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Segmenting landowners of Shandong, China based on their attitudes towards forest certification

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Abstract: Forest certification is considered a viable market-based policy instrument to promote forest sustainability. It has an important role of play in meeting the objective of modern forestry development in China, which is to sustain ecological and environmental benefits of forests. To understand differences in attitudes, opinions, and interests in forest certification, this study segmented respondents of a landowner's survey in Shandong, China based on their level of interest in participating in forest certification under different program requirements. Multivariate cluster analysis revealed three distinct groups: likely-, potential-, and unlikely-landowners. We further examined the heterogeneity of these groups in terms of their demographics, ownership characteristics, management objectives, and perceived benefits and challenges with adopting forest certification. The results suggested the necessity of differentiating landowners in formulating and designing specific motivation-based incentives and tailor outreach efforts and communication strategies to improve their interests in forest certification. Findings are useful and interesting to forest policymakers interested in promoting forest certification among landowners in China and other countries facing similar circumstances.

Keywords: Forest certification; Market segmentation; Cluster analysis; Motivation schemes

1. Introduction

Forest certification is an accreditation process during which landowners voluntarily seek a third independent party to evaluate their timber management practices based on a range of predetermined standards and then assess whether forests are managed ensuring environmental and socio-economical sustainability [1]. Primarily, forest certification was designed to reduce deforestation and promote management of tropical forests [2,3,4,5], but it has expanded as a tool to achieve sustainable forest management all over the world. China, the county with the 208 million hectares of forest area [6], has a huge potential market for forest certification. In addition, China has a high afforestation rate; for instance, the forest coverage has increased from 12% to about 21% in 30 years (from 1983 to 2013) and the current goal is to reach 23% of the total area by 2020 [7].

In the history of China, urbanization and industrialization caused overharvesting and illegal logging of natural forests for timber, iron, and steel production, which led to the severe decline of biodiversity and degradation of environment [8,9]. For example, over-logging was believed to be one of the primary reasons for the catastrophic floods of 1998 in Yangtze River [10,11], which

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triggered Chinese officials to take actions (e.g., enact policies to sustain forest management) to combat deforestation. Meanwhile, both economic globalization and the growing realization of the importance of forests in improving environmental quality drove the necessity of promoting forest management. Therefore, forest certification as a market-based strategy did receive political and policy support from government officials. Currently, China has three forest certification programs: Forest Stewardship Council (FSC), Programme for the Endorsement of Forest Certification schemes (PEFC), and China Forest Certification Council (CFCC). Those programs envision sustainable forest management practices to respond to economic, environmental and social needs of the landowners.

These forest certification programs, unfortunately, had a low familiarization among landowners; thus, designing motivation mechanism and outreach services to improve their knowledge and interests in forest certification becomes a challenge. Considering the diversity of landowners across the world in terms of their management objectives and demographic attributes [12,13,14,15], one size fits all formula becomes practically impossible to implement anywhere and more so within the convoluted social structure of China. Therefore, segmentation based attitudes towards forest certification is necessary to identify unique clientele of landowners, so as to make outreach services effective.

Recently, a number of literature have been published using segmentation techniques to study landowners in a global scale. Many studies (e.g., [16,17,18,19,20,21,22,23] segmented landowners based on their ownership objectives and yielded different owner groups. For example, Majumdar et al. [22], based on their management objectives, grouped family landowners in the southern United States into multiple-objective, non-timber, and timber landowners. Likewise, numerous studies have also examined the different characteristics of landowners regarding the implementation of forest conservation programs. For example, Surendra et al. [24] classified landowners into four groups according to their information-seeking behavior. The authors found that targeting landowners based on their ownership objectives was useful to stimulate forest management. Likewise, Salmon et al. [25] employed benefit-based audience segmentation technique to identify the education needs for nonindustrial private forest landowners (NIPF). Similarly, Butler et al. [26] segmented landowners into four groups based on their attitudes to a conservation program and implied that segmentation can improve the efficiency of program implementation by developing effective and efficient outreach policies and services to landowners. Herbohn et al. [27] grouped landowners according to their attitudes to farm forestry in eastern Australia and concluded that understanding the constraints for each segmentation was helpful for taking appropriate actions. Hujala et al. [28] grouped landowners into trusting realizers, active learners, and independent managers using their decision-making modes and suggested to differentiate weighted decision support services for each clientele. In short, review of the existing literature suggests that numerous studies have segmented forest landowners in western countries. However, they cannot be generalized to design and develop outreach program in China—a country with the distinct ideological, political, geographical, and socio-economical identity.

