Firewood development in Labuhan Badas: consumption and determinants

D Diniyati1*, B Achmad1 and M Sudanto2

1Institute for Research and Development on Agroforestry Technology
2Centre for Forest Biotechnology and Tree Improvement Research and Development

*Corresponding author’s e-mail address: dian_diniyati@yahoo.com

Abstract. Little consideration on the relationship between economy and environmental dimensions of firewood causes farmer’s reluctance in planting trees for fuel. This tendency potentially threatens sustainable farmer incomes. This paper investigates supply and demand of firewood, stakeholders involved and determinants of firewood development. The research was conducted on April and October 2016 at Boak community (Labuhan Badas village) who utilize firewood for domestic use and for income generation. A total of 25 households and 8 key persons were selected using purposive sampling. Meanwhile, the numbers of 6 brick/roof tile manufacturing and 3 middlemen were selected using snowball sampling. Data were collected by interview and analysed descriptively. Currently, there are 12,976 m$^3$ firewood deficits for the manufactures of charcoal; limestone; and brick-roof tiles. Unfortunately, none of community intends to replant trees in the forest to suffice firewood needs. The determinants of firewood development consist of three factors namely: the land is abundantly available; the species of firewood has been well recognised; and technology to develop has been mastered. These determinants could be placed as entry points for government to overcome the problem about firewood shortage as well as to increase the farmer income through facilitating the firewood development until farmers get benefit. The government also may subsidize farmers who grow trees for fuel with the efficient stove or other rewards such as reduction on the land and building tax.

Keywords: Forest, firewood energy, consumption, stakeholders, determinants

1. Introduction

People utilize various energy resources which is firewood for cooking used by most rural households in developing countries. Beside firewood, rural households also use other traditional energy such as charcoal, coal briquettes and others biomass [1] [2]. For cooking purposes, rural households consume much higher firewood energy than urban households i.e. 31.30 % and 5.15 % respectively [3], because in rural area firewood are free and easy to find [4].

Forest does not only play an important role to provide firewood for household energy, but also become a productive resource which is very easy to be accessed and available for many people [5]. Forests are important for rural households in preventing and reducing poverty [6]. Firewood is also widely used by small scale manufactures as energy source to produce charcoal, brick, roof tiles and snacks. Consequently, the demand rate of firewood energy increased and exceeds its supply. The scarcity of firewood within the villages is an indicator that the forests in these areas have been over...
exploited. The gap between supply and demand of firewood prospers farmers in Boak Village because it creates new market which is potential to give additional incomes.

The livelihood of Boak people strongly depends on the firewood business, whether for self-consumption or for selling. The business, unfortunately, trigger high activities in the forest which threatens the security of the state forest. The firewood stock in market is allegedly not only collected from the private forest but also from the state forest. According to [7], dozens of villages around the state forest are very dependent on the forest for collecting wood, firewood, fodder and for farming practice. Typically, poorer households are relatively more reliant on forest resources than the more well-off, though the latter have higher absolute forest incomes [8].

It is important to maintain income level of farmers obtained from firewood business without neglecting the environmental quality of state forest. Therefore, the increasing of demand on firewood needs to be overcome soon in order to avoid over extraction of state forest. The policy direction of firewood consumption can be designed properly if the supply-demand ratio of firewood across the community available. Moreover, to formulate policy of firewood development in Sumbawa Regency, the information about stakeholders involved in firewood business and the determinants are also important to be available. This research, therefore, aims to identify supply and demand of firewood, stakeholders involved and determinants for firewood development.

2. Materials and Methods

2.1 Study Location

The research area were in Boak Village (S 8°32′1.25″ and E 117° 26′ 45.06″) administratively under Unter Iwes Sub-District; Mokong Village (8°37′6.77″ and E 117° 25′ 13″), administratively under Moyohulu Sub-District; and Sumbawa Sub-District (S 8° 28′ 26.26″ and E 117° 25′ 34.57″), West Nusa Tenggara, Indonesia. The research was done on April and October 2016. The criteria for selecting research location encompass the availability of farmers who work as trader and as the user of firewood at the same time.

2.2 Methods

The Primary data were collected through observation and interview with structured questionnaires. The interviewees are 25 households; and 8 key persons which selected using purposive sampling method. Meanwhile, the number of 6 brick-roof tile manufactures; and 3 middlemen were selected using snowball sampling, as explained by [9]. The primary data were tabulated and classified based on the information of supply and demand on firewood, as well as the stakeholders involved. The Secondary data were obtained from relevant written reports and references.

