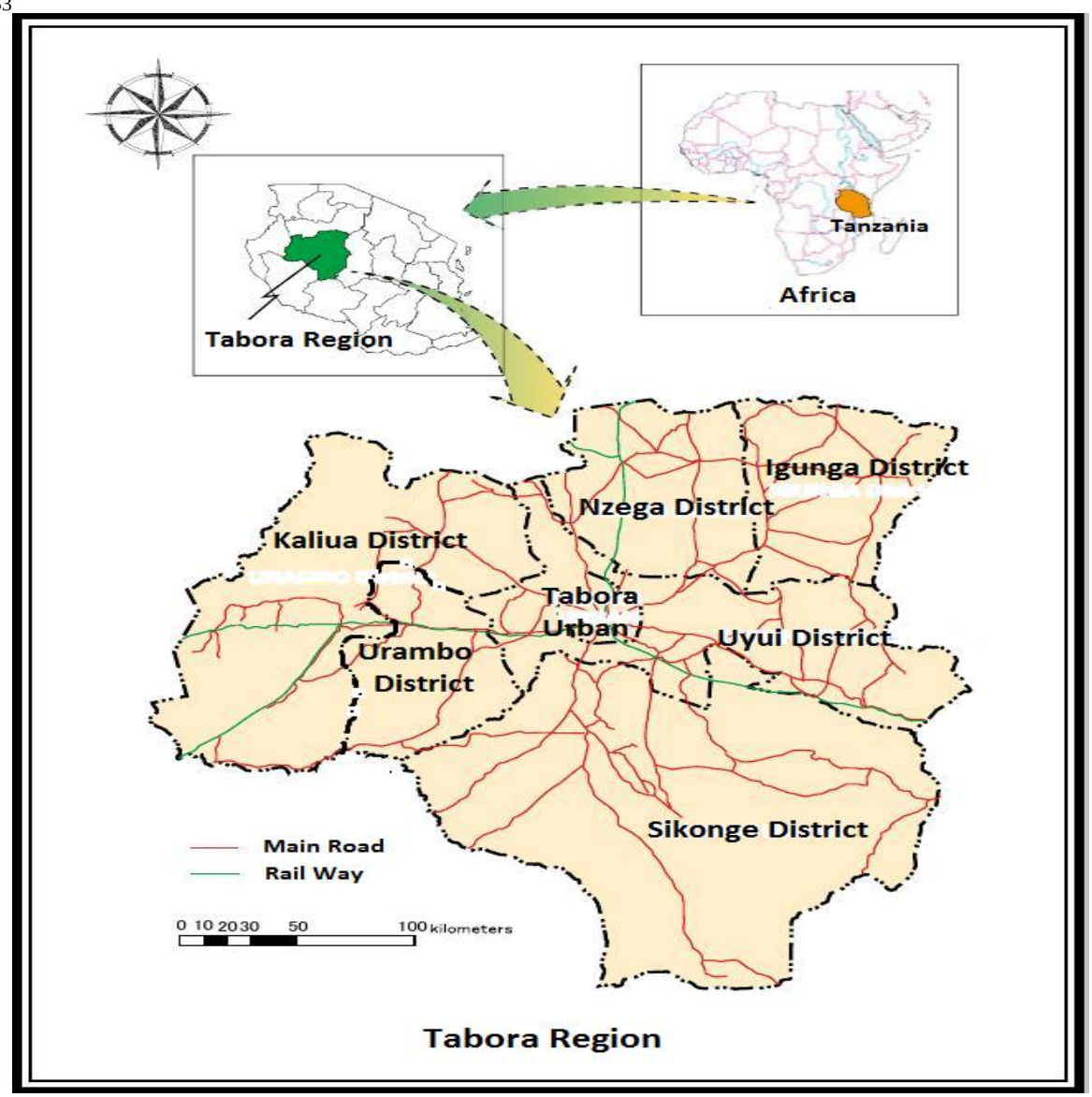

Figure 3. Map of Tabora region showing locations of research districts of Nzega and Sikonge.
Source: Modified from Japan International Cooperation Agency (JICA), 2009

Approach and Design

This study employed a mixed method approach, drawing on both quantitative as well as qualitative research methods [46]. A mixed methods approach is valuable as it can draw from the strengths and minimise the weaknesses of both and it is now being widely used and recognised as a research paradigm in itself [47]. A cross-sectional quantitative household survey was used to elicit information on respondents' characteristics, their behaviour in relation to on-farm tree planting, as well as the attitudes, subjective norms and perceived behavioural control in relation to tree planting. In addition, qualitative focus group discussions were conducted to explore some of the findings in more detail and as a way of triangulating the results of the survey.

