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Developing the under stand cropping system (PLDT) for sustainable livelihood

Eva Banowati, Sucihatiningsih Dian Wisika Prajanti,

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Eva Banowati
Department of Geography, Universitas Negeri Semarang, Semarang, Indonesia, and
Sucihatiningsih Dian Wisika Prajanti
Department of Development Economics, Universitas Negeri Semarang, Semarang, Indonesia

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Abstract

Purpose – The purpose of this paper is to investigate and develop a full-cycle teak (Tectona grandis) under stand cropping system or PLDT for sustainable livelihoods of forest village community in Indonesia.

Design/methodology/approach – An experimental analysis was used, and the population consisted of units of land of the Community-based Forest Management (in Indonesian called *Pengelolaan Sumber Daya Hutan berbasis Masyarakat* – PHBM) cultivated by 67 farmers. Further, farmers, the board of Forest Village Community Institution (in Indonesian called *Lembaga Masyarakat Desa Hutan* – LMDH), and forestry officials were also involved. The method employed was a survey approach using forest mapping result as the primary data. Secondary data were obtained from the LMDH and PHBM documents, measurement of physical conditions, model plots, and focus group discussion.

Findings – Findings reveal that replacing polycultural cropping system with sequential cropping one is useful in improving farmers' income. It was proven that the products of polycultural cropping contribute only 61.23 percent of proper income. Meanwhile, through the right selection of species of shade-tolerant crops and sequential cropping the contribution can be increased to 85.28 percent: an increase of more than 24 percent. This shows that PLDT is reliable for implementation by using certain seasonal plants and cropping pattern. Next, this research limits itself to an area having teak forest, and its practical implication is to provide an alternative way for generating income and food availability.

Originality/value – This paper is original and has unique value because it discusses issues related to seasonal plantation grown under long-circle crops for a better living condition. The proposed plant is environment-friendly and could possibly be applied to areas having teak forests.

Keywords Farmers, Income, Planting/cropping pattern, PLDT, Seasonal plants, Sustainable livelihood

Paper type Research paper

Introduction

A decline in the agricultural areas due to high population has caused limitations for landholding; this leads to the structural transformation of farmers becoming farm labors (Kustiawan, 1997). Limitedness of agricultural land ownership per farmer household is threatening farmers' livelihoods, since it can cause poverty and food shortage. Poverty lines in some of Indonesian regions are increasing and food is getting scarce (Prasetyo, 2012). For example, poverty rate in Pati Regency, based on direct survey of the residents, rose from 14.08 percent in 2011 to 14.69 percent in 2012 (Bappeda of Central Java Province, 2013).

Pati Regency is located in the northeastern part of Central Java Province. It plays a strategic part in developing economy, society, and culture due to its potential natural resources and human resources that can be further developed in all aspects of community life. The potential products of Pati are food crops, plantations, forestry, livestock and fisheries. The conditions of the existing natural resources, geographical position, and the dynamics of the society have development potential. The livelihoods in the Pati Regency lie in the "hinterland" area, i.e. areas that are not around the sea, and make use of the land for farming activities and plantations. Similarly, at Semirejo village, the land used as

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production forest covers 52.8 ha (i.e. more than 14.4 percent of the width of the village, which is 365.770 ha) while the housing area is 75.142 ha (Figure 1). People live close to forest and make a living by utilizing forest resources: people are involved in land-based activities, work as non-land-based Pesanggem farmers, or breed large animals or honeybees. Non-land-based activities refer to activities conducted outside the forest land, but the activity is greatly influenced by the condition of the forest (Figure 2).

Pati Regency has to improve and build its region to bring about a positive change; the target for Millennium Development Goals has not been achieved yet. Programs such as

