

# Taiwan Public Corporation's Participation in the Mechanism of Payment for Environmental Services

Wan-Yu Liu and Chun-Cheng Lin

## I. INTRODUCTION

**Abstract**—The Taiwan government has started to promote the “Plain Landscape Afforestation and Greening Program” since 2002. A key task of the program was the payment for environmental services (PES), entitled the “Plain Landscape Afforestation Policy” (PLAP), which was certificated by the Executive Yuan on August 31, 2001 and enacted on January 1, 2002. According to the policy, it is estimated that the total area of afforestation will be 25,100 hectares by December 31, 2007. Until the end of 2007, the policy had been enacted for six years in total and the actual area of afforestation was 8,919.18 hectares. Among them, Taiwan Sugar Corporation (TSC) was accounted for 7,960 hectares (with 2,450.83 hectares as public service area) which occupied 86.22% of the total afforestation area; the private farmland promoted by local governments was accounted for 869.18 hectares which occupied 9.75% of the total afforestation area. Based on the above, we observe that most of the afforestation area in this policy is executed by TSC, and the achievement ratio by TSC is better than by others. It implies that the success of the PLAP is seriously related to the execution of TSC. The objective of this study is to analyze the relevant policy planning of TSC's participation in the PLAP, suggest complementary measures, and draw up effective adjustment mechanisms, so as to improve the effectiveness of executing the policy. Our main conclusions and suggestions are summarized as follows: 1. The main reason for TSC's participation in the PLAP is based on their passive cooperation with the central government or company policy. Prior to TSC's participation in the PLAP, their lands were mainly used for growing sugarcane. 2. The main factors of TSC's consideration on the selection of tree species are based on the suitability of land and species. The largest proportion of tree species is allocated to economic forests, and the lack of technical instruction was the main problem during afforestation. Moreover, the method of improving TSC's future development in leisure agriculture and landscape business becomes a key topic. 3. TSC has developed short and long-term plans on participating in the PLAP for the future. However, there is no great willingness or incentive on budgeting for such detailed planning. 4. Most people from TSC interviewed consider the requirements on PLAP unreasonable. Among them, an unreasonable requirement on the number of trees accounted for the greatest proportion; furthermore, most interviewees suggested that the government should continue to provide incentives even after 20 years. 5. Since the government shares the same goals as TSC, there should be sufficient cooperation and communication that support the technical instruction and reduction of afforestation cost, which will also help to improve effectiveness of the policy.

**Keywords**—Payment for environmental services (PES), afforestation subsidy, Taiwan Sugar Corporation

W.-Y. Liu is with Dept. of Ecology and Tourism Management, Aletheia University, Tainan, Taiwan. (Corresponding author; e-mail: nellyliu@gmail.com)

C.-C. Lin is with Dept. of Industrial Engineering and Management, National Chiao Tung University, Hsinchu, Taiwan. (e-mail: cclin321@nctu.edu.tw)

AT the fifth World Forestry Conference, Seattle, USA, 1960, the multiple use of forest was the main topic. At the tenth World Forestry Conference Paris, France, 1991, the encouragement for afforestation on farmland was proposed as the topic with the highest priority. At the Earth Summit 1992 held in Brazil, leaders and representatives from various countries jointly signed the statement of forest principles to encourage afforestation via various incentives, which include economic incentives and financial support to promote public attention on greening and afforestation tasks [4,12]. Since January 1, 2002, the Taiwan government has started to promote the “Plain Landscape Afforestation and Greening Program”, in which the key task is the payment for environmental services (PES), which entitled “Plain Landscape Afforestation Policy” (PLAP). Since the opportunity cost of afforestation in the plain area is greater than afforestation in the slopeland area, the government increased the payments and subsidies of afforestation in the plain area to increase the green area in plain afforestation landscape. If this task is implemented successfully, the demands of green afforestation for various industries may be provided in future. Through adequate planning of green space and active planting in conjunction with industry, culture as well as landscape to develop leisure agriculture, opportunities for farmers and rural areas can also be generated [3]. In order to provide a living environment of better quality for the next generation and build a new green Taiwan, afforestation in the plain area plays an indispensable role and is also one of the key policies for Taiwan's transformation into a developed country.