Overall, how landowners manage their forests or whether certify their forests to ensure sustainable management practices is an issue of significant public interest. To meet the goals of sustainable forest management and increase the sound forest stewardship, the policy makers need to have a deeper and better understanding of landowners before developing effective outreach, policies, and service programs. Given that landowners have varying perceptions for forest certification and differing levels of interests in its participation, it is critical to understand landowner typologies to develop a well-focused communication program. Therefore, to improve the health and productivity of forests and consequently to meet the sustainable management goal, the main objective of this study is to understand the characteristics of different landowners and to identify outreach approaches that can help motivate passive landowners to participate in forest certification programs. Specifically, the objectives are to: 1) segment landowners based on their interest level in forest certification; 2) understand the demographics, forestland characteristics, and

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ownership characteristics of different landowner groups; 3) obtain the differences among landowner groups concerning their familiarity with forest certification and perceptions for potential benefits and drawbacks of this program; 4) suggest outreach and services to enhance landowners' interest in certification.

2. Methodologies

2.1 Data Collection

The survey was designed after a comprehensive review of the literature regarding landowners' willingness to adopt forest certification and the associated factors that potentially influence their management decisions. We totally developed 27 questions in this survey and they were grouped into: 1) ownership characteristics (e.g., tenure, ownership size etc.); 2) landowners' motivations of owning forestland; 3) landowners' management objectives; 4) landowners' willingness to adopt forest certification under various program requirements; 5) landowners' perceptions for possible benefits and drawbacks correlated with forest certification; 6) socio-demographic (e.g., age, gender etc.). Meanwhile, landowners' interest level in forest certification under various program designs were measured using 5-point Likert scale (1 = very unlikely, 5 = very likely); similarly, their agreement level for perceived benefits and drawbacks of forest certification was also measured using Likert scale (1 = strongly disagree, 5 = strongly agree).

This survey was developed in both English and Mandarin and both of them were approved by the Institutional Review Board at the University of Tennessee, Knoxville in the United States. The survey was administered in different cities (Taian, Jinan, Linyi, Liaocheng, Jining, and Weifang) of Shandong, China in summer of 2016 and the Mandarin version was mainly used in the field. We firstly visited the local forestry officials after getting each city and collected information regarding who has forestland and how could we approach them etc. With the assistance of local officials, we personally approached those randomly selected landowners, who were later requested to fill out the survey. For those who were not familiar at all with forest certification, we offered a brief informative instruction accompanied with the survey. In latter case, landowners were requested to provide their response to the questions that required minimal understanding for forest certification. In total, we approached 557 landowners out of which 50 did not finish all the questions included in the survey. Therefore, we have used 507 completed surveys for the remainder of this analysis.

2.2 Cluster analysis

Market segmentation is a widely used approach in marketing field to separate a heterogeneous population (e.g., landowners) to homogeneous subgroups based on their common/shared characteristics [24]. The intent of market segmentation is to identify subgroups of customers according to a series of demographic and behavior variables and then incorporate this information into outreach and policy development. Multivariate regressions techniques such as cluster analysis have been commonly applied in market segmentation [29,30,31,12]. Among others, $\boldsymbol{k}$-means cluster analysis with Euclidian distance was a widely used algorithm for segmenting audience [29,31]. In principle, the clusters should capture the structure of the data meaning that the objects within same group share the common characteristics, whereas those within different group have different characteristics. Hence, the objective of $\boldsymbol{k}$-means cluster analysis is to minimize within group differences but maximize between group differences [32] (Eq. 1).

$$\boldsymbol{J(V)} = \sum_{i=1}^{c}\sum_{j=1}^{c_i}(\|\boldsymbol{x_i} - \boldsymbol{v_j}\|)^2 \quad (1)$$

where: $(\|\boldsymbol{x_i} - \boldsymbol{v_j}\|)$ is the distance between $\boldsymbol{x_i}$ and $\boldsymbol{v_j}$; $\boldsymbol{c_i}$ is the number of data points in $\boldsymbol{i^{th}}$ cluster; $\boldsymbol{c}$ is the number of cluster centers.