Sampling and Sampling Procedure

A total of 288 respondents were randomly selected from a sampling frame of 540 households established by the National Population and Housing Census of 2012 using the formula by [48]. The unit of analysis was the household and the subject of analysis was the household head.

$$S = \frac{s^2 NP(1-P)}{d^2\,(N-1) + X^2\,P(1-P)}$$

Where:

s = required sample size
N = Sampling frame (the given population size, this case N = 540)
P = Population proportion that for table construction was assumed to be 0.50 as this magnitude yielded maximum possible sample size required.
d = degree of accuracy as reflected by the amount of error that can be tolerated in the fluctuation of a sample proportion (P)
x^2 = Chi-square value corresponding to one degree of freedom relative to the desired level of confidence (95 percent)

Various researchers have found that using mixed methodologies during in-field studies are particularly helpful because it enables a study to capture the complexities seen on the ground [49]. This study combined household surveys, focus group discussions and field observations. The quantitative analyses add rigour to studies that often lack in agroforestry project evaluations [50].

A household survey was used to elicit information about respondents' attitudes, perceptions and behaviour in relation to tree planting. Preceding the survey, informal visits and discussions with farmers and an exploratory survey were conducted in both study areas to elicit information about beliefs, attitudes, normative referents and control factors in relation to tree planting. In these interviews, respondents were asked about their experiences with and opinions of planting trees and this information were used to develop the final questionnaire. The questionnaire comprised two parts. The first part contained questions about personal, household and farm characteristics, as well as questions on the extent of tree planting. Several socio-economic variables were extracted from this part of the survey and used in the analysis in this paper. These included age, sex, education level, employment, wealth, household size, estimated annual income (estimated by the respondent in the local currency) and farm experience. The questionnaire also asked respondents about any trees they have planted on their farms or on communal lands, making the behaviour studied reported rather than actually measured behaviour.

The second part of the questionnaire consisted of an attitude scale to assess the attitudes, subjective norms and perceived behaviour control towards tree planting. Based on the responses during the informal discussions and exploratory survey, items for an attitude scale were developed to measure the modified TPB constructs towards tree planting. The response format used in the attitude scale was a five-point Likert scale [51]. The components of attitude were each measured on a scale ranging from 'strongly agree' (5) to 'strongly disagree' (1). The components of subjective norm were evaluated on a scale ranging from 'strongly agree' (5) to 'strongly disagree' (1). The control beliefs were also measured on a scale ranging from 'strongly agree' (5) to 'strongly disagree' (1).

In each district, 12 villages were selected using random numbers from a list of villages provided by District Lands Officers. In each village, 12 households were selected randomly from the lists of all farm households in each village. The household head was interviewed, in most cases, this was a male, but in some cases, mostly due to divorce, death, separation or long term absence of the husband, the woman was the household head. If the head of the household was not available to be interviewed, another household was selected from the list using the random sampling procedure. In Nzega District, the household survey was administered to 65 male headed households and 79 female-headed households, whereas 86 male-headed households and 58 female-headed households were included in the survey in Sikonge. The final list was piloted to improve the order of the statements. The final questionnaire was administered to 288 respondents.

Upon completion of all interviews and surveys, interactive focus group discussions were conducted. They were carried out according to the methodology described by [52]. In each district, two focus group discussions were carried out with female participants and two with male participants resulting into 8 focus group discussions in total. Each Focus Group Discussion (FGD) consisted of 7-9 participants and lasted approximately one hour. After the villages had been selected, participants were selected randomly from the list of all farming households provided by the Village Executive Officers (VEOs). Some participants of the focus group discussions had also participated in the household survey in the preceding cycle. A discussion guide was developed and the focus group discussions were conducted in the national language of Kiswahili. The focus group discussions included several open discussion questions about people's experiences and opinions about tree planting.

Structured Equation Modeling

This study made use of the Structural Equation Modelling (SEM) approach performed in Partial Least Squares (PLS), a path modelling technique, to analyse the survey data. The SEM, as opposed to other widely used techniques (such as multiple regression, multivariate analysis of variance, factor analysis and path analysis) which can only treat a single relationship at a time, combines

factor analysis and multiple regression analysis which makes the investigation of a series of dependent relationship much easier [53]. SEM techniques should not be operated without a strong theoretical foundation for specification of both the structural and measurement models [54]. SEM has often been used to study environmental behaviour in different disciplines including tourism [55], agriculture [56], and risk perception [57]. Therefore, the usage of SEM along with the TPB was best suited for this study.

Measurement Scale

A measurement scale was developed for each major variable consisting of multiple items (indicators) borrowed from previous studies. Guided by the theoretical understanding derived from the literature, questionnaire items that were relevant to the constructs in this study were identified. The principal constructs were developed based on existing measures where possible or were adapted from similar scales. Measures for attitude (A), perceived behavioural control (PBC), and subjective norms (SN) (societal norms and social influences) were based on empirical studies of [25], [24], and [18]. Although most items were based on previous empirical studies, actual measurement scales were developed to capture the context of this study. The questionnaire items were then modified to match this study of on-farm tree planting in Tabora region.