In order to promote afforestation in the plain area, the government considered the potential productivity of private farmland, opportunity cost of using private farmland, land values, as well as willingness of farmers' participation, and based on the previous experience of implementing afforestation on farmland as well as nationwide afforestation to increase the amount of the subsidy for afforestation in the plain area, for enhancing the incentives of afforestation<sup>1</sup>. The requirements of integrated consideration are under the “Enforcement Guidelines for Afforestation Subsidy” and “Follow-Up Project of Utilization and Adjustment of Paddy and Drought Farmland”.

<sup>1</sup> Regarding the previous payment methods for afforestation on farmland and nationwide afforestation, interested readers are referred to [9]. For relevant papers of afforestation on farmlands, they are referred to [1,2,5,6,7,8,10,11,13,14].

In order to prevent any impact on the overall farming environment from scattered afforestation, the government adopted the long-term set-aside concept towards the planning of afforestation in the plain area. Based on the principle of group afforestation, the government specifies that afforestation should cover 2 hectares in area, or be adjacent to each other more than 5 hectares in the same land section, which is expected to reach a certain scale of afforestation and develop the expected effectiveness.

The PLAP was certificated by the Executive Yuan on August 31, 2001 and enacted on January 1, 2002. By December 31, 2007, it is estimated that the total area of afforestation will be 25,100 hectares. Until the end of 2007, the policy had been enacted for five years in total and the actual area of afforestation was 8,919.18 hectares. Among them, Taiwan Sugar Corporation (TSC) was accounted for 7,960 hectares (with 2,450.83 hectares as public service area) which occupied 86.22% of the total afforestation area; the private farmland promoted by local governments was accounted for 869.18 hectares which occupied 9.75% of the total afforestation area. As far as TSC was concerned, its operational objective respects the policy objective. Therefore, the policy promotion to TSC was successful, and the target achievement ratio of TSC exceeded 100%. Since the government invested tremendous amounts of funds on the PLAP, private farmers are entitled to receive NT\$ 1.61 million per hectare over 20 years, whereas TSC is entitled to receive NT\$ 488 thousand per hectare over 20 years. However, the rate of participation from private farmers was not high, and most of the afforestation area in this policy is executed by TSC. That is, the success of the PLAP is seriously related to the execution of TSC. As a result, it is of interest and urgent importance to investigate how to increase the afforestation achievements and benefit of TSC's participation in the PLAP.

The objective of this study is to analyze the relevant policy planning of TSC's participation in the PLAP, suggest complementary measures, and draw up effective adjustment mechanisms, so as to improve the effectiveness of executing the policy. The method of our analysis mainly applies questionnaire survey to understanding not only the characteristics of TSC's sugar refineries in participating in the PLAP but also TSC's perspectives on PLAP, in order to further provide suggestions of improvement. The study is divided into four sections: an introduction to our study is given in Section 1; Sections 2 and 3 give the result analysis and empirical analysis on TSC's participation in the PLAP, respectively; the conclusions and the policy suggestion are given in Section 4.

## II. MATERIALS AND METHOD

### A. TSC's Status of Land Utilization and Planning

About the promotion for state-owned enterprises, the task of plain landscape afforestation is closely combined with the operation direction of the TSC, and thus the promotion of PLAP in TSC was very successful. As a state-owned enterprise, TSC possesses a land area of about 54,700 hectares, where the land for animal husbandry, railways and houses, as well as

leased exchanged land, non-crop land and uncultivated mountain occupy about 10,000 hectares in total; farmland occupies about 44,700 hectares, in which the area for farming operations is 33,000 hectares and the current area for forest recreation is about 3,621 hectares. Regarding the operating, the main items of TSC's operation include the production of can sugar, the breeding of pigs, and relevant horticultural products. In order to response Taiwan's participation in the World Trade Organization, TSC has operated in coordination with the Green Silicon Island Plan to modify their method of land utilization. Their planning principles include the adequate enhancement of land productivity, and the cooperation with afforestation and greening for the development towards multiple objectives, as well as the combination of leisure industry to develop natural ecology, forest recreation and cultural tourism, for increasing added values of land utilization. Each item of land utilization must be based on the greatest consideration of enhancing operation performance for the TSC. In relation to land utilization, TSC planned three purples at present, i.e. greening and afforestation, the transformation into the land for high economic crops and the development of regions for cheese and hay. Among those purples, greening and afforestation may be combined with PLAP. Most of the land possessed by TSC is planted with sugarcane for manufacturing can sugar, but recently such production has been no longer internationally competitive. In coordination with making large areas of sugarcane fields be set-aside, the company planned to release 20,000 hectares of farmland from 2002 to 2007, to correspond with the PLAP promoted by the government. From the government's view, the response from TSC would enhance the effects of executing the PLAP. To society, TSC's participation in large-scale afforestation could increase national land cover, purify the air and reduce CO<sub>2</sub>, as well as provide a leisure and recreational environment for the public. To the company, since the price of sugarcane is low and partial sugarcane fields have been set-aside, the use of those idle lands for greening and afforestation would generate new opportunities for the company by adequately planning these green plain areas with the development towards leisure agriculture and recreational tourism, as well as implementing enterprise-based management.