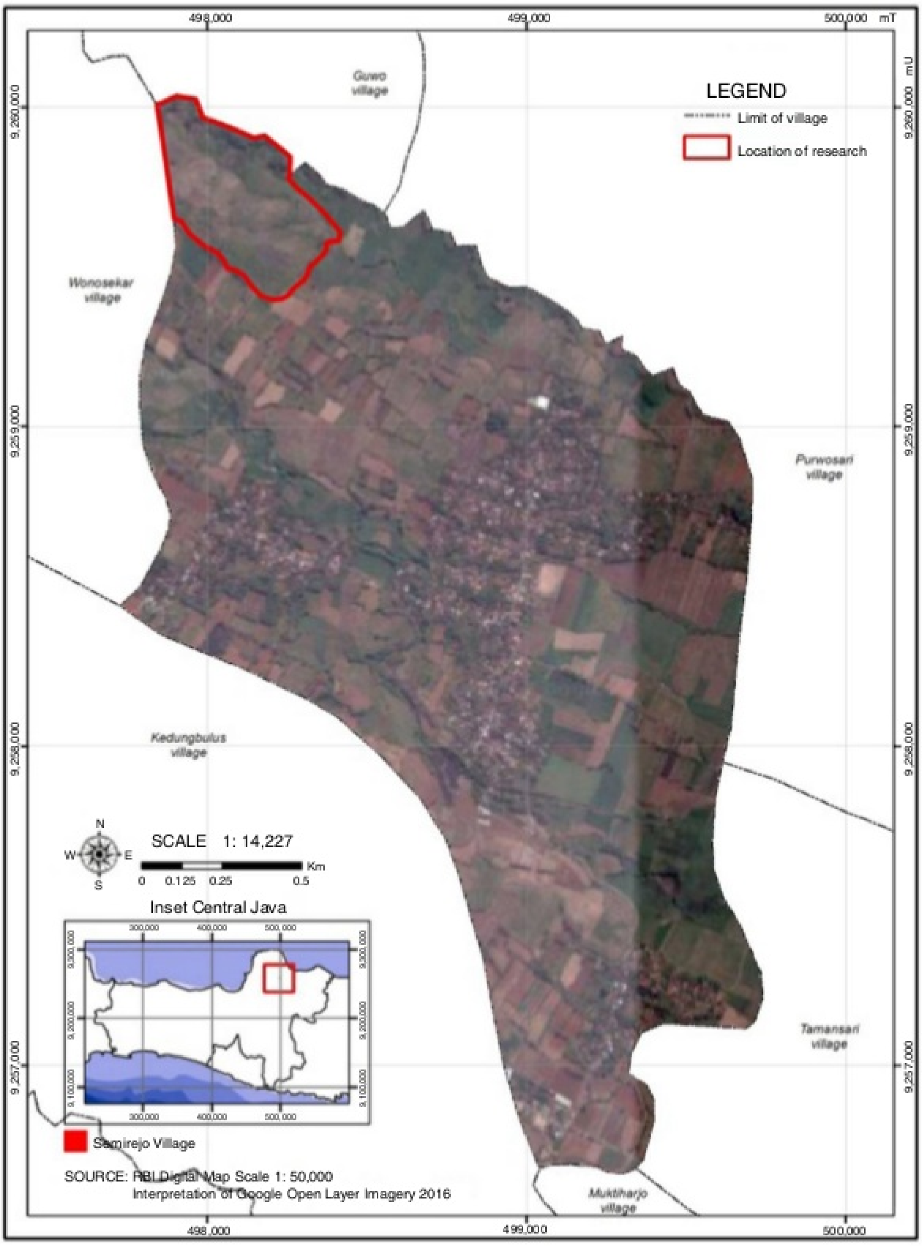


Figure 1.
The map of land use in Semirejo village, Gembong sub-district

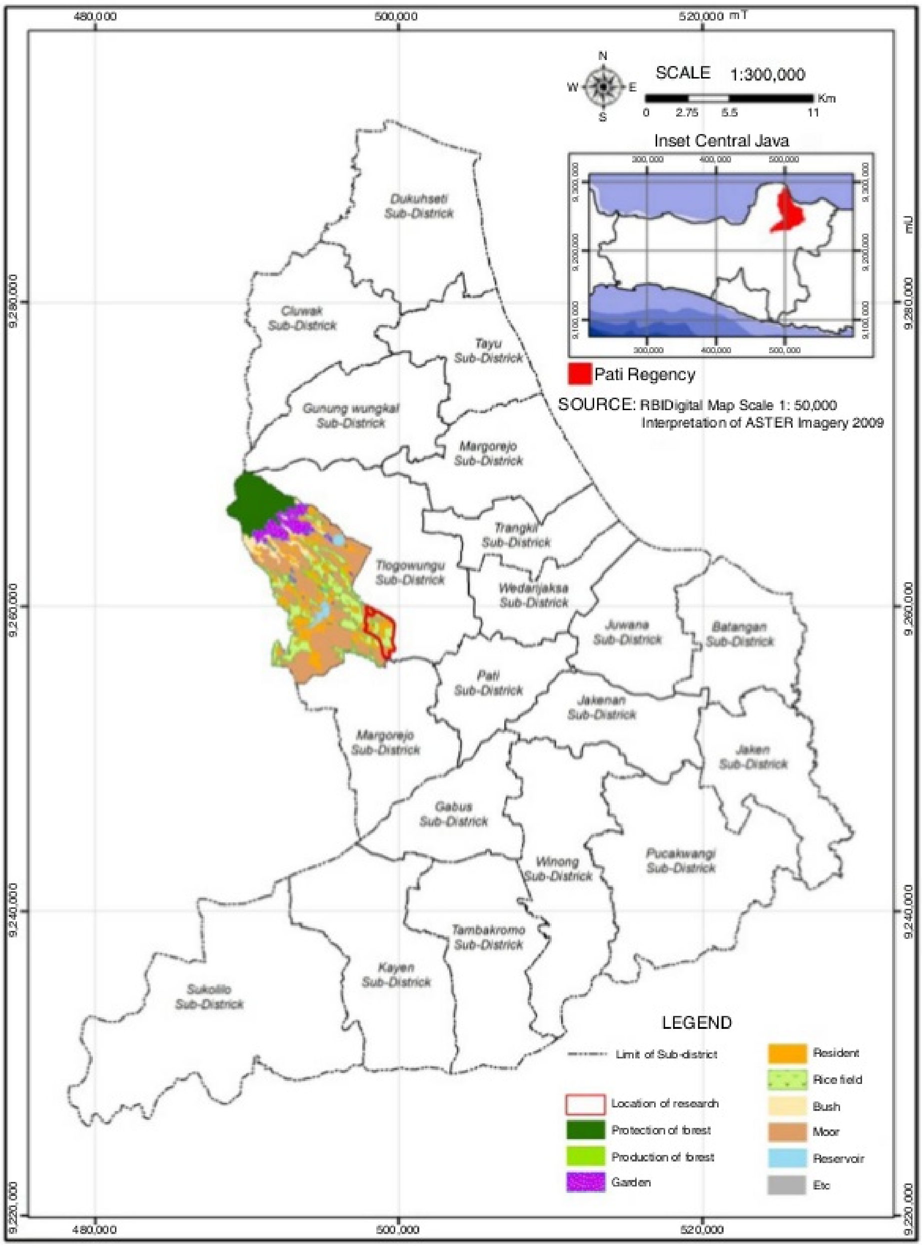


Figure 2.
The map of land use in Gembong sub-district, Pati Regency

the Alleviation of Poverty and the Community Welfare only achieved 16 percent of the total target. This is below the average of 30.9 percent for Central Java. The prosperity approach was carried out by *Perhutani* through Community-Based Forest Management (in Indonesian called *Pengelolaan Sumber Daya Hutan berbasis Masyarakat* – PHBM) encouraging forest villagers to share with each other in order to achieve a common goal, i.e. optimal and proportional sustainability of functions and benefits of forest resources.

Shade-tolerant crops can be grown under tall teak *(Tectona grandis)* stands. Besides, during six months of dry season, the teak trees adapt to the season by shedding their foliage.

This condition is exploited by farmers to cultivate crops using the polycultural (multi-species) cropping system to support their livelihoods. Species and varieties of crops selected must be suitable along with the physical condition of the stands based on cropping rotation concept in order to maintain land fertility (Thahir and Hadmadi, 1992; Suharjo, 1999; Rukmana, 1995 cited in Banowati, 2011). Biophysical or agro-climatic environment, characteristics of soil, species and varieties of crops, and socio-economic condition of forest villagers determine the cropping system selected by the community. The amount of different exposure to sun that each species of crop vegetation receives is used as the basis for developing a full-cycle under stand cropping system (PLDT), in harmony with seasonal changes.

Success in the development of the under stand crops refers to the productivity concept used to measure capability of increasing total yields over time (Cahyono, 1996). An increase in the yield productivity of forest village community is identified as having two dimensions. The first dimension is effectiveness, which refers to the achievement of production target for under stand crop harvest and is related to quantity and harvesting times. The second target is efficiency, which is related to an attempt to compare input with realization of land resource optimization using farming skills, knowledge of planting calendar (times), capital and other resources for better quality of life (Ravianto, 1989; Sinungan, 1995; Herjanto, 2007).

