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Socio-Economic and Demographic Factors Influencing Farmers' Decision on Homegarden Management Practices and Carbon Storage in Mizoram, Northeast India

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ABSTRACT

The influence of socioeconomic factors on homegarden (HG) management practices impacting carbon storage was studied in Mizoram by involving 40 households based on the theory of planned behavior. Traditional/Ancestors (normative belief) had the highest influence on decision-making and it significantly ($P<0.05$) influenced practices such as cultural operations, plant residue application, and fertilizer application. The education/experience factor (behavioral belief) influenced the decision with tree planting in a positive manner and affected the decision with fertilizer application in a negative manner. Other important factors influencing the farmer behavior were friends (normative belief), financial condition (control belief) of the farmer, and economic importance of the HG. The results of this study may have application in understanding the strength of socioeconomic and demographic factors in influencing homegarden management practices and can be used as a baseline for further research on HG carbon storage.

Key Words: Socioeconomic Factors; Theory of Planned Behavior; Homegarden; Carbon Storage

INTRODUCTION

Carbon (C) storage in different components of biosphere (vegetation and soil) is greatly influenced, either greatly reduced or promoted, by various agricultural management practices such as tillage, plant residue management, manure usage, fertilizer application, tree planting, etc. (FAO 2004, Yelenik et al. 2004, Haile et al. 2008, Li et al. 2013, Lorenz and Lal 2016, Song et al. 2016; Shresta et al. 2018). Tillage is an important practice and is reported to decrease C stocks in agricultural soils (Carter 1996, Lal et al. 1999, Busari et al. 2015, Haddaway et al. 2016) as it causes destruc-tion of aggregates and exposure of stored C to microbial degradation. The effect of tillage varies from site to site (Buschiazzo et al. 2001, Mathew et al. 2012) and the no-tillage approach may be beneficial for soil C storage (Phillips et al. 1980, Reicosky et al. 1995, Liang et al. 2014). Plant residues provide resources for the production of soil organic carbon (SOC). About 15% of the plant residue is converted to passive SOC (Lal 1997) depending on several factors like temperature, moisture, type of crop, and quality of residues. Manure application increases the formation and stabilization of soil macroaggregates (Whalen and Chang 2002, Du et al. 2014) and particulate organic matter (Kapkiyai et al. 1999, Xie et al. 2015). Manure is more resistant to microbial decomposition than plant residues, thus for the same input, C storage is higher with the manure application (Jenkinson 1990). Fertilizer application increases the yield and any increase in biomass promotes the scope of C storage, thereby proving to be a successful method of enhancing C storage (Lal et al. 1999). On the contrary, application of nitrogenous fertilizers is considered as a source of greenhouse gases (GHGs) because they generate nitrous oxide (N_2O) (Robertson et al. 2000). The carbon sequestration potential (CSP) of a system varies according to the type of plants included in it. More the biomass more will be the C storage, thus trees may have a better CSP than annual herbs. The tree component of the agricultural systems are potential sinks of atmospheric C due to fast growth and productivity (Gupta et al. 2017, Singh and Sahoo 2018) and by adding trees, the system can increase the C storage capacity of the system (Kursten 2000, Pinho et al. 2012).

The extent of influence of these practices on C storage depends on the intensity of the management. The farmers' decision on the intensity of management is influenced by a large number of factors including socioeconomic and demographic factors (Seabrook et al. 2008, Kinyangi 2014, Riar et al. 2017), as well as the financial condition, education, age and gender of the farmer, land holding-size, availability of resources, and extension contact (Anjichi et al. 2007, Matata et al. 2008, Miheretu et al. 2017, Mango et al. 2017). Size of the land-holding is also an important factor that influences the farmers' decision to implement certain management practices. Resource-poor farmers can be inversely influenced by the size of the farm and may have a tendency to not apply manure, plant residues, or fertilizers uniformly and adequately to the farm. Size of the land-holding influences the plant species density and tree density in homegardens (HGs) which in turn may affect the stocking of soil C. Age of the farmer is another important factor for making farm decisions as it affects farmers' knowledge and ability to adopt changes (Anjichi et al. 2007, Alassaf et al. 2011). Older farmers may be inflexible with many new developments or may take more time to adopt new technologies. The role of gender in HG decision-making is still under debate. Availability of resources such as raw materials, labor, household cattle etc. influenced the farmers' decision with the management practice. Contacts with peers and organizations may also influence farmers' decision with farming practices. However, little information is available about the role of underlying socioeconomic and demographic (or social) factors in influencing the farmers' decision with practices such as tillage, application of plant residue, manure, and fertilizer, and planting trees. Mercer and Miller (1997) and Glover et al. (2012) reported that one of the main reasons for the failure of agroforestry development projects in developing nations was lack of attention to the socioeconomic issues during the development of the systems.