### B. Expected Benefit of TSC's Participation in PLAP

The proposal of PLAP submitted by TSC to the Forestry Bureau in 2002 mentioned their overall expected objective and benefit, which include the following: assistance to the government on increasing the area covered by greens and forests on plain areas, implementation of the government's policy on greening plain areas, water conservation, reduction in soil erosion, improvement in living quality, provision of an excellent environment for leisure, recreation and ecological education, coordination in making Taiwan an island of beauty, as well as improving Taiwan's international image on conservation of natural environment. The expected benefit may be divided into the following two categories: the increase of green areas on plain land and the development of the forest's function on public welfare. The benefit of TSC was very similar

to the objectives of the PLAP planned by the Forestry Bureau, and hence, if TSC was capable of bringing the objectives of the policy into effect and thoroughly executing the plain landscape afforestation on a large scale, the overall performance of PLAP would be improved dramatically.

#### *C. TSC's Executive Results*

Until the end of 2005, the area of afforestation by TSC was 7,960 hectares (with 2,450.83 hectares as the area for public service), which accounted for 86.22% of the total area of PLAP, which exceeded the 100% rate for target achievement. The area of afforestation in 2003(3,940.09hectares) was the highest. Although the new afforestation area was reduced progressively from 2003 to 2007, TSC still played an important role in the PLAP generally, and its executive results in afforestation imposed a distinct contribution to the policy. Through the result analysis on TSC's participation in the PLAP mentioned above, questionnaires are adopted in this study to understand TSC's perspective and opinion towards the PLAP. Furthermore, we investigate the modified direction and complementary measures for the PLAP, providing reference to the government in drawing up policies on farmland and afforestation.

#### *D. Research Assumption and Questionnaire Design*

Based on our research objective, we developed the assumptions of questions for questionnaire to design questionnaire items, which included questions on the design of the PLAP and suggestions for future improvement. In addition to an evaluation on the current status of promotion and executive performance, relevant questions on the direction of improving the current mechanism and suggestions for future development were also added into the content of questionnaire in this study, so that it could properly express the problems and demands under the PLAP at present. The analysis on this questionnaire is used for the reference of the suggestions and complementary measures in planning the PLAP.

#### *E. Sampling Method and Sampling Structure*

The objective of this study is to analyze TSC's participation in the PLAP as well as TSC's perspectives on the PLAP, and thus judgment sampling was adopted and representative samples were selected for investigation. The questionnaires of this study were mainly conducted on TSC, inclusive of its headquarters and various sugar refineries. Three questionnaires were distributed to the general manger, vice director of sugar factory department, and main undertaker of plain landscape afforestation from headquarters. There were 10 sugar refineries under TSC participating in the PLAP in 2002, and two questionnaires were distributed to each sugar refinery. Therefore, the number of total samples added up to 23.

The duration of the questionnaires ran from July 2003 to August 2003 with a total distribution of 23 questionnaires. 20 questionnaires were retrieved, and thus there is an effective rate of 86.96%. Among the 20 effective samples in gender aspects, males took the majority percentage of 90%; in terms of age, the 50-59 group took the majority percentage of 57.9%; in terms of education, junior colleges took the majority percentage of 47.37%; in terms of annual income, the 1-1.5 million group

took the majority percentage of 41.18%.

### III. RESULTS

#### *A. Causes of TSC's Participation in PLAP*

TSC had an estimated afforestation of 20,000 hectares within 6 years; thus it is a significant key to the success of the PLAP. In this study, five possible causes were drawn up on TSC's participation in afforestation: (1) Cooperation with the central government's national policy; (2) Cooperation with TSC's company policy; (3) Advantage for the company's long-term transformation; (4) Advantage for increasing short-term revenue; (5) Advantage for increasing long-term revenue of sugar refineries. Among these causes, "Cooperation with central government's national policy" was ranked the highest with a percentage of 90%; "Cooperation with TSC's company policy" was ranked the second highest with a percentage of 80%; "Advantage for company's long-term transformation" was ranked the third highest with a percentage of 75% and the "Advantage for increasing long-term revenue" was ranked the lowest with a percentage of 35%. From the aspect of land selection among the 20 effective samples, the causes of participating in afforestation for majority of sugar refineries were "land being suitable for afforestation" (55%), "land being idle now" (55%) and "low income in growing sugarcane but high income for transformation into afforestation" (35%). The smallest percentage in the causes of afforestation was "low income to lease land to farmers" (10%).

