

A comparison of Socio-Economic Characteristics of Farmers Adoption of Stone Jatropha (*Vernicia montana*) Cultivation in Northern, Lao PDR

Khambai Phunthavongsa¹, Thanaporn Athipanyakul² and Naruemol Kaewjampa^{1*}

ABSTRACT: The objective of this study was to compare the different inherent socio-economic characteristics among Stone Jatropha (*Vernicia montana*) adopters in Xiengnguen district, Luangprabang province, Lao PDR. They can be classified into four groups; early adopter, majority adopter, late adopter and non-adopter. The study was carried out on 67 adopters and 89 non-adopters. The study examined the land utilization, personal factors, physical factors and economic factors. These data were collected using a structured questionnaire and descriptive statistics such as means and percentage. Results showed that land utilization for Stone Jatropha cultivation was highest in the majority adopter group (0.54 ha), while the late adopter and the early adopter utilized about 0.46 ha and 0.42 ha, respectively. Non-adopter group used the land mostly for cash crop, main crop, livestock and orchard production. As well as personal household characteristics of all adopter groups; age, gender and number of household members were higher than that of non-adopters. Approximately 34.80-50.80% of all adopters and non-adopters studied at least at primary school educational level. Husband was a key decision maker in adopters group with the percentage in this group being higher than that of non-adopters. Most of adopter and non-adopter groups were Lao Keamu and their main occupation was agriculture. The early adopters had larger land holding than did majority adopters, late adopters and non-adopters. Additionally, the adopters had higher average household income (8,213.40 \$USD) than did non-adopters (3,477.70 \$USD). About 83.10% of the non-adopters did not trust buyer, while half of early adopters having complete trust in the buyers.

Keywords: Stone jatropha (*Vernicia montana*), Socio-economic, Adoption, Lao PDR.

Introduction

Since 2005-2006, Lao PDR has been promoting energy renewable policies. Stone Jatropha (*Vernicia montana*) is newly introduced for production in Lao PDR. It is mainly planted by small-scale farmers and private companies and used for producing biodiesel. Plantations of this plant are increasingly spreading and becoming an important source for biodiesel production in Lao PDR (Vongvisith and Theuambounmy, 2015). Lao PDR has also paid attention towards biofuel production that included an initiation of multiple

pilot activities which were founded from private companies with subsidy support from the government. Despite the promotion on the adoption of Stone Jatropha by both private agencies and the government since 2005, it appears that no massive adoption has been made by smallholding farmers. According to Esterhuizen (2010), it can also be noted that the adoption of *Jatropha curcas* and establishment of plantations of at least one hectare have been very slow, for instance, in 2010, there was only 30,000 ha out of a projected 120,000 ha by 2017 having been planted in Zimbabwe. Although, the

¹ Land resources and environment section, Department of plant sciences and agriculture resources, Faculty of Agriculture, KhonKaen University, KhonKaen, Thailand, 40002

² Department of Agricultural and Resource Economics, Faculty of Economics, Kasetsart University, Thailand 10900

* Corresponding author: narue77@gmail.com

Stone Jatropha plantation area in Lao PDR is rapidly increasing and was roughly 13,000 ha in 2013. The plantations have mainly been introduced in upland areas of the northern province of Hauphanh, Oudomxay, Xiengkhaung, Luangprabang, Xayabury, Vientiane and Borikhamxay and operated by 41,172 smallholders (Vongvisith and Theuambounmy, 2015). There is a need to find out the socio-economic factors, which are played a very important part in the decision to cultivate this plant. In this study we gave a description of Stone Jatropha adopters and non-adopters. The adopters in this context refer to any farmer who grow the plant on their farm while non-adopters are farmers who do not grow. Description of socio-economic characteristics such as gender, age, marital status, education level, number of household members, relative, main occupation, ethnic, religion, key decision makers, land holding, land rental, income and trust in buyers is provided to establish, comparison between Stone Jatropha adopters and non-adopters.

Therefore, the objective of this study was to investigate the socio-economic characteristics of Stone Jatropha (*Vernicia montana*) adopters and non-adopters specifically in Xiengnguen district, Luangprabang province, Lao PDR.