Analytic Framework

The quantitative survey data collected was analysed using non-parametric statistical techniques to detect associations and differences between respondents of the two study sites and between male and female household heads. First, the psychometric quality of the measures was assessed by calculating their validity and reliability. Second, the theoretical relationship between the variables was tested by estimating structural models. To obtain more accurate results, the SEM technique using the PLS algorithms was applied to evaluate the measurement model and structural model simultaneously. To conduct a quantitative study on practical problems, the SEM assesses the theoretical model according to the extent of consistency between the theoretical model and the actual data. The use of the SEM is mainly justified in the social sciences due to its capacity to impute relationships between unobserved (latent variables) and observable constructs.

This approach lends itself to this research because SEM answers a set of interrelated research questions in a single, systematic, and comprehensive analysis [58]. It also accommodates latent variables (LV) that are unobservable and cannot be directly measured. Therefore, the use of LVs in this study has the potential to model theoretical constructs such as intentions, attitudes, and perceptions that are difficult to measure directly. Analysis of Variance (ANOVA) was used to test if attitudes, subjective norms and perceived behavioural control were different among the respondents. The test was performed in order to assess whether the TPB constructs explain significant variance in tree planting behaviour among farmers. This step was necessary because there was no prior knowledge of potential multicollinearity among variables. It was necessary to use this test to explain variations in tree planting behaviour. SEM techniques were performed with the aid of Analysis of Moment Structure (AMOS) version 19 [59] software package. Focus group discussions were transcribed verbatim and coded according to a thematic framework and presented in narrative summaries. The software used for the Tran blocked ions was f4 (Windows). Data were analysed using the Software Atlas.ti v 6.2.26.

III. RESULTS

Response rate

Two hundred and ninety questionnaires were administered to household heads in selected villages of Nzega and Sikonge Districts of Tabora region, Tanzania. The respondents' response rate was 100 percent, with 288 valid questionnaires, which was accepted adequate for testing the stated hypotheses. Sample size plays a major role in the estimation and interpretation of SEM results [60]. In general, the literature suggests that sample sizes for structural equation models commonly run in the 200 to 400 range. This study sample size is reasonable enough to analyse descriptive statistics, multivariate analysis and structural equation model. There are several studies using less than 300 of sample size, such as seatbelt use (N=277) by [61], motorcyclists' intention to speed (N=110) by [62], drivers' decision speed (N=250) by [60], and truck driver behaviour (N=232) by [63].

Socio-demographic Characteristics of the Respondents

The socio-demographic characteristics of the sample are summarised in Table 1 and the parameters included are age, sex, education, household size, wealth and farming experience. Referring to the age of the respondents, most of them laid between 20 to 50 years (64 percent and 73.8 percent in Nzega and Sikonge districts respectively), then followed by those aged below 20 years and above 50 years by (2 percent and 0 percent) and (34 percent and 26.2 percent) for Nzega and Sikonge districts respectively. The mean age was 39.4 years (SD = 11.7, range = 18 – 63) while only a few of the respondents were above sixty-five years of age. The larger number of a young population could imply increased pressure on agricultural land and therefore momentously affect its economic value. The chi-square tests indicated no significant ($p>0.05$) difference in age between villages in the two districts. As regards, gender, out of the total sample, (45.1 percent) and (59.7 percent) of the respondents were males in Nzega and Sikonge districts respectively. The majority of the sample was male (52.4 percent). In this respect, this proportion

Table 1. Summary of socio-demographic profile of the respondents in study villages in two districts of Tabora region

Respondents characteristics	Nzega		Sikonge	
	Frequency	Percentages	Frequency	Percentages
Age				

Below 20 years	3	2	0	0
20 – 50	92	63.8	107	73.9
50 and above	49	34	38	26.2
χ^2 = 2.156, df = 2, p-value = 0.340				
Gender				
Male	65	45.1	86	59.7
Female	79	54.9	58	40.3
χ^2 = 0.102, df = 1, p-value = 0.749				
Marital Status				
Married	90	62.6	81	56.3
Singles	47	32.8	54	37.4
Widowed	7	4.6	9	6.3
χ^2 = 2.237, df = 2, p-value = 0.327				
Education				
None formal education	9	6	22	14.8
Primary school	127	88	109	75.4
Secondary school	9	6	12	8.2
Adult education	0	0	3	1.6
Post secondary	0	0	0	0
χ^2 = 10.125, df = 4, p-value = 0.038				
Wealth				
Economically poor	81	56	95	65.6
Very poor	55	38	40	27.9
Better off	9	6	10	6.6
χ^2 = 1.55, df = 2, p-value = 0.461				
Household size				
1-3 people	9	6	36	24.6
4 - 6 people	58	40	36	24.6
7- 10 people	75	52	66	45.9
More than 10 people	3	2	7	4.9
χ^2 = 11.750, df =2, p-value = 0.003				
Farming experience				
1-10 years	39	27	35	24.3
11-19 years	48	33	41	28.5
20 and above years	57	40	68	47.2
χ^2 = 0.276, df =2, p-value = 0.871				