#### *B. Status of Revenue from Land Utilization before TSC's Afforestation*

Based on the investigation of this study among 13 effective samples, the sugar refineries with land used for growing sugarcane before afforestation ranked the highest at a proportion of 64.29%; the ones with land leased to farmers for growing crops ranked second highest at a proportion of 57.14% (annual rents are about NT\$ 35,500 per hectare); the ones with idle land (average idle years are 5.33) or scattered forest land in the past ranked third highest at a proportion of 35.71%; the ones with land for growing crops or the ones originally taking part in afforestation were ranked lower at a proportion of 7.14%. According to the investigation of this study, the average rent for current afforestation land is about NT\$ 48,000 per hectare and the net income is about NT\$ 34,300 per hectare, per year. At present, the government does not give direct subsidies to TSC's afforestation, and thus TSC has continuously requested direct payments to redeem the possible loss after participating in the afforestation. The results shows the subsidies received before TSC's participation in PLAP among 14 effective samples, where it was found that the sugar refineries which did not receive any payments and subsidies are the majority (84.62%). The reason why almost none of the sugar refineries interviewed received subsidies may be due to the fact that the government has always viewed TSC as a state-owned enterprise, and its sugar refineries are always correlated with growing sugarcane.

### *C. Factors of TSC's Consideration upon Selection of Tree Species*

In this study, 9 questions were set for the factors of TSC's consideration upon selection of tree species, which include (1) the tree species recommended by Forestry Bureau directly; (2) the tree species determined by professional personnel in TSC; (3) the tree species recommended by scholars and experts; (4) the tree species suitable to the climate of the place; (5) the tree species suitable to the soil condition; (6) the tree species with high economic value; (7) the tree species with greater survival rate; (8) the easier-grown tree species and (9) the tree species with a more pleasant landscape view. The above questions may be divided into two major categories: factors (1), (2) and (3) were mainly the tree species selected from other people's recommendations. The other questions were mainly the tree species selected according to their own properties or characteristics. According to the investigation of this study, among the 20 effective samples, "the tree species suitable to the climate of the place" ranked the highest at 90% from the factors considered by interviewees. "The tree species suitable to the soil condition" was ranked second highest at 85%; "the tree species with high economic value" and "the tree species with greater survival rate" were ranked third and "the tree species recommended by scholars and experts" ranked lowest at 0%. TSC's headquarters had the highest proportion in "the tree species suitable to the climate of the place", "the tree species suitable to the soil condition", "the tree species with high economic value", "the tree species with greater survival rate", "the tree species determined by professional personnel in TSC" (all 100%). The factors of "the tree species recommended by Forestry Bureau directly" or "the tree species recommended by scholars and experts" received lower proportions. For each sugar refinery of TSC, on the other hand, the factor "the tree species suitable for the climate of the place" ranked the highest at 88.24%; "the tree species suitable for the soil condition" ranked the second highest at 82.35% and "the tree species recommended by scholars and experts" ranked lowest at 0%. Overall, most of the factors for TSC's headquarter and sugar refineries emphasized more on the characteristics or conditional limits of the tree species.

### *D. Plantlet Source for TSC's Participation in PLAP*

For plantlet source in 2002, TSC had the highest plantlet source "provided by Forestry Bureau" at 43.75%; "self purchase" was ranked second highest at 31.25% and "self incubation" ranked the lowest at 25%. For TSC's perspective on the future source of plantlets, most interviewees from TSC wished to obtain the plantlet source by self-incubation, and the proportion of such a wish was 75%. However, the proportion of self-purchase was lowest at 20%.

### *E. TSC's Tree Species Weight for Future Afforestation*

The tree species for future afforestation by TSC are estimated to be divided into three types, namely, economic forest, landscape forest, and the forest for the development of leisure agriculture. Through the investigation of this study, the weight was 52.75% for economic forest, 27.63% for landscape

forest and 14.53% for the forest for the development of leisure agriculture. Apparently, TSC mainly wished to grow economic forest, next the landscape forest, and next the forest for the development of leisure agriculture.