Materials and Methods

Study site

The study was conducted in Xiengnguen district (19° 46' 36.35" N, 102° 11' 20.92" E) Louangphabrang province, Lao PDR (Figure 1), where agricultural household number was 5,774. Annual crop area was 381.15 ha in wet season and 6,306.98 ha in dry season. In addition, the total number of perennial crops during wet and dry seasons in 2010 was 418.92 ha. Agricultural households with irrigation available in the area was 389,968.62 ha, hence; Lao government and industries have promoted Stone Jatropha cultivation since 2008, and planting was expanded each year, which was accounted for 1,096.07 ha, of 1,086 small-scale farms.

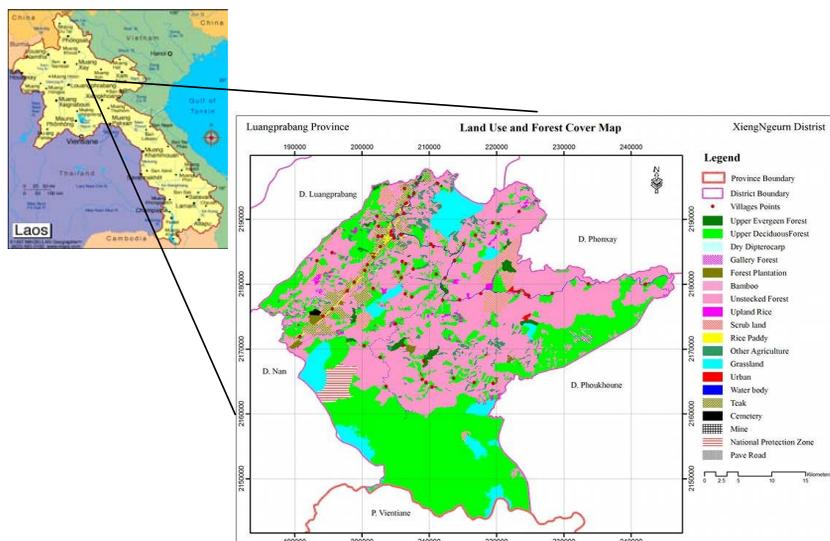


Figure 1 The study area in Xiengnguen district, Louangphabrang province, Lao PDR.

Source: modified from <http://goo.gl/uzTRRx>

Sampling and data collection

The survey was conducted in 2014 and it involved questionnaires for farmers in Xiengngeun district, comprising two groups; adopters and non-adopters of Stone Jatropha (*Vernicia montana*). Two farming villages, Samakeesay and Donmo, were selected. A sample size of 156 farmers, constituting 67 adopters and 89 non-adopters, was selected base on sample size equation (1) (Yamane, 1973). These numbers formed a significant proportion of the total number of households in each village. Details for the selected villages and the number of Samkkeesay and Donmo farmer adoption and non-adoption are given in **Table 1**. A structured questionnaire was used to collect data from each selected household. Individual discussion with farmers socio-economic data and farming system data were collected. The questionnaire which focused largely only on socio-economic aspects that could affect adoption of plant production is discussed in this paper.

Adopter categories

According to Roger (2003) and Sahin (2006), the classic characteristic of adoption/diffusion continuum recognizes five categories of participants, which are based on innovativeness scores at the time of adoption. First category, innovators tend to be experimentalists, younger and enjoy the highest socio-economic status. Early adopters are technically sophisticated and more advanced in education. Early majority

adopters can be convinced to adopt by innovators and early adopters but they tend to be more cautious to adopt. Late majority adopters are less comfortable with technology and they do not adopt until most others already have done so. Lastly, the laggards may never adopt technology because they tend to be highly skeptical and resist adopting until absolutely necessary (Roger, 1962; Abera, 2008).

In this study, the adopter categories were classified by the cumulative innovativeness between the times of farmer who continued planting the plant in this area but then applied the normal curve to be used by the Rogers (2003) in assigning adopter groups membership (**Table 1**). Therefore, this study used three categories of innovation adopters, early adopters, majority adopters and late majority adopters of the cultivation. As shown in **Table 2**, the sample size in each adopter categories was 4 (2.56%), 59 (37.82%) and 4 (2.56%) respondents of early adopters, majority adopters and late adopters, respectively. Non-adopters were 89 (57.05%) respondents of the total sampling.

Data analysis and descriptive analysis

Descriptive statistics were used to characterize sampled smallholding communal farmers in three adopter categories and non-adopters of Stone Jatropha (*Vernicia montana*) cultivation. Percentage and means were used to compare between group adopters.

Table 1 Adopter group memberships as defined by the normal distribution.