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A ***k***-means cluster analysis was employed in this study to segment the landowners based on their willingness to participate in forest certification under different program designs and conditions. As is typical in any ***k***-means clustering, two, three, and four-cluster segment were tried. The three-cluster solution (Table 1) was chosen as the best fit to the data and yielded the clearest divisions among clusters comparing the results from other solutions. Then, analysis of variance (ANOVA) was used to test for differences in subsequent clusters (0.05-significance level was used for all tests). Objective information included demographics and ownership characteristics as well as their perceptions for perceived benefits and challenges associated with forest certification that further described the clusters/segmented landowners.

3. Results

Among the 507 completed surveys, 71% were male and on average, the tenure was 22 years. Regarding ownership size, 47% of the respondents owned forestland of 10~100 hectares, 25% had greater than 100 hectares, whereas 27% had less than 10 hectares. Approximately 50% of the respondents reported high school education or less being their highest educational attainment. The percentage of landowners with vocational training and college education was equal at 25%. About 34% of the respondents had annual income greater than RMB 50,000, and 50% had income between RMB 20,000 and 50, 000. Almost half (49%) of the respondents were living in rural areas, whereas 47% were in the county communities.

3.1. *Characteristics of landowners group*

The requisite survey data were analyzed using three audience segments resulted from cluster analysis. Respondents in the first group (n = 120) are likely landowners participating in forest certification under all program designs. Respondents in the second cluster (n = 233) were potential landowners and their concerns were certification cost and the requirement of management plan in managing their forestlands. Respondents in the third group (n = 154) were unlikely landowners, whose attitudes to forest certification were lower than neutral under almost all different program designs. We examined the socio-demographics, landowner motivation for owning forestlands, and forestland characteristics of these three subgroups to identify the typological differences. It was anticipated that study results could be tailored with the outreach programs that could help encourage landowners for forest certification as well as to explore other constraints. Our results suggest that landowners in those three subgroups did not differ significantly in terms of their age (Table 2). However, there were some distinctions among segments in terms of gender, education, and income. In addition, significant differences were found for forestland and ownership characteristics and motivations among the audience groups (Table 3, 4).

Likely Landowners: This group scored higher on almost all the different certification parameters than the other two landowner groups. They were the group of environmentally benign landowners with the level of motivation such that even under the condition that the certified timber received the same price and had the same market preference with the timber that was not certified, they would still likely to have their forestland certified. Therefore, we categorized them as likely landowners. The average age of landowners was around 37 years, 76% of them were male—the highest gender disproportion among all three segments. Almost half (47%) of landowners in this group hold bachelor's degree or higher, which was higher than the other two groups. Regarding their annual household income, 44% of landowners had annual income between RMB 50,000 and 75,000, which was higher than the other two groups. Referring to the occupation of the landowners, 11% of them were government employee, which again was higher than other groups (Table 2). This segment had the highest acres (166 hectares) of ownership size and the average tenure was around 25 years. Almost half (46%) of them had a written management plan and they owned a timber oriented poplar forest. With regard to the forestland location, 39% of them were located in the rural/village area and 38% were located in town/county area as well as 23% was nearby/suburb of the

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metropolitan (Table 3). Among the reasons for managing forests, 87% of landowners were for timber production (Table 4) which is significantly higher than the other two groups.

Table 1. Cluster membership for three landowners groups.