### *F. Problems Experienced during TSC's Previous Afforestation*

For the policy, adequate planning in advance and thorough review afterwards was able to improve the efficiency of executing the policy. As for the problems experienced during afforestation in 2002, this study sets 6 questions, which include: (1) lack of professional instruction on planting techniques; (2) insect and disease problems; (3) low plantlet survival rate during planting process; (4) too few payments and subsidies for new afforestation; (5) insufficient labors so that impossibility of detailed care; (6) impact on plantlet survival rate due to Forestry Bureau's remote plantlet-transporting distance or inadequate handling. Through the investigation of this study, about the problems experienced during TSC's afforestation in 2002, the "lack of professional instruction on planting techniques", "insect and disease problems" and "impact on plantlet survival rate due to Forestry Bureau's remote plantlet-transporting distance or inadequate handling" occupied the highest proportions (at 65%, respectively), which was followed by "too few payments and subsidies for new afforestation" at 60%. For the problems experienced during afforestation in 2003, the "insect and disease problems" was ranked highest at 65%; "lack of professional instruction on planting techniques" ranked the second highest at 55% and "too few payments and subsidies for new afforestation" came in third highest at 45%. Overall, there was no large difference between the problems experienced in 2003 and 2002. Most interviewees considered that a "lack of professional instruction on planting techniques", "insect and disease problems" and "too few payments and subsidies for new afforestation" were the three major problems. Since the proportions of 2003 were lower than 2002, it was indicated that various problems had been solved continually.

### *G. Status of TSC's Planning on Afforestation*

TSC did carry out relevant preliminary afforestation planning in 2002 (95%). Since the land area for TSC's afforestation was larger and the company's operational objective was close to that of the policy, preliminary planning was necessary. For the sugar refineries that did not plan accordingly, further investigation was carried out in the study, and the possible causes included (1) insufficient funds for planning; (2) tight timeframe; (3) no need for planning. According to the investigation in the study, TSC's headquarter considered that the "tight timeframe" was the main cause of insufficient planning (100%) and each sugar refinery considered that "insufficient funds for planning" was the main reason (100%).

### *H. Did TSC Have a Long-term Plan?*

Regarding the long-term plan for plain landscape afforestation, since the scale of TSC's afforestation was large, and the operational objective of TSC complied with that of the

PLAP, thus in theory, there should have been a long-term afforestation plan. According to our investigation, 80% of TSC's headquarters and sugar refineries expressed that there was a long-term plan for plain landscape afforestation.

#### *I. Was There Self-willingness of Budgeting?*

It was necessary to adequately budget for the long-term afforestation plan in advance. Nevertheless, was TSC willing to budget for the long-term afforestation plan? According to the investigation in the study, headquarters was not willing to budget, and only 26.67% of the sugar refineries were willing to budget for the long-term afforestation plan. Apparently, all TSC personnel understood the significance of afforestation planning, but were not willing to budget for the afforestation planning. In view of this, the funds of the planning and research for afforestation may be budgeted by the central government, so that the policy can be executed easily.

#### *J. Was There Frequent Contact and Assistance from Forestry Bureau and Forest District Office to TSC?*

According to the investigation in this study, 33.33% of the personnel in TSC's headquarter considered that there was "very close contact" between the Forestry Bureau and TSC, and 66.67% of the interviewees considered that there was "frequent contact". For TSC's sugar refineries, 56.25% of the interviewees considered that there was "casual contact" between Forestry Bureau and TSC, which was followed by "frequent contact" at 31.25% and "very close contact" at 12.5%. Regarding the status of contact with the Forest District Office, among the 20 effective samples under TSC's headquarters, 100% of the interviewees considered that there was "very close contact" between the Forest District Office and TSC. For the sugar refineries, the proportion of "very close contact" was the highest rate at 35.29%, which was followed by "frequent contact" at 29.41% and "casual contact" at 23.53%. Basically, there was a smooth channel of contact and communication between TSC and Forest District Office, as well as Forestry Bureau.

#### *K. Were the Amount of the Subsidized Tree Species Sufficient?*

The Forestry Bureau specified a total of 40 tree species for landscape and the use of timbers among the tree species subsidized for the plain landscape afforestation. Through the investigation in this study, the proportion of agreeing with the amount of tree species was 37.5% for TSC's sugar refineries and 0% for headquarters, respectively. Basically, over half of the interviewees considered that the amount of subsidized tree species were insufficient.