The "Theory of Planned Behavior" (TPB) (Ajzen 1991), a popular theory on human behavioral science, which assumes that people behave in accordance to their belief and the beliefs are based on experiences, social or peer influence, and availability of resources. The underlying beliefs of TPB are associated with the social factors that influence the human behavior. Any demographic, social, or economic differences between farmers should, if relevant to the behavior, be reflected in differences in their beliefs (Beedell and Rehman 1999). Ajzen (1991) identified three basic beliefs that influence the outcome of a behavior: behavioral belief, normative belief, and control belief.

Behavioral belief is the belief or concept that the behavior will produce a given outcome (e.g. application of manure will help plants to grow and develop). This in combination with subjective values of expected outcomes determine the attitude towards the behavior. Attitude toward the behavior is the degree to which performance of the behavior is positively or negatively valued. Factors such as education and experience of the farmer built up his behavioral beliefs. Normative belief refers to the perceived behavioral expectations of such important referent individuals or groups (e.g. my father applied manure and my friends apply it, too). It is assumed that these normative beliefs in combination with the person's motivation to comply with the different referents, determine the prevailing subjective norm. Subjective norm is the perceived social pressure to engage or not to engage in a behavior. In this study normative beliefs refer to referent individuals or groups such as ancestors, friends, agricultural extension agents, experts from the farmers' club etc. These factors create the perceived social pressure to engage or not to engage in a behavior, which is basically the subjective norm. Control beliefs have to do with the perceived presence of factors that may facilitate or impede performance of a behavior (e.g. I have household cattle, so I will have supply of manure). It is assumed that these control beliefs, in combination with the perceived power of each control factor determine the prevailing perceived behavioral control. Perceived behavioral control refers to people's perceptions of their ability to perform a given behavior. It is assumed that perceived behavioral control is determined by the total set of accessible control beliefs (i.e., beliefs about the presence of factors that may facilitate or impede performance of the behavior). Control beliefs in this study refer to the financial condition, e.g. availability of funds to perform an action, availability of family labor, cattle and raw materials such as plant residue and manure. These factors influence the perceived behavioral control and facilitate the process of decision -making. Actual behavioral control is similar to the perceived behavioral control refers to the extent to which a person has the skills, resources, and other prerequisites needed to perform a given behavior. Successful performance of the behavior depends not only on a favorable intention but also on a sufficient level of behavioral control. To the extent that perceived behavioral control is accurate, it can serve as a proxy of actual control and can be used for the prediction of behavior.

HGs are such agroforestry systems where profit maximization, in most of the instances, is not the main objective and social factors have strong effects on farmers' decision with the management practices. They are intimate, multistory combinations of various trees and crops, sometimes in association with domestic animals, around the homesteads (Fernandes and Nair 1986, Kumar and Nair 2004, Sahoo et al. 2010). The social importance of HGs is very high (Nair 1993, Kumar 2006) and there are several socioeconomic and demographic factors that influence the farmers' behavior with management decisions. The objective of the study is to understand the effects of socioeconomic and demographic factors on farmers' decisions with HG management practices that influence C storage.

STUDY AREA

This study was conducted in Aizawl district of Mizoram, India. Four villages, *viz*. Durtlang, Sairang, Selesih and Tanhril in the district were chosen based on the availability of HGs covering a total of 40 gardens. Home gardens are the second most widely practiced form of land use after shifting cultivation in Mizoram (Sahoo 2009, Sahoo and Rocky 2015). Thus understanding the importance of the ecological and socioeconomic sustainability values, HGs in these villages offer a good opportunity. A household survey questionnaire was developed, which was the primary data gathering tool, on the effects of socioeconomic and demographic factors related to HG management decision.

