



Vietnamese Academy of Forest Sciences

Silviculture Research Institute

**Assessment Report on  
Success Rate of the 5 Million Hectare Reforestation Program**

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Ha Noi, July 2016

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## Abbreviations

CH	Central Highland
FREL/FRLs	Forest Reference Emission Level/Forest Reference Level
FAO	The Food and Agriculture Organization of the United Nations
LOA	Letter of Agreement
NFIS	National Forest Inventory and Statistics
NE	Northeast
NCC	North Central Coast
SRI	Silviculture Research Institute
SCC	South Central Coast
REDD+	Reducing Emission from Deforestation, forest Degradation, forest carbon conservation and enhancement and sustainable management of forests
VAFS	Vietnamese Academy for Forest Sciences

## Executive summary

This report aims to describe the methods and the estimation of the success rate of plantation and assisted regeneration activities implemented under the 5 millions hectare reforestation program (commonly known as 661 program) implemented for 1998-2010 per different stratification criteria. Under this study, the Silviculture Research Institute of the Vietnamese Academy of Forest Sciences, sampled 11,013 plots of plantation and assisted regeneration activity implemented under the Program 661, corresponding to a total area of 71,568.86 ha, in five provinces. All the plots were then visually interpreted based on Google Earth through images available as of June 2016 and cross-checked with Landsat8 images.

The results of the visual interpretation and data analyses show that the overall success rate of plantation and assisted regeneration activities under Program 661 for the five provinces is 87.62%, but variations are observed among provinces, among the three forest functional types (i.e. production, protection, and special use) and by forest owners, but no significant differences were observed among different forest interventions (plantation and assisted regeneration).

By province, the lowest success rate is 60.4% for Kon Tum province (where access to market is relatively limited) and the highest success rate is 93.3% for Binh Dinh province.

By the three categories of forest functions, the highest success rate is for the production forests (over 90%), and the lowest success rate is of 64.7% for special use forest (sampled only in Yen Bai province).

When compared across provinces within the category of protection forests, the lowest success is 60% found in Kon Tum province.

The assessment results suggest that the success rate of plantation and assisted regeneration activity tends to be lower in areas/regions where there is low access to market and under high pressure of conversion of plantation to agriculture land. It is recommended that the overall success rate of 87.62% may be applied for the whole country, with the exception of provinces Dien Bien, Son La, and Lai Chau where access to market is extremely difficult and under high pressure of conversion of plantation to agriculture land. Separate rates can be applied to plantations and assisted regeneration, however the differences are small.

## 1. Background

As part of Viet Nam's efforts to submit and improve its Forest Reference Emission Level / Forest Reference Level (FREL/FRL) the Government of Viet Nam decided, as recommended by experts within the FRL working group that a review of the success rate of the national Program No. 661 (1998-2010) should be conducted. As Viet Nam FREL/FRL proposes an adjustment of the carbon removed due to Program 661, its success rate should be estimated based on the verification of the areas planted or regenerated rather than on expert judgement – which, assumed a 75% success rate as was included in the initial FREL/FRL submission of Viet Nam in January 2016.

At the request and agreement of the Government of Viet Nam, under the UN-REDD Viet Nam Phase II Programme, the Food and Agriculture Organization of the United Nations (FAO) commissioned the Silviculture Research Institute (SRI) under the Viet Nam Academy of Forest Sciences to undertake an estimation of an overall success rate of Program 661. The objective was to estimate the Program 661 success rate based on the visual interpretation of the presence and/or absence of forest after 2010 on Program 661 implemented areas.