2.3 Analysis

To identify the level of supply and demand of firewood and various stakeholders involved, data were grouped according to those three categories and analyzed descriptively. Meanwhile, the factor analysis is used to identify factors which influence the development of firewood energy [10]:

\[ F_1 = W_1X_1 + W_2X_2 + W_3X_3 + \ldots + W_kX_k \]  (1)

Where:
- \( F_1 \) = factor
- \( W \) = weight variable on factor
- \( k \) = number of variable
- \( X \) = variable
3 Results and Discussion

3.1 Supply and Demand of Firewood

One of firewood producers in Sumbawa Regency is Boak Village which is located inside KPH Puncak Ngengas-Batulanteh. It makes Boak communities to intensively interact with forest, particularly in collecting firewood. Actually, the Boak communities lean on two energy sources for cooking i.e. firewood and kerosene. A household consumes 3 bunches of firewood per week at the cost of IDR 5,000/bunch, and consumes 4 to 5 litres subsidized kerosene per week at the cost of IDR 4,000/litre. According to [11] the consumption of firewood by household in South Central Timor Regency reached 2-4 bunches per week at the cost of IDR 1000-2500 per bunch. The decrease of firewood prices combined with the increase of kerosene prices have increased competitiveness of firewood in the market [12].

The Boak communities use firewood for everyday life with various reasons as shown by Figure 1.

![Figure 1. Reasons why Boak communities collect firewood](image)

The Poverty and unemployment are basic cause of people to use firewood [13]. However, main reason of Boak people use firewood is in accordance with [14] who mentioned that using firewood could save money and make food tastier or more aromatic [13]. Nevertheless, some people firstly prefer using kerosene although at the end they back to firewood due to kerosene scarcity (20%), while some others due to unable to purchase kerosene (16%). About 16% of communities remain deal with firewood business as additional income.

Firewood is traded not only for domestic use but also for industries. Firewood is needed by small scale manufactures to produce brick, roof tile, limestone and charcoal. Gathering firewood is more affected by climate condition, during the rainy season the production of firewood was very limited. The gathering of firewood for commercial use is the main task of male (40%), while for domestic use is female responsibility (28%). In addition, female also responsible in cooking which make them more vulnerable to be infected by various diseases related to respiratory organs [15].

In general, the traders can purchase firewood twice a month. In one transaction, they earn of IDR 887,500 per truck (equal to 4 m³). Hence, their annual income would reach IDR 42,600,000. The small scale industries use eight tree species as energy intake i.e. kayu johar (Cassia siamea Lamk.), ketimis (Protium javanicum Burm.), secang (Biancaea sappan), sonokeling (Dalbergia latifolia Roxb.), jati (Tectona grandis L.f.), kosambi (Schleichera oleosa), kaliandra (Calliandra calothyrsus) and asam jawa (Tamarindus indica). Asam jawa, the most preferable firewood, is a local tree species which contributes for many benefits to local community. Unfortunately, it is getting difficult to find in the field due to less cultivation efforts. Based on the sources of firewood, community claimed that majority of firewood came from state forest (92%) without cutting trees, but just picking up branches and fallen
twigs. They also claimed that, this tradition has been practised since 25 years ago. All family members are responsible for collecting firewood. The male is the most frequently collect firewood (40%) by carrying them when coming back from farm, mainly for commercial use. Meanwhile, the female take 28% of the portion done in a group after completing their houseworks, mainly for domestic use. Similarly, firewood for domestic use in Uganda is also collected mainly by women [16] which was handled together with other productive activities.

Women in Indonesia have many responsibilities i.e. doing housework and looking for additional incomes. When they have to collect firewood, some other responsibilities might be neglected. Collecting firewood by mother may be decreased by introducing innovated stove. Foreexample, women in China are free from obligation to collect firewood after operating innovated stoves [17]. Burning firewood has negative impact on health due to high emission such as respiratory and heart diseases, lung cancer and eye irritation [18] [19]. However, for mothers of Boak village, the collection of firewood is regarded as a moment to meet other women. This is a pleasure time for mothers to share the condition of their family, village and welfare with others. To respond those two different conditions, subsidising efficient stove may effective since mothers still can gather in a regular meeting, such as in a training on processing of non-timber forest product.