METHODS

Homegarden Household Survey and Carbon Stock Inventory

Forty households with HGs were selected randomly for the survey from the four study villages (ten from each village). HG owners are basically farmers of their own garden and would be referred to as "farmers" in rest of the paper. Head of the household/family who may be male or female answered the questions. The question-naire sets included general questions in Likert scale. The Likert scale is a type of response measurement system or scale where respondents specify their level of agreement to a statement (Likert 1932). Owners of randomly selected HG households were asked questions from the questionnaire set and answers were recorded. Each interview lasted for approximately half an hour; a local contact to act as an interpreter accompanied in the survey. Basic information about the HGs such as age and size of HGs, age of the head and number of members in the family, details of management practices such as cultural operations, fertilizer, manure and plant residue application, etc. were recorded. Tree cover (%) in each of the HGs was calculated following standard procedures (Mishra 1968). Carbon storage in biomass and SOC pools of HGs were estimated through non-destructive approaches described under IPCC (2006).

Socioeconomic and Demographic Factors

The socioeconomic and demographic factors that were significant for influencing the farmers' decision with the HG management were identified and selected based on the TPB framework, in relation to HG management practices that are known to influence C storage. The identified factors are listed below.

Traditional/Ancestors (TRAC): This factor designates the effects of traditional knowledge and lessons learned from ancestors.

Friends/Relatives (FRRL): Several management decisions for HG are made by imitating friends, relatives, and neighbors. Farmers learn the consequences of a behavior from their peers and make the decision to carry out the behavior. HG-owners are well connected through social ties and depend on each other for several practices and decisions.

Forest/Agricultural office (FOAO): Local government agricultural offices and their agents play a major role in controlling the trend of agriculture by supplying inputs (e.g. information, seed, bio-pesticide, and so on). Farmers generally visit agricultural offices to resolve their agricultural problems and also to learn about modern technology.

Education/Experience (EDEX): This factor primarily indicates the academic qualification of respondents. Also, education incorporates the respondents' outlook/knowledge of modern agriculture developments, thus making a huge difference in decision making. Education gives the farmers exposure to modern agricultural developments.

Financial Solvency of Farmer (FISF): The financial condition of the farmers affects the management decisions (e.g. buying expensive fertilizer or manure and employing external labor for tillage).

Availability of Family Labor (AVFL): Family members serve as laborers and in general, the more family members in a household, the less need for external laborers.

Type of Plant (TYPL): The availability of plant residues is a determining factor for its application to the HG. The main sources of plant residue are the HGs and public areas. The more available are plant residues, the more likely farmers will apply them to their HG.

Aesthetic values/Ecological Concepts (AVEC): The level of environmental awareness or the ecological concept of the farmers may encourage them to plant more trees.

Categorization of Management Intensity

The selected HG management practices were grouped into categories with varying intensities of application of manure or fertilizer, and the tree density. The categories are:

Plant Residue: Amount of plant residue applied per unit area (kg ha^{-1}). Scale Range: 0-1000 kg ha^{-1} = Low; 1001 -2500 kg ha^{-1} = Medium; and 2501-10000 kg ha^{-1} =High

Manure: Amount of manure applied per unit area (kg ha^{-1}). Scale Range: 0 - 1000 kg ha^{-1} = Low; 1001 - 2500 kg ha^{-1} = Medium; and 2501 - 7500 kg ha^{-1} =High

Fertilizer: Amount of fertilizer applied per unit area (kg ha^{-1}). Scale Range: 0 - 100 kg ha^{-1} = Low; 101 - 250 kg ha^{-1} = Medium; and 251 - 800 kg ha^{-1} =High

Tree: Percentage of trees in the total plant population. Scale Range: 0 - 30 % = Low; 31 - 60% = Medium; and 61 -100% = High

Statistical Analysis

A regression analysis was performed to determine the significance levels of the independent factors. Independent factors were socioeconomic and demographic factors (ancestors, friends, education, availability of objects etc.) and the dependent factor was the intensity of the farm management activity. Statistical tests were performed with software package SPSS (Version 17) and differences were considered significant at p value < 0.05. Figures were prepared using MS EXCEL and SPSS version 17.