Years	Adoption	Percentage (%)
2005	1	1.49
2006	1	1.49
2007	0	0.00
2008	2	2.99
2009	21	31.34
2010	20	29.85
2011	18	26.87
2012	3	4.48
2013	1	1.49
2014	0	0.00
Total	N=67	100

Table 2 Sample size of adopter categories in this study

Adopter categories	No. of adopters	Percentage (%)
Non-adoption	89	57.05
Early adoption	4	2.56
Majority adoption	59	37.82
Late adoption	4	2.56
Total	156	100

Results and Discussion

Land utilization of Stone Jatropha (*Vernicia montana*) adopters and non-adopters in Xiengnguen district, Laungprabang province, Lao PDR.

Primary information is provided in **Table 3**. Results of the comparison of land utilization in each group of Stone Jatropha (*Vernicia montana*) adopter and non-adopter revealed that land utilization of early adopter and majority adopter groups was for producing cash crop, main crop (upland rice), Stone Jatropha, livestock and orchard. Only main crop and Stone Jatropha were produced by late adopter group. In addition to non-adopter group, most of land utilization was

for cash crop, main crop, livestock and orchard production. Cash crop was the main land use of early adopter group and non-adopter group, which the area of cash crop was accounted for 0.74 ha (38.95%) and 0.53 ha (56.84%), respectively. Main crop was the major land use of late adopter group, covering the area of 0.87 ha (54.05%), whilst the main land utilization of most adopter groups was for Stone Jatropha, having the area of 0.54 ha (37.69%).

Most adopters in the study areas started growing Stone Jatropha in main crops area by intercropping with fruit, upland rice, maize, job's tears and other crops (around 1/3 of each area). The largest area of Stone Jatropha was majorly in the adopter group with the area of 0.54 ha, while

0.46 ha and 0.42 ha respectively, being in the late adopter and early adopter. Most of Stone Jatropha in each area was cultivated on agricultural land formerly used for the main crops (upland rice), cash crop, orchard (fruit tree) and livestock. This

is clearly contrary to the prior intention, advertised by the promoters of Stone Jatropha cultivation to compete with main crops in terms of land use (Brittaine and Lutaladio, 2010).

Table 3 Types of land utilization between adopters and non-adopters in Xiengnguen district, Loungprabang province

Crops	Early adopter		Majority adopter		Late adopter		Non- adopter	
	Average (ha)	%	Average (ha)	%	Average (ha)	%	Average (ha)	%
Stone Jatropha (<i>Vernicia montana</i>)	0.42	22.11	0.54	37.69	0.47	29.08	0	0
Main crops (upland rice)	0.50	25.96	0.52	35.74	0.87	54.05	0.34	36.28
Cash crop	0.74	38.95	0.36	25.45	0.27	16.87	0.53	56.84
Livestock	0.25	12.98	0	0	0	0	0.02	1.61
Orchard (Fruit tree)	0	0	0.02	1.12	0	0	0.05	5.27
Total	1.91	100.00	1.43	100.00	1.60	100.00	0.93	100.00

Personal household characteristics of Stone Jatropha (*Verniciamontana*) adopters and non-adopters in Xiengnguen district, Laungprabang province, Lao PDR.

The basic socio-economic characteristics which are the personal factors indicated that most of Stone Jatropha (*Vernicia montana*) adopters (50-76.30%) were male (Table 4). For non-adopters, male also was higher than females constituted 60.70%. This shows that there was no difference between Stone Jatropha adopters in each stage and non-adopters of gender. However, gender category was considered as decision makers to farming which based on the role and responsibilities to decision adoption (Ezeibe et al., 2015).

An average age of early adopters and late adopters quite high was 52.5 and 57 years old, respectively, while the age of 46.78 and 47.60

years was in the group of non-adopters and majority adopters. The result revealed that the age proportion of farmers selected were 46-57 years which are more farming experience. Mazvimavi and Twomlow (2009) also suggested that Stone Jatropha production is for an elder generation. Moreover, 100% of early adopters were married and also 94.92% and 75% of respective majority adopters and late adopters were married, which was similar to non-adopters (88.76%). This also agrees with Adetunji and Adesiyan (2008) who confirmed that 64% of high status farmers were married. On marital status, 4.67% of farmers were single and all belonged to Stone Jatropha non-adopter.