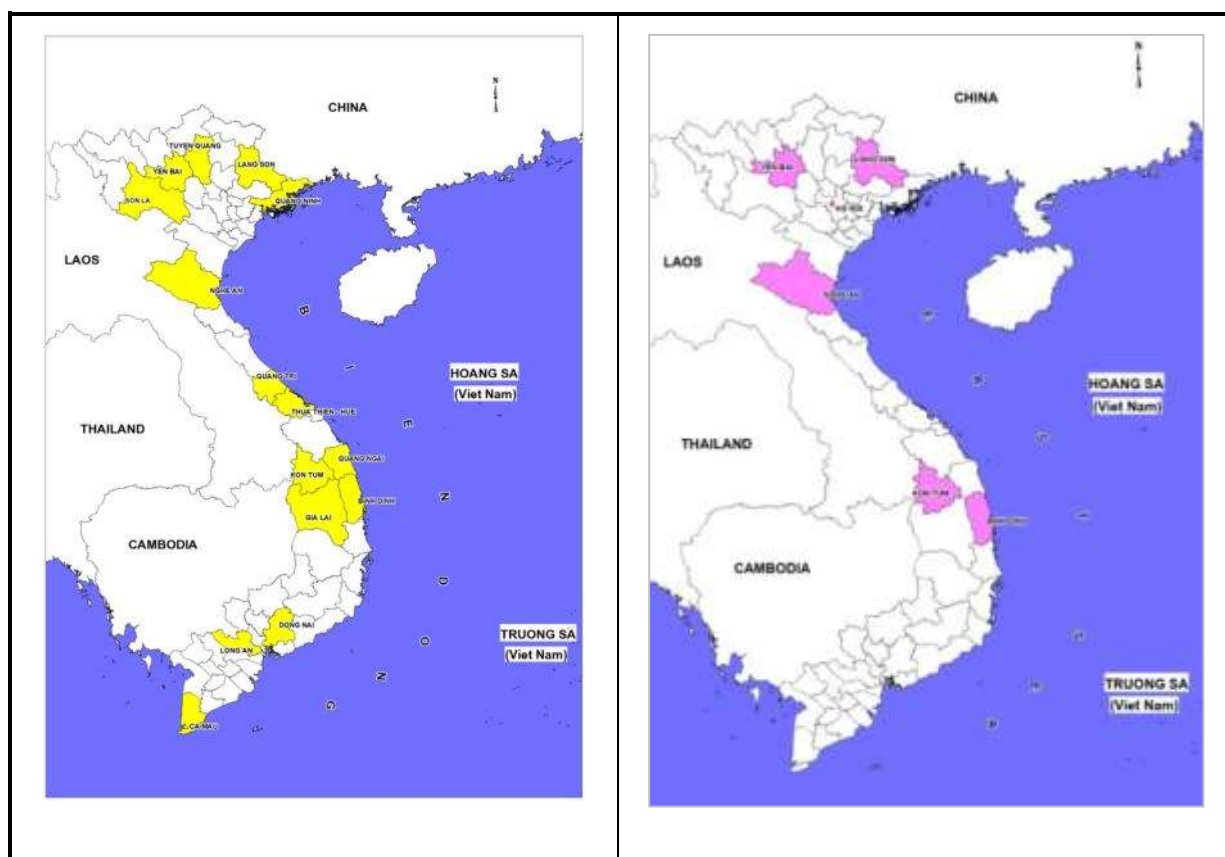
This report aims to describe the methods and results of Program 661 successful implementation rate for plantation and assisted regeneration. The third activity implemented under the Programme was supporting plantations of industrial crops and fruits (941,464 ha implemented) and is not included in this study. The report also details the methodology and equipment used for digitizing the maps and detecting the presence/absence of forests used as criteria for determining Program 661 success.

## 2. Method

### 2.1. Sample selection

The selection of provinces for the estimation of an overall success rate included two steps. First, 15 provinces where Program 661 was implemented were identified, based on the biggest areas of forest plantations and assisted regeneration under the Program 661, taking into account representativeness of the agro-ecological zones in Viet Nam, and selecting provinces with different level of access to timber markets (roads, industrial harbors, big cities). The 15 provinces selected were Son La, Yen Bai, Tuyen Quang, Lang Son, Quang Ninh, Nghe An, Quang Tri, Thu Thien Hue, Quang Ngai, Binh Dinh, Kon Tum, Gia Lai, Dong Nai, Long An and Ca Mau (Figure 1, left).

Figure 1: Map of initial 15 provinces (left) and final five provinces selected (right)



Then, five provinces were selected based on the results of the consultations with the provincial forestry officers on their data availability (digital and/or hardcopy files of Program 661 implementation maps). The five provinces are Yen Bai, Lang Son, Nghe An, Binh Dinh and Kon Tum (Figure 1, right and Table 1).