Notes: Alpha level or significance level set at 0.05
Source: Tabora Population-Agroforestry study, 2016

explains the fact that most of those who practice agroforestry and tree planting, in general, are mostly matured males though, in reality, it is the women who are engaged in crop farming. On the other hand, female respondents were (54.9 percent) in Nzega and (40.3 percent) in Sikonge. These findings reveal the presence of more males than females when both districts are combined. The chi-square tests showed no significant difference ($p > 0.05$) in gender between villages in the two districts. Education wise, majority (88 percent and 75.4 percent in Nzega and Sikonge districts respectively) of respondents had completed primary school education, followed by those with none formal education (6 percent in Nzega and 14.8 percent in Sikonge), while those attained secondary education were 6 percent in Nzega and 8.2 percent in Sikonge. Very few of them have attended adult education (0 percent in Nzega and 1.6 percent in Sikonge). The chi-square test indicated significant difference ($p<0.05$) in education level between villages in the two districts. Additionally, a one-way ANOVA test was performed and presents that there were significant age differences among people reporting different education levels: $F (4, 7.68) = 4.011$, $p = .047$, $\eta^2 = .01$. The mean age of those who obtained a primary school education level certificate was ($M = 42.24$, $SD = 12.52$). These results show that majority of respondents attained primary education, thus indicating a low level of education in the study area. It further reveals minimal application of land management practices in the study villages, which partly could be caused by low level of education, amongst other factors. Regarding wealth, a large proportion of respondents were economically poor by 56 percent in Nzega, and 65.6 percent in Sikonge, followed by very poor (38 percent) in Nzega and 27.9 percent in Sikonge and better off were 6 percent in Nzega and 6.6 percent in Sikonge. The chi-square test indicated further no significant difference ($p>0.05$) in wealth between the two districts. These results imply that majority of respondents in both districts are economically poor. Furthermore, as discernible from Table 1, the average annual income of respondents was the equivalent of Tshs 885,132.05 per annum ($1=Tshs 2,228 as per exchange rate of 2017). Farmers in the lowest range of annual income (the very poor) might, however, need to augment their income earnings as they were all leaving below the

poverty line by earning below Tshs 2,300 which is approximately $1 per day. This confirms the prevalence of poverty among rural farmers in Tabora region and Tanzania in general.

On household size, the majority of respondents in Nzega (52 percent) and Sikonge (45.9 percent) had a household size ranging from 7 to 10 household members. 1 to 3 households' members were 6 percent in Nzega and 24.6 percent in Sikonge, while 58 (40 percent) in Nzega and 36 (2.6 percent) in Sikonge had 4 to 6 households' members. Few respondents by 2 percent in Nzega and 4.9 percent in Sikonge had more than 10 households' members. Overall 59.52 percent of the respondents have an average household size of 5 people with a Standard Deviation (SD) of ± 2 in both areas. Chi-square tests indicated high significant difference ($p<0.05$) in the size of households between the two districts.

As regards marital status, the majority of the sample included couples (62.6 percent), followed by singles (32.8 percent), and widowed (4.6 percent) for Nzega and 56.3 percent for the married, followed by singles (37.4 percent) and widowed (6.3 percent) for Sikonge. The chi- square tests for marital status indicated no significant ($p>0.05$) difference in age between villages in the two districts. The farming experience of the respondents ranged from 14 - 51 with a mean of 31.19 (+18.09) years. Furthermore, 35.72 percent of farmers had an average total farm size of 0.74 (SD 0.64) hectare in Nzega and 2.37 hectares (SD 2.29) in Sikonge. This goes to confirm that land holdings in the rural areas are usually small and is obtained mostly through inheritance. Almost all households (98 percent) own land, and some respondents (11 percent) said they rented additional land for farming. In the bivariate (chi-square) test, farm experience and tree planting yielded insignificant results at $p = 0.871$.

Assessment of validity and reliability of the measurement items

As a first step, construct reliability and validity was assessed. The interpretation of the resultant coefficient takes into account the actual factor loadings rather than assuming that each item is equally weighted in the composite load determination. In this study, construct reliability was measured using [64], with a value of 0.7 or higher being recommended [65]. Construct reliability for all the factors in this study's measurement model were above 0.7 an acceptable threshold representing strong reliability. [53] recommended a factor loading of 0.5 and above to be an acceptable indicator of validity at the item level. Construct validity for the measurement scales was assessed from their convergent and discriminant validity values. Convergent validity which indicates how each measurement item strongly correlated with its specific theoretical construct was determined from the constructs' respective Average Variance Explained (AVE) values. Convergent validity was evaluated for the measurement scales using three criteria suggested by [66]: (1) all indicator factor loadings should be significant and exceed 0.7, (2) construct reliabilities should exceed 0.7, and (3) the square root of the average variance explained (AVE) by each construct should exceed the variance due to measurement error for that construct (i.e., AVE should exceed 0.50). All values in the Confirmatory Factor Analysis (CFA) model exceeded 0.7 and were significant at $p = 0.001$. Composite reliabilities of constructs ranged between 0.78 and 0.93. AVE ranged from 0.58 to 0.87 indicating that on average, all Latent Variables (LVs) were able to explain more than half of the variance of their respective indicators and thus demonstrated sufficient convergent validity. Therefore, all three conditions for convergent validity were met.