A cropping system utilizing the area under the stand on monocultural production forest similar to natural forest structure is viewed as an important innovation, as it creates multi-layered vegetation and root systems that can control erosion. In order for land use to be easier and more efficient, planting calendar is reset by considering rainfall spread and precipitation volume within a period of one year. Farmers require knowledge about cropping system that is suitable for their particular environmental conditions, since it will help them maximize their total yields without disregarding land stability, soil fertility, erosion, and regional and global environmental damage. Based on this background, this paper presents the results of the research investigating the development of the full-cycle PLDT (or what is sometimes called "land use under canopy (PLDT)") for sustainable livelihoods of forest village community (or forest-dependent people).

According to Alao and Suhaibu (2013), agroforestry is a dynamic, ecology-based natural resources management system that through the integration of trees in farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels. However, the earnings derived through agroforestry cannot serve as the main earning for the whole family. For example, although agroforestry provides a basic income and covers a significant amount of families' food requirements in Israel, unfortunately it cannot provide full income for families (Rabia *et al.*, 2008). The benefits derivable from the interface between forest trees and agricultural crops are enormous. They include the optimal use of land for both agricultural and forestry production on a sustainable basis, including the improvement of the quality of soil. This is in addition to the socio-economic benefits that are accruable from agroforestry. Indeed, the advantages of agroforestry are all encompassing and germane to a sustainable production system and livelihood.