Variables	Cluster Membership: Likely landowners (n = 120)	Potential landowners (n = 233)	Unlikely landowners (n = 154)	F and P-value
If certifying organization were:				
Products industry association	4	3	3	F =57.9973 (p<0.001)
Forest landowner association	4	3	3	F = 45.85 (p<0.001)
Pay all of certification cost	3	2	2	F = 67.57 (p < 0.001)
Certification results not available to the public	4	3	2	F = 73.65 (p < 0.001)
Management plan required	4	4	3	F = 63.97 (p < 0.001)
No management plan required	3	2	2	F = 124.01 (p < 0.001)
Required to use professional forester	4	4	2	F = 64.34 (p < 0.001)
Not required to use professional forester	3	2	2	F = 195.37 (p < 0.001)
Required to use trained loggers	4	4	2	F = 65.46 (p < 0.001)
Not required to use trained loggers	4	4	2	F = 164.93 (p < 0.001)
May receive higher price for stumpage	5	4	3	F = 14.00 (p < 0.001)
May receive the same price for stumpage	3	3	2	F = 155.86 (p < 0.001)
Preference for wood in market	5	4	3	F = 14.69 (p < 0.001)
No preference for product in market	3	3	2	F = 136.76 (p < 0.001)

Note: 1 = very Unlikely; 2 = Unlikely; 3 = Unsure; 4 = Likely; 5 = Very Likely.

Potential Landowners: The members in this group were unlikely to have their forestlands certified, if they need to pay all the certification costs. In addition, they were willing to participate only if there was requirement of having a written management plan as well as to use of professional forester. We categorized this subgroup as potential landowners because their participation was contingent upon overcoming previously mentioned constraints. The average age of this group was 40 years, which was relatively higher than other groups (Table 2) and almost half were farmers (45%) (Table 2). Majority landowners in this group had high school/vocational training, whereas only one-third had the university degree. Over half of the respondents (52%) had household income between RMB 20,000 and 50,000 (Table 2). On average, potential landowners owned about 148 hectares of forestland, which was much higher than the third group and slightly smaller than likely group. The average tenure for this group was about 21 years (Table 3). Majority (70%) landowners did not have a management plan and slightly more than one-fifth (22%) of their total forestlands were located

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nearby metropolitan area. Finally, nature protection (73%) and timber production (69%) were the two most important motivations for owning their forestland (Table 4).

Unlikely Landowners: This group scored relatively low (<= 3) on all program requirements, as such we categorized them as unlikely landowners. The average age of the members was 37 years, which was slightly less than the second group of members. However, this group represented more than two-fifth of female landowners—the highest among all three categories. As a group, these landowners had the lowest percentage of educational attainment, which was at statistically significant distance to the first group. Likewise, majority landowners in this group represented lower income class with 73% having household income lower than RMB 50,000. Most of the respondents were farmers (50%) or professional managers (33%) with no representation of foresters/loggers/miners (Table 2). Landowners, on average, owned about 89 hectares of forestlands, which was significantly lower than other two groups and the average tenure of 26 years was also the lowest among groups (Table 3). Less than one-fourth (23%) of the members had a written management plan and 62% of the forestlands were distributed in town/county areas—the highest among groups (Table 3). The most important reason for owing forests was for land investment (84%).

Table 2. Demographics by landowners group.

	Likely landowners	**Potential landowners**	**Unlikely landowners**
Average Age (yr.)	37	40	37
Gender**			
Male (%)	76	75	57
Female (%)	24[a]	25[a]	43[b]
Education**			
High school degree/vocational training (%)	48[a]	54[a]	53[a]
Did not complete high school (%)	5[a]	13[a]	31[b]
Bachelors or higher (%)	47[a]	33[ab]	21[b]
Income**			
Less than RMB 20.000 (%)	8[a]	14[a]	15[a]
RMB 20.000 – 50,000 (%)	39[a]	56[ab]	68[b]
RMB 50.000 – 75,000 (%)	44[a]	21[b]	11[b]
Greater than RMB 75,000 (%)	9[a]	9[a]	6[a]
Forest income (%)	41	38	36
Employment Status*			
Forester/loggers/miner (%)	14[a]	8[a]	0[a]
Professional manager (%)	29[a]	27[a]	32[a]
Government employee (%)	11[a]	5[a]	5[a]
Farmer (%)	26[a]	45[b]	50[b]
Retired/businessman/others (%)	20[a]	15[a]	13[a]

Note: * significant at 5% level; ** Significant at 1% level;
a, b, c means with different subscripts are statistically different.