Collecting firewood has become a routine activity for Boak community, and makes the local government difficult to stop. To anticipate conflict and to minimize pressure on the state forest, the local officers keep controlling the firewood collectors. Although the KPHP officer do not prevent local community extracting firewood from the state forest, but the officers recognise the location of group who often gather firewood. This makes easier for the officer to control and to supervise community in gathering firewood to avoid further forest pressure. Actually Boak people realize that collecting firewood from the state forest is prohibited, but due to difficult situation in obtaining job, fuel, and money, they tend to break the rule. Similar situation also happened in Northern China whereas the economic wealth of household become a significant and negative determinant of firewood consumption [20]. Besides, they also have perception that Boak people have right to get access and to collect firewood since they involved in planting trees in the past. Income consistently turned out to be an important influence on the level of firewood use, and consumption of firewood usually decreases with an increase of income.

The high potency of firewood in Boak village provides business opportunity for people surrounding forest. Farmer group is able to sell 32 m$^3$/month, with the highest demand during the dry season. As Boak village has three groups of firewood traders, total of 96 m$^3$/month can be sold from the village earning IDR 1,800,000 each, or bit higher than Nigerian farmers do (IDR 1,364,200 per month) [21]. There are 10 kilns for limestone and 15 kilns for charcoal manufacturing identified at one location in Mokong Village. The other big firewood consumers are brick and tile manufacturings located in Nijang Village. The manufacturing are inherited from their parent, that makes these activities easy to practise and by the time become the main job for most local people. There are 140 households of brick and tiles manufacturers but they are not usually located at the same place and not operated at the same time. Only industries with large capital could operate both manufacturings together. Yet the farmers are not interested to plant energy tree species. Based on the survey, the demand of firewood energy for manufacturing brick and tiles reach 12 m$^3$/month, or equivalent to 1,680 m$^3$/month/village.

The activity of limestone manufacturing is getting rarely practised due to lack of demand. Nevertheless, manufacturing of charcoal is still active because the demand for households consumption and small scale industries are always increased. In Africa, nine out of ten people rely on firewood and charcoal as their primary source of energy for cooking, heating and other uses [22]. Manufacturing charcoal and limestone actually have been practised since 14 years ago, and when the firewood is limited they prioritise to operate charcoal manufacturing. Climate does not affect manufacturing charcoal and limestone because the manufacturers usually have enough stock of firewood. They buy a truck of firewood (4 m$^3$) per month. It can be used to manufacture charcoal for tree times, meanwhile for manufacturing limestone, it is only enough for one time. The income per month from manufacturing charcoal is bigger than manufacturing limestone i.e. IDR 1,920,420 and IDR 1,137,410 respectively.
The industries do not know the origin of firewood because the transaction is conducted at industry location. To avoid unsustainable supply, the industries never depend on one single supplier. The transaction is always conducted in cash and industry will buy firewood when money is available. However, firewood is now getting difficult to find that instigate the increase of its price. Asam jawa (*Tamarindus indica*) and kosambi (*Schleichera oleosa*) are the two most favourite tree species. The price of asam jawa and kosambi firewood are higher than other species, i.e. IDR 1,000,000/truck and IDR 900,000/truck respectively. Many people are recently interested to develop business dealing with brick and tile manufacturing due to its potential incomes. The incomes from brick and tile manufacturing are estimated of IDR 3,375,000/month and IDR 5,445,000/month respectively. However, these jobs must be stopped during the rainy season, and replaced by cultivating paddy because this the best time to plant paddy. Although brick-manufactures realized the drawback of firewood usage, they find that it is still difficult and expensive to find another source fuel to fire their kiln [23].

### 3.2 Stakeholders Involved

**3.2.1 Village Government.** Boak village (2,279 ha) is a part of Unter Iwes sub-district which is bordered by four other villages i.e. Pungka (North); Legeng (South); Kerekeh (West); and Seranding (East) (Profil Desa Boak, 2014). Boak village is bordered by the state forest that causes collecting firewood from the state forest by villagers are unavoidable. Village officer cannot stop this activity, because collecting firewood is the main source of income for villagers. To anticipate conflict, village government issued a regulation allowing villagers to collect firewood from dead trees, stump and fallen branches. However, villagers feel that their right to utilize firewood from the state forest is very limited. On the other hand, outsiders who never contribute in regenerating forest have been rewarded privilege to collect firewood in the state forest. When the forest was managed by State Owned Enterprise (Perhutani), most villagers get involved in cultivation activities. Therefore, they are allowed to extract forest product as compensation of their work. Unlike community outside Boak Village, the Boak community are prohibited to utilize forest product. The conflict in the forest region had been arisen since long time ago that was caused by violation right of local people, unfair treatment, offense, blamed, oppressed, which creates further hostility. The peak of conflict was then send to public domain and was processed under dispute case [24]. To decline firewood consumption, the local government issued policy to provide LPG programs (3 kg) started in 2017. It was scheduled that by 2017, a number of 500 complete stove set based on 3 Kg LPG would be distributed. Unfortunately, the programme failed because people are afraid of the gas explosion and only 180 of 603 households accept the programs.