RESULTS

Socioeconomic Factors of Home Garden Owners

The basic information about the HGs, HG-owners, management practices and carbon storage are listed in Table 1. The age of the surveyed HGs varied from 12 to 35 years .The age of the HG owner varied from 32 years to 73 years. Tree cover in selected HGs varied from 20 to 85%. Total carbon storage in the homegardens ranged from 100.39 to 242.04 Mg C ha^{-1} with an average of 173.09 Mg C ha^{-1}. The frequency of occurrence of tree species across HGs was rather variable (Figure 1). *Mangifera indica* (38.33 %) and *Parkia timoriana* (35.83 %) were the most frequent trees in HGs. Out of 40 surveyed HG-owners, 100% applied plant residue, 87.5 % applied manure and 80 % applied fertilizer to their HG in last one year. Proportion of rate of application of fertilizers, manure and plant residue are presented in Figure 2.

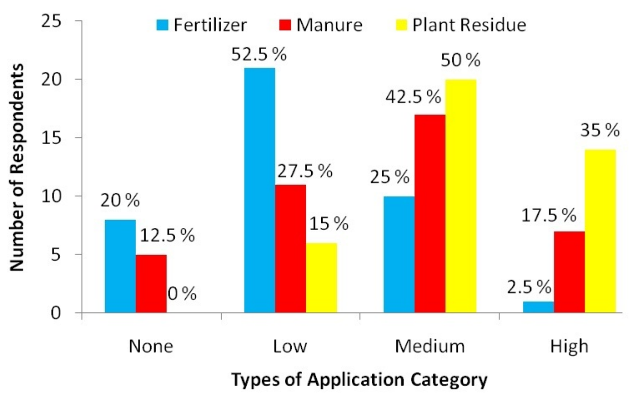

Figure 2. Proportion of farmers (n=40) applying fertilizer, manure and plant residues in home gardens in Aizawl district of Mizoram

Table 1. Basic information about the homegardens (HGs, n=40) surveyed for the study in Aizawl district of Mizoram

Parameters	Mean	Median	Mode	Lowest	Highest
Age of HG (years)	21.78	22	18	12	35
Size of HG (ha)	0.312	0.215	0.16	0.09	0.72
Age of HG owner (years)	53.52	53.5	52	32	73
Size of Family (no. of members)	6.58	7	7	4	9
Annual Fertilizer Application (kg ha^{-1})	93.16	83.33	0	0	271.19
Annual Manure Application (Mg ha^{-1})	1.45	1.58	0	0	2.99
Annual Plant Residue Application (Mg ha^{-1})	2.2	1.94	1.88	0.41	5.42
Tree Cover in HG (%)	52.12	50	50	20	85
Biomass Carbon Stock (Mg C ha^{-1})	99.08	102.33	-	56.24	141.56
SOC Stock (0-40 cm) (Mg C ha^{-1})	74.00	73.76	-	36.26	108.64
Total Carbon Stock (Mg C ha^{-1})	173.09	173.89	-	100.39	242.04