Mahanty *et al.* (2006) state that recent years have seen a growing interest in the role and potential of PHBM as a vehicle for poverty reduction. Some analysts suggest that PHBM initiatives show limited potential for poverty reduction, because they are prone to elite capture, they focus on low value, degraded forests, they place emphasis on forests rather than integrated natural resources-based livelihood development, and because of the high transaction costs facing the interest of the poor in harnessing high-value goods such as timber. They also state that there are three key areas in which more work needs to be done by PHBM professionals in order to harness the poverty reduction potential of community forestry: governance, appropriate enterprise development and integrated approaches.

Farmers in the village are in favor of agroforestry because it is believed to play important role in decreasing poverty (Mahanty *et al.*, 2006). It can offer basic income and meet food requirements (Rabia *et al.*, 2008), and can also improve the condition of the society, economy and environment (Alao and Suhaibu, 2013). However, agroforestry also has its weaknesses. Even though it can generate income for farmers, it cannot fulfill the needs of Pesanggem farmers' families. This is due to less optimum farming management driven by the planting pattern, and the planting system that does not consider the existent climate. This research (the development of PLDT model) is offered as one of the solutions from professional PHBM, as an education platform for forest farmers. Besides, it provides farmers an insight related to regulation forbidding planting cassava in the forest area.

Research method

This research employed the experimental method to manufacture experimental plots under teak stands at three various ages: 14, *Peneresan* (discard the cambium to reduce the moisture content in the wood prior to clearing) area, and on logged-over area (LOA)/ in the post-harvest timber area. The types of agricultural crops in each plot are various depending on the canopy density and planting calendar. The quantity of the harvest from the plot trial was analyzed and was compared with the controlled groups having no manipulation (Creswell, 2003; Sugiyono, 2009).

The research took place in production forest where teak (*Tectona grandis*) stands are grown, i.e. Muria Forest area in Pati Regency. The population was units of land of the PHBM of Semirejo Village, Gembong sub-district, and the sample area was determined based on age of the stands. This research used a survey approach using spatial analysis. Primary data were gained from observation of forest mapping. Then, measurement of physical condition was conducted by the use of geographical tool and soil tester (Table I). After this, to gather comprehensive data, focus group discussion (FGD) was employed to collect information on problems and solution for sustainable livelihood for Pesanggem farmers cultivating the land, involving 263 family members of 67 farmers. Secondary data were obtained from the Forest Village Community Institution (in Indonesian called Lembaga Masyarakat Desa Hutan – LMDH) and PHBM policy documents.

FGD was conducted by involving related stakeholders: *Pesanggem* (12 people), the officers of LMDH, and villagers officers (5 people). They were selected for this FGD because they were regarded as knowledgable people due to their understanding of the issue and could give inputs.

This research has three stages, namely the preliminary research, model development, and implementation models. The preliminary stage was conducted by measuring the physical environment, and by counting and measuring plots at the location of research for soil type, size, kind of stands, and stand age. In addition, analysis of the physical environment was also carried out to measure intrinsic condition of the forest village

Plot	Soil: solution used Aα Bifiridil	H_2O_2	HCl	pH	Air temperature (%)	Elevation (m)	Tilt (%)
Plot under teak stands aged 14 years old	Water Seeped (AM)	Color changed (BB)	Frothy (BB)	6.8	31°C/ 72	138	16
Plot *Peneresan*				6.6	31°C/ 67	137	10
Settlement				6.5	30°C/ 67	136	5

Source: Primary data (2015)

Table I. The measurement of physical condition at the research area communities: cropping patterns, crops and crop varieties. At the stage of development, physical environment measurement and social environment data were used to produce a model area which was then used for the implementation model. Implementation of the model was carried out with the cooperation between researchers, and community and forestry stakeholders.

Meanwhile, data analysis was based on geographic approach focused on spatial analysis (Singarimbun and Effendi, 1995; Yunus, 2010). It results in area features. The area feature includes the structure of leaf stage on plot development model. This shows an association between plant stand and agricultural crop in one area (spatial association), in the commensalism way. It also involves analysis of spatial structure focusing on elements needed to optimize the function of the forest.

The framework closely used the ecosystem approach by balancing the three involved environmental elements (Abiotic-Biotic-Culture) in forest ecosystem as the sustainable life support integrated with agroforestry at the forest production management (Yunus, 2010).

Findings and discussion

Muria Forest area is located 49-52 m above sea level, which is a relatively steep slope with the elevation ranging from 135 to 138 m. The average air temperature is about 32.3 °C with an average relative humidity (RH) of 63 percent. Result of measurement revealed that the soil has a pH of 6.3, an RH of 60 percent, good drainage, a lot of organic compounds, and contains lime in the soil (Banowati *et al.*, 2015). At regencial level, the average annual rainfall is about 1,002 mm falling over 55 rainy days. The lowest identified temperature is 23 °C and the highest is 39 °C. Based on precipitation and rainfall spread, the areas in Pati Regency fall under various types of climate: for agriculture, the types are C2, D2 and E1-E4 (Department of Agriculture of Pati Regency, 2014).