Evaluation of the Measurement Model (outer model)

The measurement model specifies the relationships between the constructs and the associated indicators. The parameters in the SEM were estimated by maximum likelihood (ML) method using the computer software program AMOS version 19. A variety of indices was used in this study. Absolute fit indices that measure how best the proposed model replicates the data were included. In other words, the fit indices assess the overall discrepancy between the implied and observed covariance matrices.

Absolute, incremental, and parsimonious indices of fit were included in the measures of the overall model fit. The commonly known index of absolute fit is the Chi-square (χ^2). Despite the fact that the χ^2 statistic has been found to be sensitive to sample sizes, two other indices were used in this study to assess the overall absolute fit of the proposed model: the Goodness of Fit Index (GFI) and the Comparative Fit Index (CFI). For assessing the fit of the proposed model as well as for incremental fit measures, the Adjusted Goodness of Fit Index (AGFI), The Incremental Fit Index (IFI), and the Normed Fit Index (NFI) were also applied. Lastly, the Root Mean Square Error of Approximation (RMSEA) was used to assess the parsimonious fitness of the model used in this study. The minimum accepted values and the observed values from this model are presented in Table 2. Results of the test of the overall model fit present $\chi^2 = 289.2$ with 177 degrees of freedom and a p-value of more than 0.05. In this manner, it was accepted that the model fits the data. The other indices were found to be higher than the suggested values. The recommended cut-off value for the goodness of fit indices was based on [67] recommendation. On the ground of the recommended values, the study concludes that the research model fitted the data well.

Table 2. Goodness-of-fit test results.

Fit index	χ^2 (p-Value)	GFI	CFI	RMSEA	AGFI	IFI	NFI
Suggested value	>0.05	>0.9	>0.9	<0.08	>0.8	>0.9	>0.9

Observed value	0.061	0.902	0.973	0.022	0.837	0.911	0.902
Conclusion	Accepted	Good fit	Good fit	Good fit	Good fit	Good fit	Good fit

Source: Tabora Population-Agroforestry study, 2016

3.5 Evaluation of Structural Model (inner model)

The structural model represents the relationship between the constructs. It specifies the relationships between the latent variables. Latent variables can play the role of predicting. A latent variable which is never predicted is called an exogenous variable. Otherwise, it is called endogenous variable. This section presents results of the test of the structural model (in which research hypotheses are embodied). The structural model was tested using the structural equation modelling (SEM) approach performed in PLS. This approach is particularly appropriate for testing theoretically justified models [68]. Each indicator (manifest variable) was modelled in a reflective manner which means a variation of the construct yields a variation in the measures. As a result, the direction of causality is from the construct to the indicator. Each manifest variable represents the corresponding latent variable, which is linked to the latent variable using a simple regression model. The six constructs comprise four exogenous variables (attitudes, subjective norms, perceived behaviour control, and situational factors and two endogenous variables (intention and behaviour). All of these were linked as hypothesised (see Figure 4), and model estimation was done by assessing the path coefficients that indicate the strength of the hypothesised relationship between the exogenous and the endogenous variables and the variance explained (R^2 value) by each path. Figure 4 presents the standardised path coefficients as well as the path significance as reported by PLS. The betas were used to determine the relative weights of each factor.

The sample size of n=288 was sufficient because the required number of cases for this PLS analysis is only ten times the number of indicators in the reflective constructs [69]. The modified model derived from the Theory of Planned Behavior was made up of all reflective constructs that are influenced by the prime latent indicators [70]. These reflective latent constructs (attitude, subjective norms, perceived behavioural control, intention situational factors, and behaviour), are characterised by the fact that changes in the underlying latent construct will be reflected in changes in their corresponding measurement indicators. Since the indicators in a reflective construct represent the construct in a reflective model, a high degree of correlation between the indicators was expected to be seen.

Hypothesis 1 examined the influence of socio-demographic variables on the TPB constructs. A one-way ANOVA test was performed to determine whether socio-demographic characteristics significantly and positively influence the respondent's attitude, subjective norm, and perceived behaviour control pertaining to tree planting behaviour. In this case, the socio-demographic characteristics are statistically significant only when the p-value is less than 0.05. Table 3 presents the statistics of the effects of the socio-demographic characteristics on tree planting. Results indicate that age, gender, wealth, and farming experience do not seem to be statistically significant except household size and education. Farmers with different levels of education have different separation behaviours, with the secondary education group demonstrating more positive behaviour as opposed to those with lower education. For situational factors, all sociodemographic variables were not significant.