Table 1. Area (in ha) of plantations and assisted regeneration for the five provinces selected

Province	Assisted Regeneration	Total plantation	plantation for sustainable use and protection	Plantation for production	Total plantation + assisted regeneration	Location
Lạng Sơn	43 005.2	135 867.7	39 109.0	96 758.7	178 872.9	NE
Nghệ An	52 677.0	108 463.0	31 831.0	76 632.0	161 140.0	NCC
Yên Bái	15 100.0	137 683.0	32 309.0	105 374.0	152 783.0	NE
Bình Định	40 306.0	56 448.1	12 985.7	43 462.4	96 754.1	SCC
Kon Tum	3 450.2	47 510.0	10 583.0	36 927.0	50 960.2	CH

## **2.2. Materials and methods**

### ***2.2.1. Materials***

The activities under Programme No. 661 were recorded in paper documents, which contain for each owner of a forest plot a map of the plot boundaries together with the topography and administrative boundaries (forest owner information, plot number, compartment number, and block number). The documents also contain the information of planted species, planted year, area of plots, and forest function. They were archived at the provincial Department of Forestry offices of the five provinces. To help digitizing the center of each forest plots, digital maps (GIS files) of three forest functional categories/types, administrative boundaries, topography road and rivers were also collected at the provincial level. The most recent forest status maps of the five provinces were also collected for cross-checking. Google Earth images containing the plot center points were accessed online. A number of Land-sat 8 scenes were downloaded for cross-checks.

### ***2.2.2. Methods***

#### ***Collection of plantation and assisted regeneration design dossiers***

The maps of 661 implemented plot boundaries were collected randomly for at least 10% of the total area of plantations and assisted regeneration for the five targeted provinces. The maps were attached to each document prepared by forest owners to describe the plantation or assisted regeneration activity implemented with 661 Programme funds.

#### ***Locating plot central points and developing central point database***

All center points of the plots were located on topographic maps with VN 2000 projection, with the scale of 1:10,000 on MapInfo. Because there were no coordinate grids on the maps, all center points of plots were located based on plots information and the map information by matching information and features/objects on the maps of plots and GIS based maps. The information and features/objects of the maps of plots (paper maps) and GIS/MapInfo maps that were matched included compartment numbers, block numbers, names of commune/village, and representation of relief/contour lines, rivers, roads, etc. Each center point was then entered in a MapInfo based database, with fields of ID, compartment number, block number, plot number, area of plot, planted species, forest owner, interventions, forest functional types, interpreted status of land-use/forests, successful/un-successful, provinces and districts. All the VN 2000 coordinates of the plot center points were converted to the WGS84 coordinate system.

#### ***Visual interpretation***

Visual interpretation was conducted online on Google Earth through images taken after 2010 by experienced staff and then cross-checked on the most updated Land-sat 8 and the most up-to-date forest cover maps (mainly from the National Forest Inventory and Statistics Program). All the plots were visually interpreted into eight main land use classes of agricultural land, bare land,

natural forest, plantation forest, newly planted forest, water body and other land (road, houses/residential area, mining, etc.). The image key for the eight main land uses is in [Annex 1](#).

### **Criteria and determination of success and failure of plots**

Every plot was determined for success or failure based on the results of the visual interpretation, its intervention (assisted regeneration or plantation, and species and/or intervention objectives).

Plantation activity: the planting was conducted on bare-land. The criteria for a plantation plot to be determined as a success is the identification of the status/land use as either plantation, or newly planted trees, or newly harvested based on images after 2010 available through Google Earth and cross-referenced with most recent Land-sat 8 images. Otherwise it would be determined as a un-successful plot.

Assisted regeneration activity (with and without additional plantings): the purpose of this intervention is to assist natural regeneration, targeting natural forests. When assisted regeneration plots are identified as natural forest for its land use based on images taken after 2010, it is determined as a successful plot.

### **Calculation of success rates**

The success rates in percentage were calculated by each province and for the Program as a whole. The success rates were also estimated based on strata of forest function types/categories, forest owners and levels of market access.

The following formula was used for the calculation of success rate for each province/category:

$$R = \frac{\sum_1^{ns} x_{is}}{\sum_i^n x_i} * 100 \quad (1)$$

Where  $R$  is a success rate in percentage for each category/province,  $x_{is}$  is the number of success plots of each province/category, and  $x_i$  is the total number of the collected plots of each province/category.

Overall success rate is calculated by the formula:

$$\bar{R} = \frac{\sum_i^5 R_i * w_i}{\sum_i^5 w_i} \text{ or } \bar{R} = \frac{\sum_i^{ns} X_{is} * 100}{\sum_i^n X_i} \quad (2)$$

Where  $\bar{R}$  is an overall success rate in percentage,  $R_i$  is the success rate for province  $i$  ( $i=1,2,3,4,5$ ),  $w_i$  is weighted value for province  $i$ .