In Gembong sub-district, annual precipitation averages between 2,001 and 2,500 mm (Nurhayati and Nugraha, 2013). This area is designated as type D2 which merely enables single-species cropping, i.e. where paddy or other types of crops are grown only once within a year, depending on the availability of water supply by irrigation. On the other hand, 42 percent of unit 114 and unit 115 of PHBM area of about 52.8 ha are used to cultivate crops during a year. These units of land had been cultivated by 67 local *pesanggem* farmers under the coordination of LMDH *Wana Makmur*.

Contribution of food crop yields per cycle toward people's income

On average (Table II), a *pesanggem* farmer uses a plot of 0.33 ha for polyculture. Until now, prior to cropping model, these units of land had been used for intercropping peanut (*Arachis hypogaea* or *Kacang tanah*), corn (*Zea mays* or *jagung*) and cassava (*Manihot esculenta* or *singkong*). This system had been implemented by more than 89 percent of the community. Based on information which was elicited from the farmers and cross-checked by field observation, it was found that the largest area (12.7 ha) had been used for cultivating cassava, and the smallest area (0.5 ha) had been used for cropping aromatic ginger (*Kaempferia galanga* or *kencur*). However, a paddy (*Oryza sativa* or padi) field of 1.8 ha

Table II. Land use structure of community-based forest management PHBM in Semirejo village (in hectare)

Cassava	Peanut	Corn	Aromatic Ginger	∑ ha
4.925	4.055	0.545	0/21	9.775
5.5875	2.705	0.235	0.2	8.7275
2.1875	1.225	0.075	0.1	3.5875
12.7 (57.49%)	7.985 (36.15%)	0.855 (3.87%)	0.51 (2.49%)	22.05 (100%)

Source: Primary data analysis (2014-2015)

(Banowati, 2011) is now used for planting cassava (1.25 ha) and the rest (0.55 ha) is utilized for monocultural cropping of aromatic ginger (Banowati *et al.*, 2015).

Out of 67 people in the *Pesanggem* community, 56 were cultivating peanut. For cultivating this crop (peanut), they allocated an area of 7,985 ha. This crop can be harvested twice a year and yield 6,388 quintals of products with a total sale value of Rp. 86,238,000.00 per annum (equal to 9,582 kg of rice or the average amount of rice consumption of 798.5 kg per month per 56 *pesanggem* people, or 14.26 kg of rice per month per person). Another kind of food crop is cassava cultivated by 67 *pesanggem* farmers within a period of 11-12 months in an area of 12.7 ha yielding a total production of 457.2 quintals valued at Rp. 26,517,600,00. The amount of money generated is equal to that generated by 2,946.4 kg of rice (or 245.5 kg of rice (*Oriza sp* or *beras*) per month per 67 *pesanggem* farmers or an average of 3.66 kg per month).

Aromatic ginger crop produced a large amount of yields. This huge production was due to soil that contains fertilizing organic matter and was easy to cultivate. There were 11 *pesanggem* farmers cultivating it. It was cultivated on an area of 0.55 ha and produced 4,675 kg of yields. The ginger was cultivated monoculturally (using single-species planting system) and harvested after 11 months. In 2014, aromatic ginger produced 4,675 kg of yields. The price ranged from Rp 2,000 to Rp 3,000 kg. This price was lower than it used to be in 2011, i.e. Rp 8,500 kg. Accordingly, the production value, if converted into rice price, could afford only 0.222 kg of rice in 2014 compared to 1.15 kg of rice it could buy in 2011. A drop in ginger price has made *pesanggem* farmers reluctant to continue its cultivation. The additional reason for this reluctance is that ginger is not consumed as a staple food.

Corn price, in the recent five years, has been relatively good and stayed stable at more than Rp. 3,000 kg. This crop has been used as border (fence) among plots of cultivation land used and controlled by each *pesanggem* farmer. The yields have been of high quality and not spoiled by pests (caterpillars) that usually damage baby corn. The variety of corn cultivated was *bisi 2* (two). About 90 percent of the yields are consumed and good-quality baby corns are stored as the seeds to be planted in the next cropping season. Corn production averages 5,380 kg each harvest time, which means an annual yield of 10,760 kg that is valued at Rp. 3,200.00 kg. If converted into rice, these corn yields equal 3,825 kg of rice (Banowati, 2011; Banowati *et al.*, 2015).

Total products gained by cultivating four species of crops utilizing PHBM's units of land are worth Rp. 156,537,600, which is equal to 17,393.2 kg of rice (Table III). Peanut contributes 55 percent of income as it is shade-tolerant from 40 to 70 percent. This agrees with Wahyuningrum and Pramono (2012) research finding that under teak stands with 57.27 percent canopy, a land equation ratio (LER) of 1.31 does not show significant difference compared to cropping in open area (monoculture of one-season crop), which is indicated by an LER ratio of higher than 1.