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Table 3. Forest ownership characteristics by landowners group.

	Likely landowners	Potential landowners	Unlikely landowners
Average Ownership size* (hectares)	166[a]	148[a]	89[b]
Tenure** (yr.)	25[a]	21[ab]	16[a]
Having a management plan** (%)	46[a]	30[b]	23[b]
Poplar forest** (%)	46[a]	30[b]	24[c]
Arborvitae forest (%)	0.04[a]	0.02[a]	0[a]
Forests location			
Rural area/village** (%)	39[a]	39[a]	14[b]
Town/county* (%)	38[a]	39[a]	62[b]
Metropolitan area or suburb area (%)	23[a]	22[a]	24[a]

Note: * significant at 5% level; ** Significant at 1% level;
a, b, c means with different subscripts are statistically different.

Table 4. Ownership motivations by landowners group.

	Likely landowners	Potential landowners	Unlikely landowners
Motivations of owing forests (%)			
Enjoy the scenery**	60[a]	58[a]	32[b]
Protect nature**	80[a]	73[ab]	74[b]
For recreation**	67[a]	53[b]	45[b]
Timber production**	87[a]	69[b]	66[b]
Land investment**	62[a]	68[a]	84[b]
Part of farm**	52[a]	45[a]	65[b]

Note: ** Significant at 1% level;
a, b, c means with different subscripts are statistically different.

3.2 Familiarity with forest certification

Segmented landowners showed statistical different level of familiarity with forest certification (Figure 1). For example, in likely landowners group, only 9% reported not familiar at all with certification program, distinct lower than other two groups (29% in potential landowners group and 30% in unlikely landowners group). On the contrary, the percentage of respondents who were somewhat familiar, or moderately familiar, or extremely familiar with forest certification was as high as 59% in likely landowners, whereas it was 47% in potential landowners and 24% among unlikely landowners. Respondents who said slightly familiar with forest certification was highest in unlikely landowners (46%) while it was 33% and 24% respectively in likely and potential landowners clusters.

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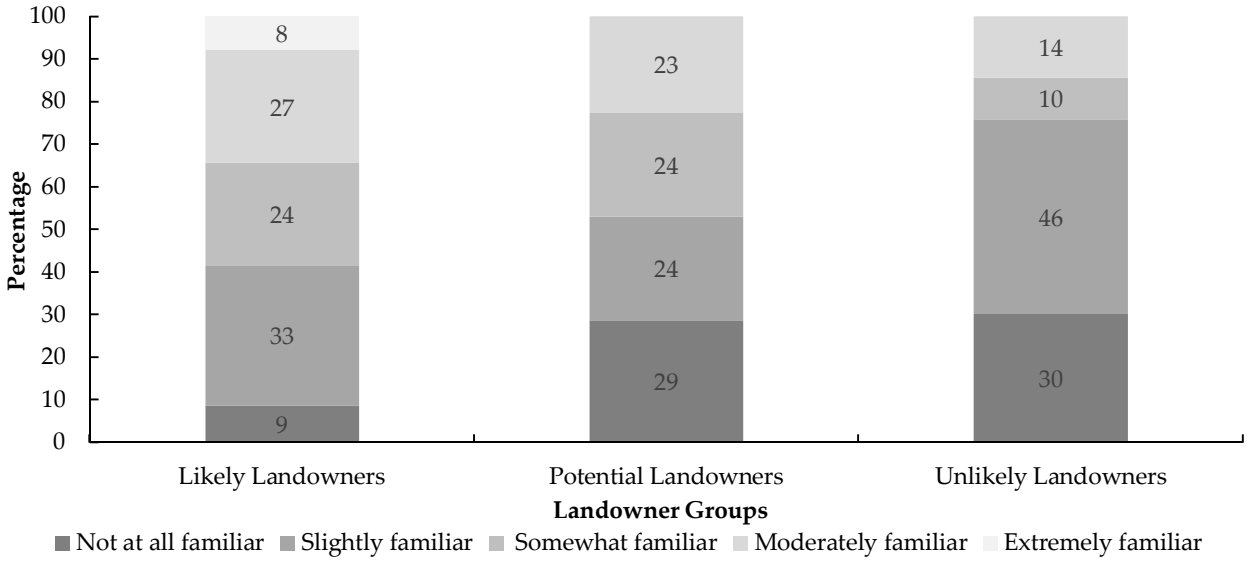