**3.2.2 Forest Management Unit (KPH) of Puncak Ngengas-Batulanteh.** The area of KPH Puncak Ngengas-Batulanteh is mainly bordered by settlement areas from following sub-districts: Batulanteh, Moyo Hulu, Moyo Hilir, Moyo Utara, Unter Iwes, Labuhan Badas, Rhee and Lape. To secure the area, KPH officers implement a kinship approach to surrounding forest community. As far as they do not cut the trees in the state forest, they are allowed to collect firewood for domestic purposes. To maintain the state forest, the kinship approach was prefered by KPH because the KPH officers are also villagers. The emotional closeness between officers and the villagers makes all programs and regulation easier to conduct. The officers know well Boak people, they even make relative bound. This is the best option so far in managing forest whereas multiple benefits e.g. economic, social and ecology could be obtained together.

### 3.3 Determinants of Firewood Development

To accelerate the fulfilment of energy in Sumbawa Regency, an integrated program involving related stakeholders have to be initiated soon. The programs should consider the potency of human and natural resources which are classified into ten variables as follows:
V1 = Planting tree among community has become a tradition
V2 = Firewood species has been well recognised,
V3 = Information of market chance has been well recognised,
V4 = Many industries lean on firewood
V5 = Firewood still used as energy for cooking by household
V6 = The extension on firewood development has been conducted by related institution,
V7 = The land for firewood development is available,
V8 = The labour for firewood development is available,
V9 = The financial for firewood development is available,
V10 = The cultivation technology for firewood development has been mastered.

The ten variables are then analysed to identify which variables support the development of firewood in Sumbawa Regency, as shown in Table 1, 2 and 3.

Table 1. Summary of answer list of community on variables tested

| No. | V1 | V2 | V3 | V4 | V5 | V6 | V7 | V8 | V9 | V10 | Total |
|-----|----|----|----|----|----|----|----|----|----|-----|-------|
| 1.  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 1  | 0  | 0   | 2     |
| 2.  | 1  | 0  | 0  | 0  | 1  | 0  | 1  | 0  | 0  | 0   | 3     |
| 3.  | 1  | 0  | 0  | 0  | 1  | 0  | 1  | 0  | 0  | 0   | 4     |
| 4.  | 1  | 0  | 1  | 1  | 0  | 1  | 1  | 0  | 1  | 6   | 6     |
| 5.  | 0  | 1  | 0  | 1  | 0  | 1  | 1  | 1  | 0  | 6   | 6     |
| 6.  | 1  | 0  | 1  | 0  | 1  | 0  | 1  | 1  | 0  | 6   | 6     |
| 7.  | 0  | 0  | 0  | 1  | 1  | 1  | 1  | 0  | 0  | 5   | 5     |
| 8.  | 1  | 1  | 0  | 1  | 1  | 0  | 1  | 0  | 1  | 7   | 7     |
| Total| 5  | 2  | 2  | 4  | 7  | 1  | 7  | 7  | 2  | 2   | 39    |

Table 2. The score of community opinion upon variables

| No. | V1 | V2 | V3 | V4 | V5 | V6 | V7 | V8 | V9 | V10 |
|-----|----|----|----|----|----|----|----|----|----|-----|
| 1.  | 2  | 2  | 2  | 2  | 2  | 1  | 2  | 2  | 1   | 2   |
| 2.  | 2  | 3  | 3  | 3  | 2  | 3  | 2  | 3  | 3   | 3   |
| 3.  | 3  | 4  | 4  | 4  | 3  | 4  | 3  | 4  | 4   | 4   |
| 4.  | 5  | 6  | 5  | 6  | 6  | 5  | 6  | 5  | 6   | 5   |
| 5.  | 5  | 6  | 5  | 6  | 6  | 5  | 5  | 5  | 5   | 6   |
| 6.  | 5  | 6  | 5  | 6  | 6  | 5  | 5  | 5  | 5   | 6   |
| 7.  | 5  | 5  | 5  | 4  | 4  | 4  | 4  | 4  | 5   | 5   |
| 8.  | 6  | 6  | 7  | 6  | 6  | 7  | 6  | 6  | 7   | 6   |