*Standard deviation (SD)*. The SDs were calculated for the overall rate and overall rates of each category (e.g. forest owner, forest intervention, and three forest functional type).

$$SD_w = \sqrt{\frac{\sum_1^n w_i (R_i - \bar{R})^2}{\frac{M-1}{M_0} \sum_1^n w_i}} \quad (3)$$



Where  $SD_w$  is a standard deviation,  $w_i$  is weighted value for province  $i$ ,  $R_i$  is a success rate for province  $i$ ,  $\bar{R}$  is the overall success rate,  $M$  is the number of the province ( $M=5$ ).

### 3. Results

#### 3.1. Success rates by province and overall success rate

##### *Number of plots and corresponding areas by provinces*

The total sample size of plantation and assisted regeneration plots under Program 661 in the five provinces are 11,013 plots, corresponding to the total area of 71,568.86 ha, or 11.2% of the total area of Program 661 implemented in the five provinces. The total number of successful plots is of 9,650 plots with a total area of 63,810.74 ha (Table 2).

**Table 2. Number of plots and areas (data in brackets is in ha)**

Success	Number of plots/Corresponding area (ha) by provinces					
	Binh Dinh	Kon Tum	Lang Son	Nghe An	Yen Bai	Grand Total
Unsuccessful	146 (914.29)	252 (1,243.9)	207 (596.07)	162 (1,653.14)	596 (3,350.72)	1,363 (7,758.12)
Successful	2,057 (28,853.53)	385 (3,004.4)	2,024 (7,147.28)	1,589 (11,799.08)	3,595 (13,006.45)	9,650 (63,810.74)
Grand total	2,203 (29,767.82)	637 (4,248.3)	2,231 (7,743.35)	1,751 (13,452.22)	4,191 (16,357.17)	11,013 (71,568.86)

##### *Success rates*

The overall success rate of the plantation and assisted regeneration under Program 661 is 87.62% ( $SD=7.36$ ), but varying among provinces. The lowest success rate is 60.44% for the province of Kon Tum – considerably lower than the second lowest rate of Yen Bai province at 85.78% - and the highest success rate is 93.37% for Binh Dinh province, neighboring Kon Tum (Table 2). The success rates of the three provinces of Binh Dinh, Lang Son and Yen Bai are relatively aligned and all over 90% (Table 3).

**Table 3. Overall success rates by provinces (%)**

Rate (in %)	Binh Dinh	Kon Tum	Lang Son	Nghe An	Yen Bai	Mean <sub>w</sub>	SD <sub>w</sub>
Unsuccessful	6.63	39.56	9.28	9.25	14.22	12.38	
Successful	93.37	60.44	90.72	90.75	85.78	87.62	7.36

Yen Bai's rate of 85.78% is affected by a higher rate of failure of assisted regeneration activities and mixed species plantations of pine and native species in protection and special use forests, implemented by the forest management boards, distributed in the western part of the province (see Table 5 and Table 7).

When compared to the success rate of the province of Dien Bien (41%), the provincial success rate of any province here is much higher than the rate of Dien Bien. Dien Bien is considered an exceptional case where access to market is extremely limited, leading to little motivation for forest owners for maintaining their forests after planting. The low success rate in Dien Bien is also considered to be impacted by high pressure from upland agriculture activities (corn and upland rice production). Households (which are the predominant type of forest owner in the province and in this region), who did not physically live on their plantation land, would be motivated to convert plantations to upland rice or other agricultural fields. This pattern is also often observed in Dien Bien’s neighboring provinces of Son La and Lai Chau.

### 3.2. Success plots and rates by forest interventions (plantation & assisted regeneration)

#### *Number of plots and corresponding areas by intervention*

The total number of plots sampled for assisted regeneration is 2,739 plots, accounting for 25% of all plots; the total number of plots of plantation is 8,274, making up 75% of the total number of sampled plots in the five provinces (Table 4).