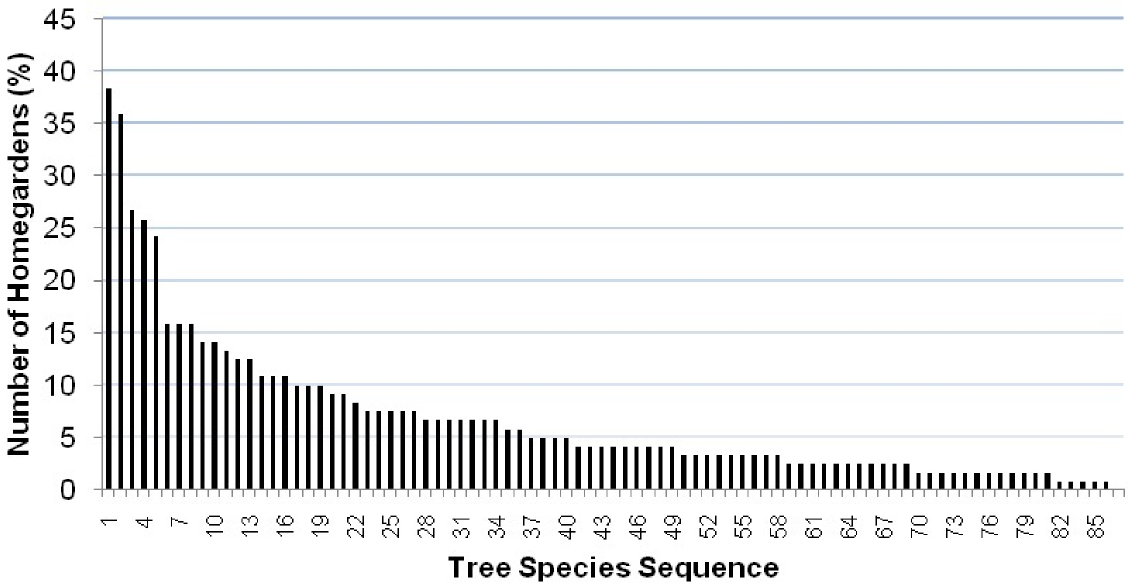

Figure 1.Frequency distribution of tree species in Home gardens (n=40) in Aizawl district of Mizoram

All five of the selected management practices (cultural operations, tree cover, and application of plant residue, manures and fertilizers) were found to be influenced either positively or negatively by the socio-economic and demographic factors (Table 2). Cultural operations was positively influenced by participants' ancestors, friends/relatives, type of plant, availability of family labor, forest/agriculture office, education/ experience and financial solvency of the farmer in decreasing order of importance, while cultural operations were inversely influenced by aesthetic/ecological values of the HGs. Plant residue application and manure application were significantly ($p<0.05$) positively influenced by traditional/ancestors, and friends/relatives respectively.

Overall comparison of social factors indicated that among the selected social factors Traditional/Ancestor had the most influence on the farmers' decision about the HG management practices in general (Figure 3). This was followed by the factor Friends/Relatives and availability of family labor. Education/Experience of farmers and forest/agricultural officers influenced management practices both positively and negatively (in case of fertilizer application). Finally, the Aesthetic/ Ecological values of homegardens and financial solvency

Table 2. Influence of social factors on home garden management decisions in Aizawl district of Mizoram

Management Practices	R^2	Importance level I	II	III	IV	V	VI	VII	VIII
Fertilizer Application	0.9	TYPL (+)* [CB]	AVFL (+)* [CB]	FRRL (+)ns [NB]	TRAC (+)ns [NB]	FISF (+)ns [CB]	EDEX (-)* [BB]	AVEC (-)ns [BB]	FOAO (-)ns [NB]
Manure Application	1	FRRL (+)* [NB]	TRAC (+)* [NB]	TYPL (+)ns [CB]	FOAO (+)ns [NB]	AVEC (+)* [BB]	EDEX (+)ns [CB]	AVFL (+)ns [BB]	FISF (+)ns* [CB]
Plant Residue Application	0.8	TRAC (+)* [NB]	FRRL (+)ns [NB]	EDEX (+)ns [BB]	AVFL (+)* [CB]	AVEC (+)ns [NB]	FOAO (+)ns [BB]	TYPL (+)ns [CB]	FISL (-)ns [CB]
Cultural Operation	0.9	TRAC (+)* [NB]	FRRL (+)* [NB]	TYPL (+)ns [CB]	AVFL (+)ns [CB]	FOAO (+)ns [NB]	EDEX (+)ns [BB]	FISF (+)ns [CB]	AVEC (-)ns [BB]
Tree Cover	0.5	EDEX (+)ns [BB]	TRAC (+)ns [NB]	AVEC (+)ns [BB]	FOAO (+)ns [NB]	FRRL (+)ns [NB]	AVFL (+)* [CB]	TYPL (+)ns [CB]	FISF (-)* [CB]

AVEC = Aesthetic values/Ecological concepts; AVFL = Availability of family labor; EDEX = Education/Experience; FISF = Financial Solvency of farmer; FOAO = Forest/ Agriculture Office; FRRL = Friends/Relatives; TRAC = Traditional/Ancestor; TYPL = Type of Plants; + = Positive effect; - = Negative effect; *ns* = not significant; * = significant (p=0.05); BB = Behavioral belief; CB = Control belief; NB = Normative belief