The average number of household member in all of Stone Jatropha adopters group was 4.75-6.00 persons per household. Early Stone Jatropha adopters had bigger number of

household (6 persons per household) than did majority adopters (5.46 persons per household) and non-adopters (4.82 persons per household), while late Stone Jatropha adopters had the smallest number of household (4.75 persons per household). The family's relative of Stone Jatropha production farmers, the result showed that 68.54% and 74.58% of non-adopters and the majority of adopters were male leader. While, half-half of male and wife leader were found in early adopters and late adopters.

With respect to educational level, less than 10.20% of Stone Jatropha non-adopters and the majority of adopters did not attain any formal levels of education, while more than 50% of late adopters had never been studied. Approximately 34.80-50.80% of all adopters and non-adopters studied at least at primary school level, indicating that the farmers of Xiengnguen district were at least able to read and write. In the case of high educational level, less than 11.20% to 8.50% attended high school level and 23.60% to 8.50% was at diploma level. These were found only in late adopters and non-adopters of Stone Jatropha cultivation. Education is a very important category towards the decision to adopt and for driving new technologies. Education are interrelated and functioning to fulfil basis human need such as reproduction, socialization, food, security, etc. in the society (Burchi, 2006). The study showed that adoption groups had a lower education level than did non-adopters, and lower-educated farmers showed higher negative response to improved technology adoption. They had active practices but were not sufficiently educated to be able to use the technology.

However, our result was inconsistent with previous studies that farmers with higher education were less interested in the adoption and did not adopt until most others already fulfilled the success.

In the context of occupation, agriculture is the major occupation in all of both adopters and non-adopters with 100%, 76.30%, 75% and 56.20% of early adopters, majority adopters, late adopters and non-adopters, respectively. All adopters and non-adopters were Lao kreamu. 100% were early adopters and late adopters with 74.60 and 51.70% being majority adopters and non-adopters, respectively. More than half of farmers (49.40 - 100%) of Stone Jatropha adopters and non-adopters in this area had no religion. They, instead, respected ghost or spirit. 75% of early adopters were Christian. Religion has led us to a perpetually uncertain attempt to sustain output by constantly regarding technological innovation (Havens, 1972; Falvey, 2005).

Key decision makers were found to be more than 50% of adopters and non-adopters where both husband and wife made the decision to grow Stone Jatropha on their land. Furthermore, the results also found that early Stone Jatropha adopters, the key decision makers were not made by the husband but by the wife as the key person to make the decision to adopt. There are many influences affecting the decision, dependent negotiation between husband and wife over the demand of labour for example can have a profound effect on the rate of adoption of labour increasing technology (Nwakor et al., 2011; Fisher and Carr, 2015).

Table 4 Personal households' characteristics of Stone Jatropha adopters and non-adopters in Xiengnguen district, Laungprabang province, Lao PDR

Item	Test	Measurement	Non-adoption	Early adoption	Majority adoption	Late Adoption
Personal factors		%				
Gender						
	Male		60.70	50.00	76.30	50.00
	Female		39.30	50.00	23.70	50.00
Age		Mean (Min, Max)				
	Mean		46.78	52.50	47.66	57.00
	Minimum		21.00	40.00	29.00	41.00
	Maximum		76.00	67.00	78.00	67.00
Marital status		%				
	Single		4.49	0	0	0
	Married		88.76	100.00	94.92	75.00
	Divorced		6.74	-0	5.08	25.00
Number of household members		Mean (Min, Max)				
	Mean		4.82	6.00	5.46	4.75
	Minimum		1.00	4.00	3.00	4.00
	Maximum		13.00	7.00	11.00	6.00
Relative		%				
	Male leader		68.54	50.00	74.58	50.00
	Wife leader		25.84	50.00	23.73	50.00
	Son /daughters		2.25	0	0	0
	Mother in law		2.25	0	1.69	0
	Grandchild		1.12	0	0	0
Educational level		%				
	Never studied		10.10	0	10.20	50.00
	Primary school		34.80	50.00	50.80	50.00
	Secondary school		20.20	50.00	22.00	0
	High school		11.20	0	8.50	0
	Diploma		23.60	0	8.50	0
Main occupation		%				
	No occupation		3.40	0	0	0
	Agriculture		56.20	100.00	76.30	75.00
	Student		1.10	0	0	0
	Own business		10.10	0	10.20	25.00
	Worker		4.50	0	6.80	0
	Government		21.30	0	6.80	0
	Company		3.40	0	0	0

Table 4 Personal households' characteristics of stone jatropha adopters and non-adopters in Xiengnguen district, Laungprabang province, Lao PDR. (Cont.)