#### *L. Were the Relevant Requirements of PLAP Reasonable?*

The relevant requirements of PLAP covered the requirements for tree species, number of trees, survival rate, number of checking, afforestation location, afforestation area, and so on. Most interviewees from TSC (72.22%) considered that the relevant requirements on plain afforestation were not entirely reasonable. For TSC, the proportion of interviewees considering the requirements on number of trees as the most

unreasonable was 69.23%, which was followed by the requirements on tree species as the second most unreasonable at 61.54%, the requirements on survival rate as the third most unreasonable at 46.15% and the requirements on number of checking as least reasonable at 0%. From the above description, since TSC has a large area of land, it was not limited by the requirements on afforestation area and location, but it cared about the requirements on tree species and number of trees.

#### *M. Was the Current Subsidy Mechanism Reasonable?*

Most of the interviewees from TSC considered that the current subsidy mechanism was not reasonable. The suggested amount for current subsidies was NT\$ 116,000 per hectare as "subsidy of new plant in year 1", NT\$ 62,900 per hectare as "subsidy of incubation in year 2-6", NT\$ 49,100 per hectare as "subsidy of management in year 7-20" and NT\$ 28,500 per hectare as "Amount of direct payment annually", which were clearly much higher than the actual subsidy amount received.

#### *N. Should the Government Continue to Provide Payments after 20 Years?*

The current subsidy limit for afforestation is 20 years, and the government will not provide any subsidies or direct payments after 20 years, in principle. However, in order to reduce forest growers' incentives of harvesting mature forest, the government considered to continue the payments for landscape and economic forests with subsidies expiring after 20 years. According to the investigation in the study, the proportion of considering that payments should be continued was 80%.

#### *O. Will TSC Increase the Weight of Landscape Forests if There are Subsidies after 20 Years?*

The current subsidy limit for afforestation is 20 years, and the government will not provide any subsidies or direct payments after 20 years, in principle. However, in order to prevent forest growers from harvesting mature forest, the government considered to continue the payments after 20 years. Therefore, this study investigated the incentives of whether TSC increases the weight of landscape forest if the government continues subsidies after 20 years. TSC's headquarters had 3 interviewees, and all of them considered that the weight of landscape forest would not increase. For the sugar refineries, 84.62% of interviewees considered that weight of landscape forest would increase. Since the investigation results from the two categories were different, it was worth further investigating the cause.

## IV. CONCLUSIONS

The "Plain Landscape Afforestation Policy" (PLAP) was certificated by the Executive Yuan on August 31, 2001, and executed from January 1, 2002 to December 31, 2007 with an estimated executing area of 25,100 hectares. Until the end of 2007, the policy had been enacted for 6 years in total and the actual area of afforestation was 8,919.18 hectares. Among them, Taiwan Sugar Corporation (TSC) was accounted for 7,960 hectares (with 2,450.83 hectares as public service area). In view of this, the success of TSC's afforestation was the key

to the overall performance of the PLAP. In this study, the background and achievements of TSC's participation in the PLAP were analyzed first. Further, a questionnaire was adopted to understand TSC's perspectives and opinions towards the PLAP. Further discussion was made on the modified direction and complementary measures for the PLAP, which provided a reference to the government on drawing up the policies on farmland and afforestation. The main conclusions and suggestions are stated as follows:

*A. The main reason for TSC's participation in the PLAP is based on their passive cooperation with the central government or Company Policy. Prior to TSC's Participation in the PLAP, Their Lands Were Mainly Used for Growing Sugarcane.*

From the results of investigating the cause of participation in the PLAP, "cooperation with central government's national policy" and "cooperation with TSC's company policy" were the factors of highest proportion for TSC's reason for participating in the afforestation. In terms of land selection, "land being suitable for afforestation" (55%), "land being idle now" (55%) and "low income in growing sugarcane but high income for transformation into afforestation" (35%) were the reasons for a majority of the sugar refineries' participating in afforestation. For the types of land for participating in the plain landscape afforestation, the sugar refineries with land used for growing sugarcane before afforestation were ranked the highest at proportion of 64.29%; the ones with land leased to others for growing crops were ranked second highest at proportion of 57.14% (annual rents are about NT\$ 35,500 per hectare); the ones with idle land (average idle years are 5.33) or scattered forest land in the past were ranked third highest at proportion of 35.71%. However, the sugar refineries with land for growing crops or the ones originally taking part in afforestation were ranked lower at a proportion of 7.14%.