Table 3. Analysis of variance of socio-demographic variables.
Values of Significance (*p*)

Socio-demographic Variable	Attitude Norm	Subjective Behavioural Control	Perceived	Intention	Situational Factors	Behaviour
Gender	0.610	0.483	0.660	0.711	0.164	0.264
Age	0.589	0.391	0.372	0.703	0.314	0.405
Education	0.027	0.043	0.036	0.033	0.221	0.049
Household size	0.006	0.027	0.002	0.046	0.331	0.039
Income	0.803	0.344	0.534	0.360	0.522	0.662
Farming experience	0.069	0.211	0.257	0.077	0.311	0.682

Source: Tabora Population-Agroforestry study, 2016

Through the lens of the TPB, this study went further examining whether differences in gender exist within TPB constructs and whether these differences explain observed gender differences in agroforestry. T-test for independent groups was performed for each case.

Attitude toward tree planting was more favourable among females (M= 3.97, SD= .75) than males, (M= 3.65, SD= .83), t (3301) = -11.31, p < .001. Further, on each behavioural belief item comprising the attitudes construct, women reported more favourable beliefs than men, p< .001. Females also reported greater control beliefs and perceived facilitation over tree planting (M= 3.75, SD= .96) than

males (M= 3.50, SD= 1.07), t (3291) = -6.91, p < .001. Across all items comprising the construct, women reported higher confidence than males, p < .001. Males on the other hand reported greater normative beliefs regarding tree planting (M= 2.29, SD= .83) than females (M= 2.13, SD= .81), t (3305) = -5.66, p < .01. As regards geographic locations of the study, respondents in Nzega district had more positive attitudes and subjective norms towards tree planting compared to respondents in Sikonge district. Irrespective of differences on their influence to TPB constructs, background factors held direct paths to antecedents of intention.

Hypothesis 2 examined the relationship between farmers' attitude towards tree planting and their behavioural intention to adopt tree planting. In regression analysis, it yielded (β=0.421, t-value=17.64, p<0.001). This hypothesis was strongly supported and therefore not rejected. Hypothesis 3, examined the relationship between subjective norms and farmers' intention to adopt tree planting (β=0.213, t-value=7.59, p<0.01). This hypothesis was also strongly supported and therefore not rejected. The fourth hypothesis examined the relationship between perceived behavioural controls and farmers' intention to adopt tree planting. (β=0.138, t-value= 4.41, p<0.05). This hypothesis was also strongly supported and therefore not rejected. Hypothesis 5 examined the relationship between intention and behaviour to adopt tree planting (β=0.62, t-value=17.59, p<0.001). This hypothesis was strongly supported and therefore not rejected. Hypothesis 6 examined the relationship between situational factors and behaviour to adopt tree planting (β = −0.55, t = −9.12, p < .001). Although 'situational factors' on tree planting behaviour was negatively correlated, still the influence was statistically significant. In this manner, H6 was supported. Tree planting behaviour will only be restricted when farmers have barriers.