**Table 4. Number of plots and areas (in brackets and in ha) by activity strata**

Intervention	Number of plots/Corresponding area (ha) by provinces					
	Binh Dinh	Kon Tum	Lang Son	Nghe An	Yen Bai	Grand Total
Assisted regeneration	1,061 (24,257.3)	254 (2,668.9)	344 (3,910.07)	823 (10,673.6)	257 (5,030.1)	2,739 (46,539.97)
Unsuccessful	31 (538.56)	91 (579.1)	31 (2,33.31)	106 (1,530.1)	62 (1,217.1)	321 (4,098.17)
Successful	1030 (23,718.74)	163 (2,089.8)	313 (3,676.76)	717 (9,143.5)	195 (3,813)	2,418 (42,441.8)
Plantation	1142 (5,510.52)	383 (1,579.4)	1887 (3,833.28)	928 (2,778.62)	3,934 (11,327.07)	8,274 (25,028.89)
Unsuccessful	115 (375.73)	161 (664.8)	176 (362.76)	56 (123.04)	534 (2,133.62)	1,042 (3,659.95)
Successful	1,027 (5,134.79)	222 (914.6)	1,711 (3,470.52)	872 (2,655.58)	3,400 (9,193.45)	7,232 (21,368.94)
Grand Total	2,203 (29,767.82)	637 (4,248.3)	2231 (7,743.35)	1,751 (13,452.22)	4,191 (16,357.17)	11,013 (71,568.86)

#### *Success rates by intervention*

The success rates of plantation and assisted regeneration are only slightly different (87.41% and 88.28%, respectively), not necessitating to separate these two interventions into two groups for estimations. The success rates of the two interventions also vary among provinces; the lowest rates of assisted regeneration and plantation are both observed in Kon Tum province (Table 5).

**Table 5. Success rates (%) of plantation and assisted regeneration**

Interventions	Binh Dinh	Kon Tum	Lang Son	Nghe An	Yen Bai	Mean <sub>w</sub>	SD <sub>w</sub>
<i>Assisted regeneration</i>							
Unsuccessful	2.92	35.83	9.01	12.88	24.12	11.72	
Successful	97.08	64.17	90.99	87.12	75.88	88.28	11.16
<i>Plantation</i>							
Unsuccessful	10.07	42.04	9.33	6.03	13.57	12.59	
Successful	89.93	57.96	90.67	93.97	86.43	87.41	7.8

### 3.3. Success rates by the production, protection and special use forests

#### *Number of plots and corresponding areas by the three forest functional types*

All three forest functional types/categories were sampled, but special use forest was sampled only from the province of Yen Bai (Table 6). The number of the protection forest samples (8,202 plots with a total area of 62,400.6 ha) makes up the biggest proportion, the sampling size of the production forest is of 2,706 plots and the smallest sample size of the special use forest is of 105 plots (Table 6).

**Table 6. Number of plots and areas (in brackets & in ha), by forest functional types strata.**

Forest functional types	Number of plots/Corresponding area (ha) by provinces					
	Binh Dinh	Kon Tum	Lang Son	Nghe An	Yen Bai	Grand Total
<i>Production</i>	109 (1,021.1)		260 (259)	544 (2,599.42)	1793 (3,774.04)	2,706 (7,653.56)
Unsuccessful	8 (27.1)		25 (27.33)	33 (140.04)	88 (319.92)	154 (514.39)
Successful	101 (994)		235 (231.67)	511 (2,459.38)	1705 (3,454.12)	2,552 (7,139.17)
<i>Protection</i>	2,094 (28,746.72)	637 (4,248.3)	1,971 (7,484.35)	1,207 (10,852.8)	2,293 (11,068.43)	8,202 (62,400.6)
Unsuccessful	138 (887.19)	252 (1,243.9)	182 (568.74)	129 (1,513.1)	471 (2,560)	1172 (6,772.93)
Successful	1,956 (27,859.53)	385 (3,004.4)	1789 (6,915.61)	1078 (9,339.7)	1,822 (8,508.43)	7,030 (55,627.67)
<i>Special use forest</i>					105 (1,514.7)	105 (1,514.7)
Unsuccessful					37 (470.8)	37 (470.8)
Successful					68 (1,043.9)	68 (1,043.9)
<b>Grand Total</b>	<b>2,203 (29,767.82)</b>	<b>637 (4,248.3)</b>	<b>2,231 (7,743.35)</b>	<b>1,751 (13,452.22)</b>	<b>4,191 (16,357.17)</b>	<b>11,013 (71,568.86)</b>

### Success rates by forest functional types

The success rates by the forest functional types vary with the three forest functional types, the highest success rate (94.31%) is for production forests and the lowest rate (64.76%) is for special use forests (Table 7).