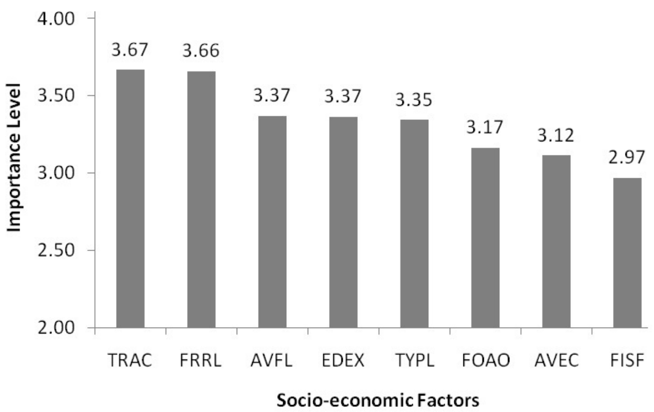

Figure 3. Importance of social factors in home garden management decision in Aizawl district of Mizoram.(AVEC = Aesthetic values/Ecological concepts; AVFL = Availability of family labor; EDEX = Education/Experience; FISF = Financial Solvency of farmer; FOAO = Forest/ Agriculture Office; FRRL = Friends/Relatives; TRAC = Traditional/Ancestor; TYPL = Type of Plants)

Table 3. Pearson's Correlation Coefficient between management practices adopted and carbon storage of HGs in Aizawl district of Mizoram

Management Practices	Biomass C Stock	SOC Stock	Total C Stock
Fertilizer Application	-0.627**	-0.564**	-0.626**
Manure Application	0.278^{ns}	0.321*	0.318*
Plant Residue Application	0.208^{ns}	0.206^{ns}	0.218^{ns}
Cultural Operations	-0.547**	-0.442**	-0.518**
Tree Cover	0.626**	0.600**	0.646**

of farmers resulted in comparatively less effects on the farmers' decision with HG manage-ment practices. Based on management practices adopted and quantities of carbon storage in HGs, the relationship between these parameters is presented in Table 3. Carbon storage is positively influenced by application of manure, plant residues and tree cover, whereas cultural operations and application of fertilizers had significant ($p<0.05$) negative influence.

DISCUSSION

The total carbon stock is the sum of biomass carbon and soil organic carbon. Biomass carbon stocks of HGs estimated in the study are in conformity with results from HGs in Mizoram which reported values ranging from 59 to 140 Mg C ha-1 with an average of 107.6 Mg C ha-1 (Singh and Sahoo 2018). Likewise SOC stock values also vary amongst the HGs studied. This variability of carbon stock amongst the HGs may be because of differences in plant composition, site characteristics, management practices and land holding sizes in different physiographic zones (Saha et al. 2009).

Social factors have significant influence on farmers' decision with all five of the selected HG management practices. The implementation of the Theory of Planned Behavior in the context of socioeconomic and demographic factors on farmer behavior has shown that the differences in beliefs can explain the differences in behavior. Beliefs are developed and influenced by the socioeconomic and demographic factors and thus they influence the process of decision-making. Cultural operations performed in the home gardens of Mizoram are popular traditional practices (Sahoo et al. 2011, Sahoo 2017). This decision on whether to adopt cultural practices (tillage, weeding, spraying, pruning, irrigation and composting) seemed to be influenced by ancestors and friends. These two factors come under normative beliefs and shows how social norms, mentioned in the TPB, influence farmer behavior. As mentioned earlier, tillage is a traditional concept, and the current generation of farmers have observed their ancestors performing this practice for conspicuous reasons such as soil aeration, better root growth and improved plant health Therefore, it is likely that recommendations from the ancestors would have an influence on the farming decisions of today's farmers. On the other hand, if neighbors do practice tillage on their land, the peer pressure would influence the farmer to till his garden. The factors traditional/ancestors and friends/relatives positively influenced the decision of plant residue application. The application of plant residue is a traditional age-old practice in the HGs. Generally, there is no external purchase of plant residues. Thus, irrespective of the economic importance of the HG, farmers apply the residues. In this study, 100% of the surveyed farmers were reported to be performing this practice. However, the amount of plant residues applied varied from home garden to home garden.

Financial solvency of the farmer was observed to negatively influence the decision on plant residue. This could be because of two reasons. First, with more money, farmers can afford to buy more organic manure and the nutritional contribution of plant residue is replaced by more effective manure. Second, rich HG-owners may actually have other sources of employment and the income from the HG may be little or none (Barbhuiya et al. 2016), which would discourage farmers from investing time and labor with activities such as plant residue application. However, this may not mean that the perceived adverse effects stop the rich HG-owners to apply any plant residue. More logical would be just to consider that their affluence inversely influence a part of their decision, because there are several other reasons for applying (or not applying) plant residues.