*B. The main factors of TSC's consideration on the selection of tree species are based on the suitability of land and species. The largest proportion of tree species is allocated to economic forests, and the lack of technical instruction was the main problem during afforestation. Moreover, the method of improving TSC's future development in leisure agriculture and landscape business becomes a key topic.*

For factors of TSC's consideration upon selection of tree species, according to our investigation, the factor "the tree species suitable to the climate of the place" was ranked highest at 90% from the factors considered by interviewees. In the future, the tree species for afforestation by TSC are estimated to be divided into three types, namely, economic forest, landscape forest, and the forest for the development of leisure agriculture, where the weight is 52.75% for economic forest, 27.63% for landscape forest and 14.53% for the forest for the development of leisure agriculture. Apparently, the tree species that TSC wishes to grow were mainly based on economic forest, which was followed by landscape forest, and next the forest for the development of leisure agriculture. In addition, all the three interviewees in TSC's headquarters considered that the weight of the landscape forest would not increase. For the sugar refineries, 84.62% of interviewees considered that weight of

the landscape forest would increase. Since the investigation results from the two categories were different, it was worth further investigating the cause.

During afforestation, there was no large difference between the problems experienced in 2003 and 2002. Most interviewees considered that "lack of professional instruction on planting techniques", "insect and disease problems" and "too few payments and subsidies for new afforestation" were the three major problems. Since the proportions of 2003 were lower than 2002, it was indicated that various problems had been solved continually.

*C. TSC has developed short and long-term plans on participating in the PLAP for the future. However, there is no great willingness or incentive on budgeting for such detailed planning.*

Regarding long-term plans for plain landscape afforestation, since the scale of TSC's afforestation was large and the company's operational objective complied with that of the PLAP, there should have been a long-term and thorough plan on afforestation, in theory. According to our investigation, 80% of TSC's headquarters and sugar refineries expressed that there was a long-term plan for plain landscape afforestation. Based on our further investigation, TSC's headquarters was not willing to budget, but only 26.67% of sugar refineries were willing to budget for the long-term afforestation plan. Apparently, all TSC personnel understood the significance of afforestation planning but were not willing to budget for the afforestation planning. In view of this, the funds of the planning and research for afforestation may be budgeted by the central government, so that the policy can be executed easily.

*D. Most people from TSC interviewed consider the requirements on PLAP unreasonable. Among them, an unreasonable requirement on the number of trees accounted for the greatest proportion; furthermore, most interviewees suggested that the government should continue to provide incentives even after 20 years.*

Most of the interviewees from TSC (72.22%) considered that the relevant requirements on plain afforestation were not entirely reasonable. For TSC, the proportion of interviewees considering the requirements on number of trees as the most unreasonable was 69.23%, which was followed by the requirements on tree species as the second most unreasonable at 61.54%, the requirements on survival rate as the third most unreasonable at 46.15%. The current subsidy limit for afforestation is 20 years, and the government will not provide any subsidies or direct payments after 20 years, in principle. However, in order to reduce forest growers' incentives of harvesting mature forest, the government considered to continue the payments for landscape and economic forests with subsidies expiring after 20 years. According to the investigation in the study, the proportion of considering that payments should be continued was 80%.

*E. Since the government shares the same goals as TSC, there should be sufficient cooperation and communication that support the technical instruction and reduction of afforestation cost, which will also help to improve effectiveness of the policy.*

For TSC, their area of afforestation for the PLAP was larger with more complete patches and it was capable of applying mechanical automation and reaching greater economic scale, so that their afforestation cost should be lower than other private afforestation, generally. TSC and the Forestry Bureau should jointly investigate the method of improving the efficiency of afforestation and forest tending, and applying lower afforestation cost to increasing the afforestation benefit. Each sugar refinery of TSC should provide adequate planning for plain afforestation, including a 6-year program, selection of afforestation land and location, determination of afforestation objectives, selection of afforestation species, improvement of afforestation technique, and improvement of afforestation efficiency. If TSC can enhance the planning function of plain afforestation and neutralize the interests of private departments in TSC with the public benefit generated from afforestation, and combine TSC's operational objective with plain afforestation policy, better policy effectiveness will be achieved.