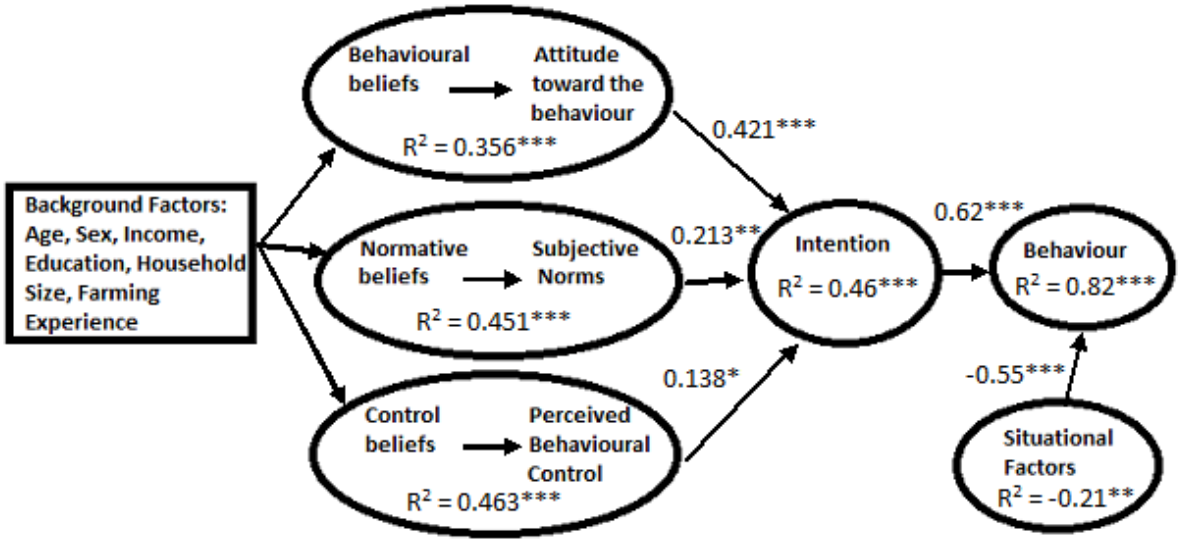

Figure 4. PLS Analysis of Research Model (modified version of Theory of Planned Behaviour by Ajzen, 1991)
Note: Observed manifest variables (survey items) are presented as a rectangle. Latent variables are presented as ellipses
Note: *P< 0.05, **P < 0.01, ***P< 0.001,
R^2 = the coefficient of determination.
Measurement model not shown above for purposes of clarity.

Source: Ajzen and Fishbein, 2005, p. 194 and Tabora Population-Agroforestry Study, 2016

The inner model provides that among the three determinants, attitude toward the behaviour had the most substantial impact on farmers' intentions to adopt a behaviour of tree planting, producing a change of 0.421 units in behavioural intention for each unit change in attitude. This influence on intention is more than twice that of subjective norm (0.231) and more than three times that of perceived behavioural control (0.138). This finding suggests that farmers' decisions about tree planting are influenced substantially by their views of its value, moderately by the opinions of significant others, and less strongly by their farmers' perceived ability to do so.

The coefficient of determination, R^2, is 0.46 for the Intention endogenous latent variable. This means that the three latent variables (Attitude, Subjective Norm and Perceived Behavioural Control) moderately explain 46 percent of the variance in Intention while Intention itself explains 82 percent of the variance of Behaviour.

The findings of the survey were reinforced by the outcomes of the focus group discussions. During the group discussions, farmers were asked to point out the most important impediments that obstruct tree planting among the people in their villages. Interestingly, the most important impediments cited were laziness, land scarcity and lack of tree seeds. Farmers further explained that planting and caring for trees is labour intensive and because of many other responsibilities within the farm and around the house, some were not

motivated to take on tree planting as additional duties. Others might have been unsuccessful with tree planting activities in the past and were consequently seen to be disinterested in any further tree planting activities.

The study probed for the reasons behind the fact that large parts of Tabora region have already been denuded of trees and still people cut without planting. A farmer at Ilagaja village, Nzega District reported that *"fuelwood gathering has been responsible for deforestation and environmental degradation"*. She further narrated that *"some fuelwood, however, is used for village industries including tobacco curing and burning bricks"*. Within the same focus group discussion, another participant reacted that *"fuelwood gathering is probably a less important cause of deforestation than land clearing for crop production"*. This response was echoed by another participant who said that *"production of charcoal for sale is probably a much more severe cause of deforestation than firewood gathering for home consumption in rural areas because charcoal burners cut the whole tree".*

One of the factors that the participants mentioned and that could pose as a barrier to the adoption of farm level tree planting is cultural practices (taboos). A 42-year-old male farmer in Ngwatu village (Nzega District) said: *"Many farmers in our village do take care of sacred trees for worshipping and other rituals. Other types for domestic and other uses receive less attention."* A 47-year-old female in Mitowo village (Sikonge District) put it succinctly*: "These trees are not allowed to be cut unless under special circumstances, especially for ritual purposes or for treating be-witched persons."* A female youth in Mitwigu village (Sikonge District) said: *"Some trees are left on the farms during land preparation or harvest for provision of fruit/food, medicines, shade or use in rituals and some are left on the farm because it is believed that they protect the harvest in the field from witchcraft."*

FGDs of farmers expressed hindrance in tree planting operations and the harbouring of cultural beliefs as having negative impacts since they have a strong influence on agroforestry uptake. These cultural beliefs appear to be powerful determinants of farmers' actions and often exert more influence than rules and regulations enforced by the government. In the case of this study, these beliefs appear to have been outweighed by social pressure and perceptions of positive impacts.

FGDs also provided interesting insights into the proportion of households where the household head is the main decision-maker. For decisions on activities such as planting, sowing, and weeding of crops, the main decision-maker is the household head in about half of the households sampled (this does not seem to differ between male- and female-headed households.). For tree planting and tree management, however, the household head is more often the main decision-maker in male-headed households and less often in female-headed households compared to the other activities. For most agricultural activities, the decision-making pattern was a mix of decision-making by the husband, the wife, or by both.

As an alternative to the escalating fuelwood problem in the Tabora region of Tanzania, farmers are attracted to woodlots. Tobacco farmers in Tanzania used to get all of their firewood from the miombo woodlands, but this is no longer the case as deforestation takes its toll. An FGD participant in Mitwigu village, Sikonge District confirmed that "*farmers are now slowly opting for alternative sources of fuelwood such as having an on-farm supply, hence the interest in woodlots".*

Following reports from the FGDs, physical observations of on-farm tree planting in the two districts suggest that intercropping the nitrogen fixing tree Leucaenaleucocephala with maize provides the farm family with sufficient fuelwood in addition to supplying the maize with nitrogen.