Figure 1. Landowners' familiarity with forest certification before reading the survey

3.3 Perceptions for potential benefits and drawbacks with forest certification

Respondents' perception of possible benefits and drawbacks related with forest certification was summarized in the Figure 2 and 3. The potential benefits of certification composed of improved timber growth and health, expanded markets and price premium for harvested forest products, public recognition for working liable forestry, environmentally-responsibly timber harvesting, and improved management practices. The group of likely landowners rated high value (> 4) for all benefits except for expanded markets for harvested forest products (= 3.9), which was slightly lower than other benefits. The only statistically significant difference between likely landowners and potential landowners was found for their public recognition for practicing good forestry (Figure 2). Comparing potential landowners and unlikely landowners, there was significant difference concerning perceptions with attributes such as: increased timber growth and health, expanded markets for harvested forest products, and price premium for harvested forest products (Figure 2). Comparing the likely and unlikely landowner groups, there was a common perception for better management practices. For other five benefits, a significant difference was revealed.

By contrast, five perceived drawbacks associated with certification program were: increased forest management cost, more recordkeeping and paperwork, increased periodic on-site inspections, required to comply with a forest management plan, and reduced diversity in timber harvesting. Among obstacles, unlikely landowners had a typical concern with the possible drawbacks of increasing management cost and paperwork, on-site inspection, and declined of timber harvesting diversity (Figure 3). In particular, there was significant difference between likely landowners and potential landowners concerning management costs and increased paperwork/record-keeping (Figure 3). Interestingly, we did not find significant difference between potential landowners and unlikely landowners for all five possible drawbacks of forest certification (Figure 3). A comparison among three landowners groups suggested no significant difference for on-site inspection and adherence to management plan— two possible challenges associated with the certification (Figure 3).

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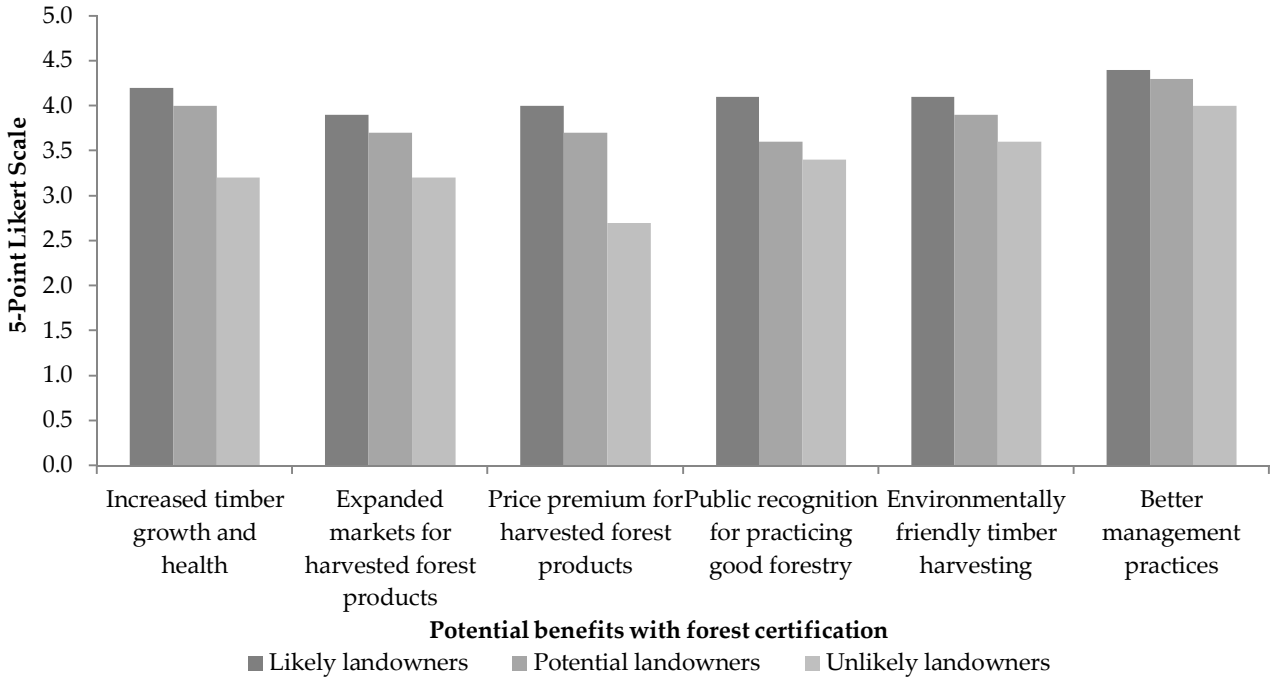