In utilizing land under teak stands, we should take into account that under stand, crops are usually influenced by such factors as characteristics, age, spacing and the canopy of

No.	Area	Peanut (Kg)		Cassava (Kg)		Ginger* (Kg)	
		Relay crop	Multi crop	Relay crop	Multi crop	Relay crop	Multi crop
1.	Under teak stands aged 14 years old	760	200	–	5,000	3,408	3,340
2.	Logged-over	–	–	7,000	7,000	–	–
3.	*Peneresan**	900	–	10,000	–	–	–

Note: [a]An activity of removing the water content by cutting the cambium and bark before harvest timber ▨ Model plots
Source: Primary Data, (2014-2015)

Table III. Production quantity of under stand crops (PLDT) gained from 1 time harvest (in 0.5 hectare) the stands. First of all, we should note that the varieties of crops are selected to suit agro-climatic conditions of the area. Naturally, the taller the trees, the wider the canopies will be. Thick canopies create heavy shade, affecting the availability of sunlight needed by under stand crops to photosynthesize. Due to this condition, it is necessary to replace the current vegetation with those that thrive in heavy shade.

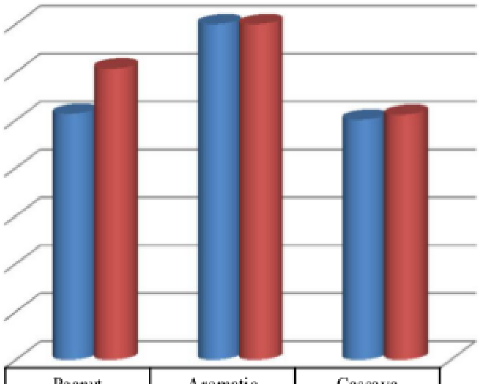
Forest plots in Semirejo village have a relatively steep slope with the elevation ranging from 135 to 138 m. The temperature and humidity average at 29°C and 72 percent, respectively. The analysis of soil condition reveals soil fertility, and of soil pH shows a normal pH value of above 6. In dry season, water from irrigation is still available. It rains over 11-14 rainy days per month (April-June, 2015). In the season, model area is intrinsically used to reinforce activities favoring sustainable livelihood of forest village community.

Development of PLDT for increasing productivity

In dry season, instead of becoming a space for weeds to grow, it is better for farmers to utilize the environment under loose spacing teak stands to grow under stand crops. Farmers grow cassava periodically and continuously. Although the price of cassava yields is decreasing, officials' recommendation for not growing cassava is ignored. Farmers are reluctant to grow other varieties of crops since they(a) lack capital for buying seeds; (b) are not brave enough to experiment with other crops; (c) are anxious about failed harvest caused by the cost for buying fertilizers and pesticides needed during planting cycle; and (d) worry about difficulties in marketing the new products. Farmers believe that the marketing of cassava is easier because there are many industries in Pati Regency needing cassava for industry tapioca flour.

In this research, full-cycle PLDT was conducted through model plots as an educative attempt to minimize and answer these three reasons ((a), (b), and (c)). Development plots for productivity increase are based on Herjanto's (2007) theory proposing how to manage and utilize land resources for optimum yields. This research was carried out with assistance, and took into account physical conditions of land and land tenure. Besides, this study offers insight related to regulation forbidding cassava planting in forest land.

Monocultural crop using sequential (relay) planting system was developed in each plot of 0.5 ha. Selected seeds in model plots were seeds of superior varieties, i.e. peanut Bison varieties, aromatic ginger Galesia-2 varieties, and cassava Daplang (bitter) varieties. Each variety of crops is planted using standard spacing distanced 1 meter to teak stands, grown in pre-determined block, and spatially analyzed in comparison to previous results (Figure 3).



	Peanut	Aromatic ginger	Cassava
Borgan (Policulture)	10,260,000	14,000,000	10,020,000
Model (Relay croping)	12,150,000	14,000,000	10,224,000

Figure 3.
Income gained from the development of under stand cropping system (PLDT) generated from PLDT model development

The quantity of yields from model plots was higher, about 1.5 to more than 3 times, than those from non-model plots. Among model plots, peanut yields increased mostly. Production quantity of cassava rose about 70 percent, but ginger yields almost stayed the same. Model plots were used as cropping model in order for *pesanggem* farmers to understand biophysical condition of cultivation land as well as cropping patterns (systems) and varieties of crops necessary and suitable for sequential (relay) cropping.

Planting calendar of PLDT combined with farmers' experience in understanding physical condition of land and selection of crop varieties in relation to land tenure are important factors in the development of land use and management; this agrees with what Widianto and Suprayogo (2003) have stated. Additionally, these factors could be solutions in resolving conflict of interests among *pesanggem* community having orientation toward non-timber yields (food crops) and *perhutani* oriented toward state-owned timber production forest (Banowati, 2011).