IV. DISCUSSION

Results of the survey revealed that the 'Attitudes' had the highest standardised effect on intention toward tree planting behaviour followed by 'Subjective norms' and lastly 'perceived behavioural control'. This observation confirmed the findings of [71] in other domains. The effect of 'Attitude' to 'Intention' and 'Behaviour', and the effect of 'Subjective Norms' to 'Behaviour' as well as 'Perceived Behavioural Control' to 'Behaviour' were significant at ($p < 0.001$, $p < 0.01$ and $p < 0.05$ respectively). Like [71], the results of this study revealed that intention was a significant predictor of the behaviour. Findings revealed that attitude was a positive predictor of intention. There was also evidence that attitude itself was a stronger predictor of tree planting behaviour. In other words, participants with more positive attitudes toward tree planting also had greater intentions to engage in the behaviour.

In evaluating inherent human behaviour towards tree planting adoption in Tabora region, respondents believed that 'Attitude' to adopt or not to adopt tree planting (SNs) significantly influences their adoption behaviour (H2). Attitude which in this study yielded a path coefficient of 0.421 has been proposed in several studies using different theories to influence behavioural intentions [40]. Respondents also believed that perceived social pressure to adopt or not to adopt tree planting (SNs) significantly influences their attitude toward adoption (H3) with a significant path coefficient of 0.213. SNs refer to the perceived social pressure to perform or not to perform the behaviour. This relates to one's intuition about others' exertion of influence. This study justified that, based on TPB, social pressure—be it from society, peers, or government—will have a positive influence on an individual's intention to adopt tree planting. Similarly, respondents also believed that their PBC (controllability and self-efficacy) to adopt tree planting significantly influences their attitude (H4) (path coefficient = 0.138). As expected, H4 received strong support. PBC involves people's beliefs that they have control over

the behaviour; performance or non-performance of the behaviour is up to them [72]. Several studies support the direct effect of PBC on intended and/or actual usage [73,74].

In H5, this study posited that farmers' intention toward tree planting positively influences their behaviour to adopt on-farm tree planting. The model strongly supported this hypothesis. The results were not surprising because the intention is proposed to influence behaviour. This theoretical prediction has received considerable empirical support in a variety of settings [75,76]. The intention is an overall evaluation of an individual's perception of tree planting adoption. Additionally, an intention is the cognitive representation of a person's preparedness to perform a given behaviour, and it is taken to be the immediate antecedent of behaviour.
Therefore, following the TPB, a positive intention undoubtedly affects the individual's behaviour to engage tree planting activities.

Consequently, the application of TPB offers a theoretical foundation for the consideration of behavioural attributes in tree planting uptake. By relating the three constructs (attitude, subjective norm and perceived behavioural control) to tree planting, a farmer is likely to gather information, share the information and ultimately utilise the information for the purpose of enhancing on-farm tree planting in the region and country in general. The tree planting achievements tend to be incremental (at the individual level) and transformative (at the community level). According to [77] incremental changes eventually lead to stable transformative community development.

The findings of the survey were reinforced by the outcomes of the focus group discussions, which besides noting the view that on-farm tree planting and tree management are mostly a task for husbands, the focus group discussions revealed that women still participated in the implementation of tree planting, and there were some gender-specific roles for women, which is in agreement with previous studies [78, 79].

V. CONCLUSION

Continuing degradation of existing forest cover driven by rapid population growth and anthropogenic activities are serious threats to the sustainability of forestry in Tabora region. Farm and community land forestry uptake has been identified as a feasible solution. Given this scenario, results of this study have shown that farmers' intention and behaviour toward conserving ecological achievements have been explained well by TPB. The farmers' behaviour was significantly positively influenced by their intention toward conserving ecological achievements, and their intention significantly predicted their attitude (positive or negative value of performance), followed by the subjective norm (social pressure in engaging behaviour), and least by perceived behavioural control (perceptions of their ability). The farmers' degree of support for agroforestry uptake and its recognition of environmental effects is the main factor that most influenced the farmers' attitude.

Guided by these findings and in response to the demonstrated need for sustainable agroforestry in Tanzanian villages, this study has adequately addressed its key objective of testing the explanatory ability of the TPB on farmers' intention to adopt on-farm tree planting behaviour and has also illuminated the factual evidence gathered from them. The application of this theory in the two selected districts of Tabora region provides an insight on farmers' behaviour towards growing trees on their farms. The achievement of on-farm tree planting is a function of the three TPB constructs. These findings can assist in developing tailored forestry programmes, to increase attitudes and foster behavioural change, in order to speed up agroforestry in the region. This approach can successfully engage farmers to support the sustainability of the ecology and environment against the uncontrolled agricultural expansion and demand for rural energy fuelled by population growth in the region.

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