Item	Test	Measurement	Non-adoption	Early adoption	Majority adoption	Late Adoption
Ethnic group		%				
	Lao moug		4.50	0	3.40	0
	Lao luam		43.80	0	22.00	0
	Lao kreamu		51.70	100.00	74.60	100.00
Religion		%				
	Buddhism		46.10	0	23.70	0
	Christian		4.50	75.00	10.20	0
	Spiritual		49.40	25.00	66.10	100.00
Key decision makers		%				
	Husband		24.70	0	44.10	50.00
	Wife		5.60	50.00	3.40	0
	Both		58.40	50.00	50.80	50.00
	Other		11.20	0	1.70	0

Physical characteristics affecting Stone Jatropha (*Vernicia montana*) adopters and non-adopters in Xiengnguen district, Laungprabang province, Lao PDR

Physical characteristic such as land holding and land rental were shown in **Table 5**. An average land holding for all adopters was higher than that of non-adopters. The highest average land holding area was 1.88 ha for early adopters, 0.86 ha for majority adopters and 0.81 ha for late

adopters whilst non-adopters had the smallest average land holding of 0.65 ha. An average land rental for non-adopters and majority adopters was 0.69 \$USD and 0.91 \$USD, respectively, while early adopters and late adopters did not pay for land rental. This result indicated that the number of land holdings and the cost of land rental were important factors that affected decision being made for Stone Jatropha adoption.

Table 5 Physical characteristics of adopters and non-adopters in Xiengnguen district, Laungprabang province, Lao PDR.

Physical factor	Test	Measurement	Non-adoption	Early adoption	Majority adoption	Late Adoption
Land holding (ha)		Mean (Min, Max)				
	Mean		0.65	1.88	0.86	0.81
	Minimum		0.01	0.50	0.01	0.02
	Maximum		4.00	4.00	5.00	2.00
Land rent(\$USD)		Mean (Min, Max)				
	Mean		0.69	0	0.91	0
	Minimum		0.00	0	0.00	0
	Maximum		48.78	0	29.27	0

Economic characteristics of Stone Jatropha (*Vernicia montana*) adopters and non-adopters in Xiengnueu district, Laungprabang province, Lao PDR.

Economic characteristic of Stone Jatropha adopters and non-adopters revealed that the average household income was 2,834.50-8,213.40 \$USD. Early adopters had the highest income of 8,213.40 \$USD, which was three times higher than that of majority adopters and late adopters. The average income of non-adopters was 3,477.70 \$USD, which was not higher than

that of majority adopters and late adopters. About 81.1% and 75% of non-adopters and late adopters, respectively, had no trust in buyer; which was in contrast to early adopters that had higher trust in the buyer (50%) with only 25% of the group that did not trust the buyer (Table 6). This was due to, in this case, the information available for farmers being poor, a lack of information on good management practice, lack of a reliable market and similarly lacking awareness about the low economic value of Jatropha production type (Mogaka et al., 2014).

Table 6 Economic characteristics of adopters and non-adopters in Xiengnueu district, Laungprabang province, Lao PDR.

Economic factors	Test	Measurement	Non-adoption	Early adoption	Majority adoption	Late Adoption
Income (\$USD)		Mean (Min, Max)				
	Mean		3,477.70	8,213.40	2,917.80	2,834.50
	Minimum		104.88	4,000.00	439.02	1,463.41
	Maximum		14,634.15	12,878.05	11,170.73	5,121.95
Trust in the buyer		%				
	No trust		83.10	25.00	45.80	75.00
	Some trust		15.70	25.00	35.60	0.00
	Trust		1.10	50.00	18.60	25.00

Conclusion

We investigated how to categorize the farmers who adopted Stone Jatropha (*Vernicia montana*) cultivation by using Rogers theory (non-adoption group, early adoption, majority adoption and late adoption). The findings were generally supported by the use of a method derived from initial empirical studies. In particular, the analysis demonstrated that certain factors affecting farmers' decisions to adopt; personal issues within households were characteristically found

to be the main cause in delaying the decision to adopt Stone Jatropha. Adopters were older with more work experience gained. Primary school was the lowest level of education in both adopters and non-adopters group. Both husband and wife could be the main key decision makers of Stone Jatropha adoption. Physical characteristics such as land holding and land rental indicated the early adopters having the largest land holding size with no cost for land rental of Stone Jatropha cultivation. Non-adopters with smaller land holding had to spend money on land rental.