Table 3. Resume of bi-serial correlation and p-values of variables tested

|        | V1    | V2    | V3    | V4    | V5    | V6    | V7    | V8    | V9    | V10   |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Point  | -0.04 | 0.36  | 0.14  | 0.47  | -0.44 | -0.17 | 0.53  | 0.25  | 0.14  | 0.36  |
| P-val  | 0.63  | 0.25  | 0.25  | 0.50  | 0.88  | 0.13  | 0.88  | 0.88  | 0.25  | 0.25  |

Biserial point correlation technique was implemented to test validity, as noted by [25] who stated that biserial point correlation is a statistical value to estimate a correlation strength between continuous and dichotomous data. The higher correlation, the more valid variables tested. Basically, when the correlation coefficient bigger than 0.3 the variables were categorized as valid [26].

To generate and develop psychology scale, minimal correlation coefficient value used is 0.3 [27]. It means that all items having value less than 0.3 will be sorted, while the items with the correlation value higher than 0.3 will be included in the test because they are valid or more consistent. Based on the
statement above, the variables which is valid to be used as an instrument to test the question to key persons are variables with correlation value similar to or more than 0.3. The four consecutive variables used as instrument to test the questions during the interview are the availability of land for firewood development is sufficient ($V_7$); industry which consumes firewood is many in number ($V_4$); community recognize the species of firewood energy ($V_2$); and the technology to cultivate firewood trees has been mastered ($V_{10}$). In other word, those four variables influence the development of firewood energy in Sumbawa Regency. Other variables in fact do not contribute a significant role in the development of firewood energy since their biserial correlation is invalid (less than 0.3 or negative). According to [28] the decision to produce firewood was positively related to native forest cover (%) in the farm and the presence of forest plantations, while negatively related to the proportion of off-farm income (%). [29] also informed that consumption of firewood per capita increases as the proportion of land under forest cover increase.

The value of $p$ in the evaluation to the biserial correlation indicates the level of difficulties, while the value of biserial indicates the quality of given variable or usually known as a problematic variable. A negative value at variable $V_1, V_3$ and $V_6$ and the lowness value of biserial correlation of variables $V_3, V_5$ and $V_9$ indicate that those variables are probably in problem or are not in accordance with the purpose of the test. Therefore, the appropriateness of those variables to the purpose of test need to be further evaluated.

To develop the firewood in Sumbawa Regency, the government should consider four determinants above $V_{7,4,2,10}$. The chance of success for firewood development in Sumbawa Regency is quite high because the firewood energy is still highly needed by many industries, while local people have recognised firewood species as well as its cultivation technology. Most importantly, the land for cultivating firewood trees is available.

4 Conclusion

This research revealed that the business of firewood involved many stakeholders namely producer (farmer); middlemen (broker); consumer (industry); and government (village officer and KPH employee). They had their own role to guaranty the use of firewood environmentally friendly, economically wealthy, and could avoid social conflict. The production of firewood in Sumbawa Regency was far smaller than its yearly demand, i.e. 9,216 m$^3$ compare to 21,040 m$^3$ respectively, resulting 11,824 m$^3$ deficits. Nevertheless, the stakeholders committed to prioritise the production of firewood to supply the local demand and had never sent firewood out to other regency. Furthermore, despite of shortage, the consumers have never imported firewood from others and led the production of brick-tile are very limited and their income just only reach subsistence level.

The determinants of firewood development comprise of: land availability; well recognition to firewood species by community; well-mastered on cultivation technology by farmer; and high demand for firewood energy by industry.

To sustain the forest and to improve farmer welfare, the enthusiasm of farmers to grow trees for energy has been appreciated by government by rewarding them the points which can be swap with daily personal uses. Furthermore, farmer who grows trees at their own land would be free from paying the land and building (PBB) tax. Alternatively, government subsidise efficient stove which can decrease the consumption of firewood as well as increase the accompaniment and extension visit to the farmers.

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