**Table 7. Success rates (%) by forest functional types**

Forest function types	Binh Dinh	Kon Tum	Lang Son	Nghe An	Yen Bai	Mean <sub>w</sub>	SD <sub>w</sub>
<i>Production forests</i>							
Unsuccessful	7.34		9.62	6.07	4.91	5.69	
Successful	92.66		90.38	93.93	95.09	94.31	2.02
<i>Protection forests</i>							
Unsuccessful	6.59	39.56	9.23	10.69	20.54	14.29	
Successful	93.41	60.44	90.77	89.31	79.46	85.71	19.4
<i>Special use forest</i>							
Unsuccessful					35.24	35.24	
Successful					64.76	64.76	

Table 6 shows that the success rate of production forests between the provinces vary only slightly, of which the success rate of the production forest of Yen Bai is the highest (95.09%). The success rates of the protection forests markedly vary across the provinces, with the highest rate of 93.41% for Binh Dinh and the lowest rates is of 60.44% for Kon Tum province.

### 3.4. Success rates by forest owners

#### *Number of plots and corresponding areas by forest owners*

The five types of forest owners were sampled and examined, namely enterprises (both state-owned and private companies), households, management boards (for protection and special use forests), military and youth union (Table 8).

**Table 8. Number of plots and area by forest owners**

Forest owners	Number of plots/Corresponding area (ha) by provinces					
	Binh Dinh	Kon Tum	Lang Son	Nghe An	Yen Bai	Grand Total
<i>Enterprises</i>	1,083 (15,958.61)	485 (2,678.1)	495 (1,370.63)	224 (647)	594 (4,473.7)	2,881 (25,128.04)
Unsuccessful	87 (490.02)	228 (1,118)	43 (201.3)	11 (19.6)	43 (781.3)	412 (2,610.22)
Successful	996 (15,468.59)	257 (1,560.1)	452 (1,169.33)	213 (627.4)	551 (3,692.4)	2,469 (22,517.82)
<i>Households</i>	258 (3,056.92)	32 (217.5)	1,222 (4,516.39)	633 (4,199.22)	2,299 (5,675.84)	4,444 (17,665.87)
Unsuccessful	16 (84.82)	11 (75.6)	125 (281.37)	42 (205.74)	150 (707.42)	344 (1,354.95)
Successful	242 (2,972.1)	21 (141.9)	1,097 (4,235.02)	591 (3,993.48)	2,149 (4,968.42)	4,100 (16,310.92)
<i>Management boards</i>	862 (10,752.29)	105 (1,298)	514 (1,856.33)	657 (6,601)	1286 (6,170.83)	3,424 (26,678.45)
Unsuccessful	43	13	39	95	403	593

Forest owners	Number of plots/Corresponding area (ha) by provinces					
	Binh Dinh	Kon Tum	Lang Son	Nghe An	Yen Bai	Grand Total
	(339.45)	(50.3)	(113.4)	(1,266.3)	(1,862)	(3,631.45)
Successful	819	92	475	562	883	2,831
	(10,412.84)	(1,247.7)	(1,742.93)	(5,334.7)	(4,308.83)	(23,047)
<i>Military force</i>		15			12	27
		(54.7)			(36.8)	(91.5)
Successful		15			12	27
		(54.7)			(36.8)	(91.5)
<i>Youth union</i>				237		237
				(2,005)		(2,005)
Unsuccessful				14		14
				(161.5)		(161.5)
Successful				223		223
				(1,843.5)		(1,843.5)
Grand Total	2,203	637	2,231	1,751	4,191	11,013
	(29,767.82)	(4,248.3)	(7,743.35)	(13,452.22)	(16,357.17)	(71,568.86)

Table 8 shows that the biggest forest owners are companies, households and management boards, they collectively make up 97% of both the total number of plots and the total area. They are the main players, who implemented the Program 661 activities.

### **Success rates by forest owners**

Overall, the mean success rates by the forest owners are relatively aligned with the lowest rate of 82.68% for management boards and the highest rate 100% for military (but noting that the sample size here is much smaller than the others (Table 9)).