#### REFERENCES

- [1] W. T. Chen, "Evaluating affects of plain afforestation policy on environment," *Taiwan Forestry Journal*, vol. 29, no. 4, pp. 31–40, 2003.
- [2] A. H. Chen, Y. L. Hsiao, C. L. Li, and H. M. Ho, "Current executing status and problem analysis of plain landscape afforestation in 2002," in *Proceedings of the Workshop of Current Status and Perspective of afforestation in Taiwan*, National Taiwan University, Taipei, Taiwan, Nov. 21, 2002.
- [3] Forestry Bureau, *Reference Manual on Promoting the Strategies of Afforestation in the Plain Areas*, Forestry Bureau, Council of Agriculture, Executive Yuan, Taiwan, 2002.
- [4] O. Hendrickson, "Influences of global change on carbon sequestration by agricultural and forest soils," *Environmental Reviews*, vol. 11, no. 3, pp. 161–192, 2003.
- [5] Y. H. Huang, *General Status on the Promotion of Projects for Rewarding Afforestation on Farmland*, Forestry Bureau, Council of Agriculture, Executive Yuan, Taiwan, 1991.
- [6] Y. H. Huang, "Deliberating the problems of afforestation on farmland, Modern Silviculture," vol. 12, no. 1, pp. 9–14, 1992.
- [7] Y. H. Huang, "Greening and afforestation in the plain and coast areas," *Taiwan Forestry Journal*, vol. 27, no. 2, pp. 3–6, 2001.
- [8] K. C. Lin, *Evaluation of Taiwan Sugar Corporation's Benefit from Plain Landscape*, Authorized Project Series of Forestry Bureau, Council of Agriculture, Executive Yuan. Report number: 95-00-5-13, 2006.
- [9] K. C. Lin and Y. N. Wang, *Evaluation and Analysis of Growing Forest for Plain Landscape Afforestation Policy*, 2003 Authorized Research Projects of Forestry Bureau and Its Affiliations, Council of Agriculture, Executive Yuan. Report number: 92-00-5-10. Graduate Institute of Agricultural Economics, National Taiwan University, 2003.
- [10] K. C. Lin and W. Y. Liu, "An Evaluation and Assessment of Reforestation Policy in Taiwan," *Agriculture and Economics*, vol. 38, pp. 31–65, 2007.
- [11] K. C. Lin and W. Y. Liu, "An Empirical Study of Afforestation Policy in Taiwan," *Socioeconomic Law and Institution Review*, vol. 40, pp. 175–211, 2007.
- [12] W. Y. Liu, *A Study on the Optimal Subsidy of Afforestation*. Master Thesis, Graduate Institute of Agricultural Economics, National Taiwan University, Taipei, Taiwan, 2004.
- [13] W. Y. Liu, *The Economics Analysis of Landowners' Participation in Carbon Sequestration Programs and Mechanisms*. Dissertation. Graduate Institute of Agricultural Economics, National Taiwan University, Taiwan, 2008.
- [14] T. M. Yen, J. S. Lee, and J. Y. Yang, "Some problems about the policy of afforestation award," *Quarterly Journal of Forest Research*, vol. 24, no. 2, pp. 1–12, 2002.

**Wan-Yu Liu** was born in Chiayi City (the fifth largest city in Taiwan) on October 19, 1979, and grew up there until 1998. She received her B.B.A. degree in Finance from National Chengchi University (NCCU), Taipei, Taiwan, in 2002; M.S. degree in Agricultural Economics and Ph.D. degree in Agricultural Economics from National Taiwan University (NTU), Taipei, Taiwan, in 2004 and 2008, respectively. Since August 2008, she has been an assistant professor of the Department of Ecology and Tourism Management at Aletheia University (AU), in Tainan. Her main research interests include environmental and resource economics analysis, applied econometrics, evaluation of GHG reduction policies, as well as forest economics.

**Chun-Cheng Lin** received his B.S. degree in Mathematics, M.B.A. degree in Business Administration, and Ph.D. degree in Electrical Engineering from National Taiwan University, Taipei, Taiwan, in 2000, 2007, and 2009, respectively. Since February 2011, he has been an Assistant Professor of the Department of Industrial Engineering and Management at National Chiao Tung University, in Hsinchu. He was an Assistant Professor of Taipei Municipal University of Education (from 2010 to 2011) and National Kaohsiung University of Applied Sciences (2009 to 2010). His main research interests include graph drawing and information visualization, computer graphics and multimedia, communications and networking, design and analysis of algorithms, as well as computational management science.