Manure application is a traditional agricultural practice predominant in the HGs with varying intensities and the results indicated, 12.5% of the farmers in the study villages did not apply any manure to their HGs. Traditionally, manures are produced in the home gardens and the raw materials such as animal litter and leaf litter are obtained from the HG itself. Manure is also procured from friends, neighbors, and relatives, and sometimes purchased from stores. However, most of the farmers, who are not economically well-off or have less economically important HG, prefer to make or collect manures rather than buying it. Therefore, the availability of homemade manure is an important factor influencing farmers' decision with manure application. Application of inorganic fertilizers was directly influenced by the type of plant grown for economic returns. It is reasonable to believe that most of the farmers would make decisions to spend funds for a complete package of fertilizers only if he is expecting economic returns from the HG. In other words, the decision of fertilizer application would depend on the economic importance of the HG. This is in concordance with what Lambin et al. (2001) observed, the agricultural decision made by individuals are often influenced by economic opportunities. Results also indicate that the ancestors have an influence of the farmers' decision with fertilizer application. Application of fertilizer is an old practice and survey information indicates that the majority of the farmers have observed older generations practicing fertilizer application. Farmers have learned and experienced the benefits of fertilizer from their parents and that encouraged them to make a decision in favor of this traditional practice. Therefore, it can reasonably be assumed that ancestors influence the farmers' decision with fertilizer application. The decision to apply fertilizer is inversely associated with the education of the farmer. This means the more education (or exposure to new developments) the farmer has, the more he is likely to apply reduced amount of fertilizer. However, this should not be construed as the more educated farmers necessarily will stop the application of fertilizers. It is more reasonable to say that being aware of the negative effects of fertilizers the farmer might apply it more judiciously and avoid applying fertilizer unnecessarily. Welch (1970) observed that increase in the level of education resulted selecting a more correct quantity of nitrogenous fertilizers.

Trees are an integral part of the HGs and results show that tree cover percentage in selected HGs varied from 20% to as high as 85%. Trees play a major role in sequestering C both in above ground biomass and through belowground root activity (Singh and Sahoo 2015, 2018). Therefore, the decision of planting trees by the owner indirectly affects the total CSP of the HGs. Therefore, the socioeconomic and demographic factors influencing farmer's decisions with planting trees are important in terms of C storage. Results show that the decision to plant trees is influenced the most by the education of the farmers. This in conformity with Pichon (1997) and Geoghegan et al. (2001) who observed that higher education had a negative effect on the levels of cutting trees in South America. The other factor that significantly influenced the decision to plant trees was the availability of family labor and financial solvency of farmers.

Agricultural management practices serve as both sources and sinks for carbon storage. Reports from other studies indicate that cultural operations like tillage have negative effects on soil carbon storage as it disrupts soil aggregates mechanically. Thus, conservation tillage practices (ridge tillage, mulch tillage, no tillage) must be adopted whereby reduced tillage intensity will reestablish the aggregation process as a result of lesser wind and water erosion (Six et al. 2000). Application of plant residue and manure as soil amendments increase the organic matter input (Buyanovsky and Wagner 1998), which upon decomposition gets converted to humus, thus increasing long term SOC pools, especially from the biologically altered manures (Jenkinson 1990). Establishment of perennial vegetation such as increasing tree cover substantially increases carbon storage in both biomass and soil carbon pools (Gebhart et al. 1994, Post and Kwon 2000). Application/availability of fertilizers especially nitrogen determines the formation of stable soil organic matter and also promotes crop biomass. However, considering the GHGs emissions from chemical fertilizers, nitrogen fixing trees (NFTs) and legumes such as alfalfa, peas, lentils, chickpea, etc. should be considered for alternative sources.

CONCLUSION

The present study revealed that the intensity of selected management practices in the HGs varied with different aspects of the Theory of Planned Behavior, such as behavioral belief (e.g. education), normative belief (e.g. ancestors, friends), and control belief (e.g. availability or resources). These beliefs significantly influenced to varying degrees the farmers' decision to implement a variety of HG management practices that impacted carbon storage. More research is required to understand the detailed effects of individual socio-economic and demographic factors on management practices and the Theory of Planned Behavior should be applied to explain the process of decision-making in agriculture in general and HGs in particular.

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