This modeling implemented monocultural (single-species) planting using land blocks of 0.5 ha each under teak stands (Table IV). Implementation of the modeling took the following steps:

(1) First, modeling was conducted in under teak aged 14 years at the beginning of rainy season, i.e. at the end of September 2014, starting with preparing the land for planting rhizome (aromatic ginger). At the time, farmers had finished harvesting cassava. Analysis of modeling illustrates that ginger is more shade-tolerant than cassava.

(2) Second, modeling was carried out in *peneresan* area in which cassava was grown. Besides, this crop is the favorite (compared to aromatic ginger) in monocultural cropping block in the LOA.

(3) Third, modeling was done under another block of stands. It was under teak aged 14 years in the LOA. In that plot, peanut (*Arachis hypogaea*) were planted at the end of the rainy season until the end of dry season. Soil of the land block still contained some water, because the position of this model plot is lower than that of the first one.

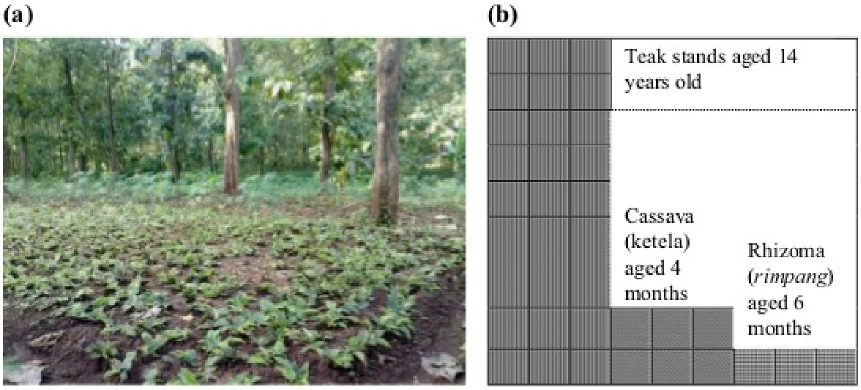
This research favors what the Ministry of Agriculture (2014) has stated that crops and rhizomes or aromatic gingers do not compete with teak trees, be it in receiving sunlight or in absorbing soil nutrients because they are shade-tolerant and can thrive in relatively low intensity of light; can thrive and produce large amount of yields in area suitable for the main crop (teak crop); are not taller than the main crop and have root system at the upper layer of the soil far above that of the main crop; are not infested by pests and harmful diseases that damage the main crops; e) do not cause production decrease in the main crop, do not cause erosion, do not damage the main crop as well as the soil; and produce yields which are marketable and profitable.

Monocultural relay cropping is more profitable economically than is mix-cropping. At different stages of age, production of stands differs. This is due to spacing, lighting and inappropriate nurture (Figure 4). Income per cycle gained from peanut production of

<table>
<tr><th rowspan="3">No. unit</th><th colspan="12">Month</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th></tr>
<tr><th colspan="3">Rainy season</th><th colspan="5">Dry season</th><th colspan="4">Rainy season</th></tr>
<tr><td rowspan="4">114 and 115</td><td colspan="8">Polyculture</td><td colspan="4">Beginning of rhizome (rimpang) planting</td></tr>
<tr><td colspan="9">Yam (ubi rimpang) cropping until harvest after 11 months</td><td colspan="3">Beginning of yam (ubi) planting</td></tr>
<tr><td colspan="6">Cassava (ubi kayu) cropping until harvest</td><td colspan="5">Corn</td><td>Bero</td></tr>
<tr><td colspan="3">Pruning</td><td colspan="5">Peanut</td><td colspan="4">Beginning of rhizome (rimpang) planting</td></tr>
</table>

Sources: BPS (2013); Primary data analysis (2014-2015)

Table IV. Planting calendar of under stand crops (PLDT) under teak stands



Source: Primary data analysis (2015)

Figure 4.
Vegetation layers of under stand cropping plots

the development of monocultural cropping was higher than that of polycultural one. In *penerasan* land (Table III), the crop could produce 900 kg of yields valued at Rp 12,150,000, while under the teak stands aged 14 years old, it could produce only 760 kg of yields worth Rp 10,260,000. It is obvious that there is a difference of Rp 1,890,000 equivalent to 210 kg of rice, which is due to the fact that the area was covered by canopy. In local market (2015), the price of wet peanut is Rp. 13,500, cassava is Rp. 2,000, aromatic ginger is Rp. 3,000, and rice is Rp. 9,000.

Figure 3 illustrates that income gained from model plots is higher than that from non-model ones. There was an increase of Rp. 2,094,000, giving farmers contribution equal to 232.7 kg of rice per annum per 0.25 ha or 30.8 kg of rice per annum per ha. Based on Table III, yields of peanut and aromatic ginger in 8.495 ha (38.53 percent of cultivation area) would increase to Rp. 2,617,500 if the cultivation area were enlarged by 50 percent.

Food availability (Raharto, 2010) is measured by ratio between normative food consumption and food availability produced in a region (rice equivalent). Normative food consumption is elicited by assuming consumption per capita per day, i.e. 300 grams per person per day. The ratio also demonstrates proportion used for consumption.