**Table 9. Success rates (%) by forest owners**

Forest owners	Binh Dinh	Kon Tum	Lang Son	Nghe An	Yen Bai	Mean <sub>w</sub>	SD <sub>w</sub>
<i>Company</i>							
Unsuccessful	8.03	47.01	8.69	4.91	7.24	14.30	
Successful	91.97	52.99	91.31	95.09	92.76	85.70	16.48
<i>Household</i>							
Unsuccessful	6.20	34.38	10.23	6.64	6.52	7.74	
Successful	93.80	65.63	89.77	93.36	93.48	92.26	3.14
<i>Management board</i>							
Unsuccessful	4.99	12.38	7.59	14.46	31.34	17.32	
Successful	95.01	87.62	92.41	85.54	68.66	82.68	12.68
<i>Military forces</i>							
Successful		100.00			100.00	100.00	
<i>Youth union</i>							
Un-success				5.91		5.91	
Success				94.09		94.09	

Table 9 also shows that enterprises achieved a very high success rate (over 90%), except in Kon Tum province (52.99%). This pattern is similar to households, but differs for management boards

(Table 8). Management boards in Yen Bai, which are usually located in the high mountainous areas and low market access areas and where native species were planted, only achieved the success rate of 68.66%. This confirms that market access affects success rates of plantations.















#### **4. Conclusion and recommendations**

The overall success rate of plantation and assisted regeneration under Program 661 in the provinces is 87.6%, but this varies among provinces, the three forest functional types, and by forest owner, but is not affected much by forest intervention type (i.e. plantation and assisted regeneration). By province, the lowest overall success rate is 60.4% for Kon Tum (where access to market is low) - this pattern is also observed in the Western part of Yen Bai Province - and the highest success rate is 93.3% for Binh Dinh province. By the three categories of forest function, the highest success rate is for the production forests (over 90%), and the lowest success rate is 64.7% for special use forest (sampled only in Yen Bai province), if compared cross provinces in the category of protection forest, the lowest success is of 60% in Kon Tum province.

The results clearly show that the success rates of plantation and assisted natural regeneration under the Program 661 tend to be lower in areas with low access to market and where native species were applied and/or mixed species plantations of protection and special use forests. The lowest success rates are all observed in the provinces of Kon Tum and the Western part of Yen Bai province where access to market is low and a large proportion was on protection and special use forests. The lowest rate observed in all the categories by this analysis is of 53% (enterprises in Kon Tum), but it is still significantly higher than the success rate of the province of Dien Bien (41%) as reported elsewhere. Dien Bien is considered to be an exceptional case. The neighbor provinces of Lai Chau and Son La may also have a similar success rate with Dien Bien provinces, as the access to market and pressure on land for agriculture are similar. This should be confirmed by additional study.

The overall success rate of 87% should be applied for plantation and assisted natural regeneration activities for the whole country, except for in the 3 provinces of Dien Bien, Son La and Lai Chau where access to market is extremely difficult and face high competition with upland rice and agricultural production. Different rates can also be used for plantation (87.41 %) and assisted regeneration (88.2%).

**Annex 1. Image key for visual interpretation of 8 main land uses. All the images are Google Earth screen shots.**

		
Agriculture/paddy rice field	Water body/water surface	Other land/residential area
		
Other land/mining area	Newly planted area	Newly planted area
		
Bare land	Bare land	Harvested site
		
Plantation	Plantation	Natural forest (rich)
		
Natural forest (medium)	Natural forest (poor)	Na. forest (regeneration)

## Annex 2. Matrix of land cover changes from the interventions up to now

Intervention	Agriculture		Bareland		Natural forest		Newly planted		Other land		Plantation		Water body		Grand total	
	Plot	Area	Plot	Area	Plot	Area	Plot	Area	Plot	Area	Plot	Area	Plot	Area	Plot	Area
AR*	13	162.7	270	3465.11	2418	42441.8	24	268.86	1	27	13	174.5			2739	46539.97
Un-success	13	162.7	270	3465.11			24	268.86	1	27	13	174.5			321	4098.17
Success					2418	42441.8									2418	42441.8
Plantation	119	364.17	903	3256.32			1291	4164.41	16	35.44	5941	17204.53	4	4.02	8274	25028.89
Un-success	119	364.17	903	3256.32					16	35.44			4	4.02	1042	3659.95
Success							1291	4164.41			5941	17204.53			7232	21368.94
Grand Total	132	526.87	1173	6721.43	2418	42441.8	1315	4433.27	17	62.44	5954	17379.03	4	4.02	11013	71568.86

\* AR: Assisted regeneration; green color highlights success plots/area