Figure 2. Landowners' perception of potential benefits of forest certification

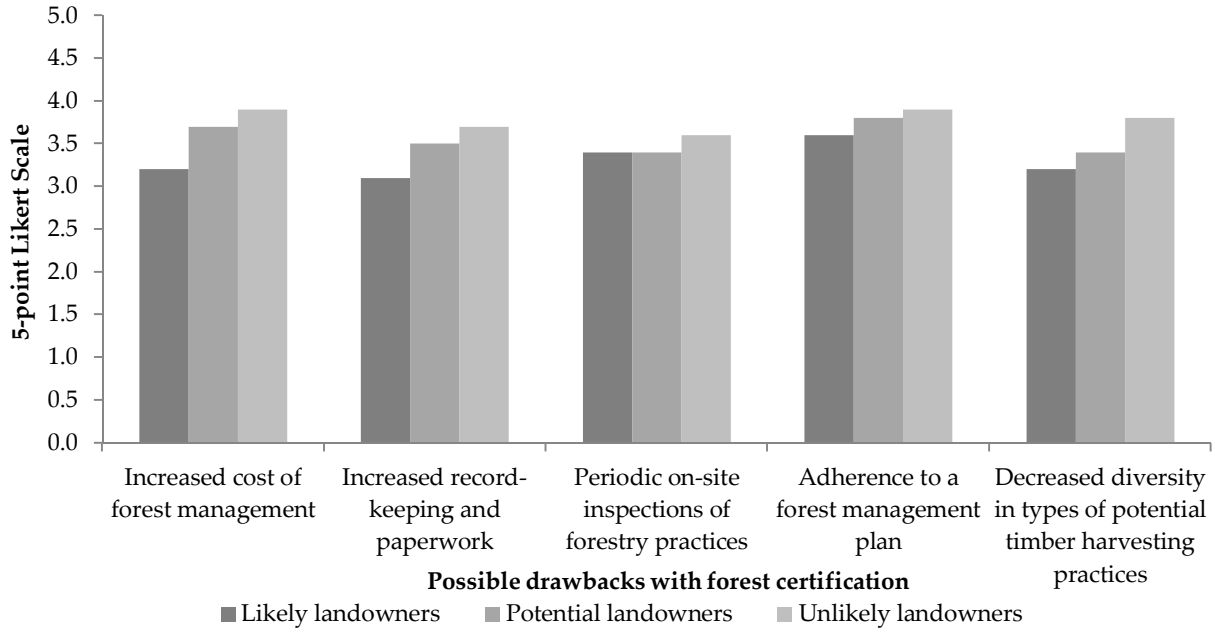

Figure 3. Landowners' perception of potential drawbacks of forest certification

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4. Discussion

The landowners in each of the three clusters have different demographics. There was striking similarity among segments in terms of average age. Percentage of female landowners in the cluster of unlikely landowners was significantly higher than the other two clusters, implying that large percentage of women were unlikely to participate in certification program. These results contrasted to findings by Tindall et al. [33], which revealed significantly higher engagement of female in environmentally friendly behavior (EFB). In addition, significant difference was found for both education and income attributes among the three clusters. Likely landowners' educational attainment and household income level was significantly higher than other two groups. These findings were in line with the results of Ma et al. [34], who found that education was positively related with landowners' willingness to participate in certification program in the United States. Also, our results implied that occupation was correlated with landowners' interest in adopting forest certification as majority in likely landowner cluster were professionals working as a forester, professional manager, or government employee. Previous studies (e.g., [35,36,15] also found that landowner occupation have significant effect on conservation behavior.