Additionally, economic characteristics were, on average, found to be higher amongst early adopters, indicating that economic factors played a significant role in the farmers' decision to adopt and continue cultivating Stone *Jatropha* in order to earn more income. However, farmers both in adopter and non-adopters groups had low and no trust in buyers whereas early adopters had trust in the buyer. Furthermore, socio-economic characteristics played a very important part in the decision to cultivate Stone *Jatropha*.

References

- Adetunji M. O. and I. O. Adesiyun. 2008. Economic analysis of plantain marketing in Akinyele local government area in Oyo state, Nigeria. *Int. J. Agric. Econ. Rural Dev.* 1(1): 15-21.
- Banmeke T. O. A., and M. T. Ajayi. 2008. Farmers' Perception of the Agricultural Information Resource Centre at Ago-Are, Oyo State, Nigeria.
- Brittaine R., and N. Lutaladio. 2010. *Jatropha*: a smallholder bioenergy crop. Food and Agriculture Organization of the United Nations, Roma. *Integr. Crop Manag.* 8: 96.
- Burchi F. 2006. Identifying the Role of Education in Socio-Economic Development. Papers of the Annual IUE-SUNY Cortland Conference in Economics. pp. 193-206.
- Ezeibe A. B., D. O. Edafigho, N. A. Okonkwo, C. C. Okide. 2015. Gender differences and challenges in cassava production and processing in Abia State, Nigeria. *African Journal of Agricultural Research.* 10(22): 2259-2266.
- Fisher M., and E. R. Carr. 2015. The influence of gendered roles and responsibilities on the adoption of technologies that mitigate drought risk: The case of drought-tolerant maize seed in eastern Uganda. *Global Environmental Change.* 35: 82-92.
- Mazvimavi K., and S. Twomlow. 2009. Socioeconomic and institutional factors influencing adoption of conservation farming by vulnerable households in Zimbabwe. *Agricultural Systems.* 101(1-2): 20-29.
- Mogaka V., A. Ehrensperger M. Iiyama, M. Birtel, E. Heim, and S. Gmuender. 2014. Understanding the underlying mechanisms of recent *Jatropha curcas* L. adoption by smallholders in Kenya: A rural livelihood assessment in Bondo, Kibwezi, and Kwale districts. *Energy for Sustainable Development.* 18: 9-15.
- Mponela P., C. B. L. Jumbe, and W. F. Mwase. 2011. Determinants and extent of land allocation for *Jatropha curcas* L. cultivation among smallholder farmers in Malawi. *Biomass and Bioenergy.* 35(7): 2499-2505.
- Mujeyi K. 2009. Socio-economics of commercial utilization of *Jatropha* (*Jatropha curcas*) in Mutoko district, Zimbabwe. *Journal of Sustainable Development in Africa.* 11(2): 36-53.
- Noltze M., S. Schwarze, and M. Qaim. 2012. Understanding the adoption of system technologies in smallholder agriculture. The system of rice intensification (SRI) in Timor Leste. *Agricultural Systems.* 108: 64-73.
- Nwakor F. N., G. E. Ifenkwe, B. C. Okoye, F. N. Onumdu, H. N. Anyaegbunam, T. O. Ekedo, and C. E. Onyia. 2011. Socio-Economic Factors Affecting Adoption of Improved Cassava Varieties among Farmers in Abia State. *JASR.* 11(1): 63-71.
- Partala, T., and T. Saari. 2015. Understanding the most influential user experiences in successful and unsuccessful technology adoptions. *Computers in Human Behavior.* 53: 381-395.
- Rogers, R. M. 2003. Applied mathematics in integrated navigation systems. American Institute of Aeronautics and Astronautics, Reston.
- Satcher, D. 1998. Tobacco Use among U. S. Racial Ethnic Minority Groups: Alaska Natives, Asian Americans and Pacific Islanders, Hispanics. DIANE Publishing.
- Sysaneth, S., and L. Duangsavanh. 2009. Impacts of *Jatropha* Plantation on Smallholders. National Agriculture and Forestry Research Institute, TSMR Network.
- Vongvisith, B., and H. Theuambounmy. 2015. Bio-Energy Science and Technology Innovation and Policy in Lao P.D.R. *Journal of Sustainable Energy and Environment Special Issue.* 2015: 13-18.