Ownership and forestland characteristics also differed significantly among three clusters. Ownership size in the clusters of likely and potential landowners were significantly larger than unlikely landowners, suggesting that small ownership, which may cause higher per unit cost, can be a concern for landowners to certify their forestland. These results were consistent with the previous findings that passive landowners in the southern United States had the lowest acres of landholding than other two groups with active or some interest in wood-based bioenergy [12]. Similarly, our results suggested that landowners with longer tenureship of forestland were more likely to participate in forest certification. In particular, there was a significant difference in tenure between cluster of likely and unlikely landowners. This observation was consistent with Bensel [37] and Tian et al. [15], who found that tenure was a significant factor influencing landowners' willingness to certify their forestland. Among three clusters, there was significant difference in availability of management plan, which was positively correlated with their interests in certification. Our results, however, contrasted with previous findings of Kilgore et al. [38], who reported that landowners' participation in a conservation friendly stewardship program was not correlated with whether or not they had a written plan. Our results implied that landowners owning poplar forests might be relatively more willing to certify their forestland. Of note, poplar forest is a common timber production forests in Shandong, China [39,15]. To this end, our observation was consistent with that from Kilgore et al. [1], who found that likely timber certifiers were interested in timber production forests.

Landowners' familiarity degree with forest certification might have an impact on their participation in this program. Likely landowners were more familiar with certification program than unlikely landowner groups, suggesting that landowners' familiarity with forest certification was positively correlated with rate of participation. This result was in line with Bell et al. [35], Mercker and Hodges [40], and Sun et al. [41], who reported that landowner knowledge on forest certification can positively impact their motivation/willingness to participate.

Landowners' perceptions of benefits and drawbacks related with forest certification showed significant differences among three segmentations. Likely landowners agreed more on increased timber growth, expanded market, and price premium than unlikely landowners, suggesting that those three benefits associated with forest certification might have a positive relationship with landowners' willingness to adopt certification. On the contrary, potential and unlikely landowner clusters agreed more on increased management costs and paper work than likely landowners, which implied that those two possible drawbacks might restrict landowners' willingness to participate in certification.

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5. Conclusions and Management Implications

Findings from this study suggested unique outreach strategies for each market segment. For example, 'likely landowners' represented highly educated and wealthy group with large ownership size and long tenureship, who seemed to be interested in forest certification program. However, considerable percentage in this group do not know the logistic or operational details of certification. Therefore, information on availability of different volunteer certification programs (e.g., FSC, PEFC, and CFCC) and their enrollment criteria might help this group. Similarly, since 'potential landowners' are skeptical of potential costs associated with forest certification, incentive-based programs such as providing subsidy might help this segment. Finally, since 'unlikely landowners' represent landowners in lower household income bracket, government cost-share assistance might be needed for this group. Overall, study results suggested that multifaceted and long-term motivation approaches were needed to encourage more landowners to certify their forestland.

A couple caveats of this research are worth noting. First, while the results in this study provide a guideline for general support of forest certification among diverse landowners, we do not assess whether a landowner will actually choose to participate in forest certification; thus, these results should be interpreted as an indicator of landowner's intentions to participate given those program requirements. Second, the three landowner groups only represented the landowners in Shandong and could not symbolize the landowners in other provinces. Given the land use and socio-economic diversity in China, a broader study might be needed in the future.

Author Contributions: Nana Tian, Omkar Joshi, and Neelam Poudyal prepared the manuscript and analyzed/interpreted data. Nana Tian and Fadian Lu implemented survey.

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