Table V illustrates that the proportion of food availability in Semirejo village consumed by 67 *Pesanggem* farmers from PHBM area is equal to rice of 48.3114 kg per day (or 48,311.4 grams per day). Accordingly, food consumption of each member of household is 183.693 grams (48,311.4 grams: 263 people). This means that the food consumption lacks 116.31 grams per person per day (300 grams per person per day–183.693 grams) from normative proportion. Cumulatively, this indicates food vulnerability of 917,685.9 grams

Table V.
Food availability of each household of *pesanggem* community in Semirejo village

Food resources	Rice equivalent (Kg) Per annum	Per month	Per day
Cassava	2,946.4	245.5	3.66 (67)
Peanut	9,582	798.5	26.62 (56)
Aromatic ginger	1,039	86.58	7.87 (11)
Corn	3,825	318.75	10,625 (67)
Under stand cropping (PLDT)	17,392.4	1,449.33	48.3114
Under stand cropping (PLDT) model	25,303.07	2,018.55	67.285
Value added	7,910.67	569,222	18,974

Source: Primary data analysis (2014-2015) per month (116.31 grams × 30 days × 263 people) or is a lack of 917.7 kg of food per month or a lack of 11012.4 kg per annum.

Results of analysis show that under stand crop yields contribute 61.23 percent of daily needs. By transforming cropping system from mix-cropping into monocultural crop system using sequential cropping method or polycultural crop system using blocking method, which takes agro-climatic condition into account, the planting calender under stand cropping contributes 255.84 grams of rice per person (67,285 grams: 263 people) or approaches 85.28 percent normative fulfillment of food or it increases by 24.05 percent. It is an innovative educative strategy in developing PLDT. The result shows that the development of innovative PLDT considering planting calender could improve food availability and income generation.

Selection of cropping system and under stand crop varieties should consider difference of spacing of the canopy. Aqsa (2010) classifies canopy spacing as sufficiently tight (40-70 percent) and loose (less than 40 percent). This is important in order to be efficient in utilizing the land and favor sunlight intensity, water and minerals. Murniyanto *et al.* (2011) found that intensity of sunlight penetrating canopy during November to December ranged between 4.47 and 14.85 percent. It is further explained that sunlight penetrating canopy and touching the forest floor could cause damaging effect. On the one hand, under stand cropping is beneficial. On the other hand, it could cause problems. In order to be effective, we should consider crop selection and timing, and season (Huxley, 1999 in Murniyanto *et al.*, 2011).

The comparison of ecology in various cultures is associated with the approach of the forest development in a conventional and engineered way (treated under circumstances). For example, the agroforestry management without engineering was provided at the Resort Forest Management (in Indonesia Language it is called *Resot Pemangkuan Hutan*) Kuwojo – Parts of Forest Management Unit (in Indonesian Language, it is named *Bagian Kesatuan Pemangkuan Hutan*) Selogender, Resort Unit Management Randublatung (in Indonesian language, it is named *Kesatuan Pemangkuan Hutan*). The cropping pattern was conducted by using intensive silviculture (in Javanese, it is called *Silin*) by having intercropping with maximum result. PLDT teak aged 10 years in plot 102b with average result of the corn around 7-8 tons of wet shelled per one hectare or Rp. 9,600,000 of gross income. After subtracting from production cost, the average income was around Rp. 3,000,000-Rp. 4.000.000 (Muis, 2014). This means that it can only cover the physical minimum needs (in Indonesian language, it is named *Kebutuhan Fisik Minimum*).

Conclusion and implication of policy

Sustainable livelihoods for *pesanggem* community can overcome food vulnerability and also generate income. In cultivating under stand crops, the crops and cropping system selected should suit the biophysical conditions of land in order to avoid any unwanted damage to the forest. Growing crops is advantageous since they can control erosion, they improve soil structure, and they do not compete with teak stand. Furthermore, this could contribute to social sustainability and also support large-scale normative livelihoods.

The results of the research related to full-cycle PLDT for optimal land use with food and non-food products can be applied to various types of tropical monsoon forest with the following assumptions: having dry and rainy seasons allowing precision choice of crops adapted to the cropping calendar; homogeneous tree species to be easily manageable due to its homogeneity features; slow-growing long rotation from planting to harvest affects the availability of sufficient time for crops (seasonal crops) which is supposed to be cultivated throughout the lifecycle of the stand (annual crops); and the use of the woods as a limited production forest and the production forest of the timber will remain to be harvested. Based on the assumptions, it could be concluded that the teak forest can be considered appropriate as full-cycle PLDT area. In fact, the habitats of teak forests are spread out in India, Myanmar, Laos, Cambodia, Thailand, Indochina and Indonesia (especially in Java). Therefore, the development of PLDT could be implemented in those areas by considering natural condition and the increase of population.

Therefore, practically, this research could be useful to cope with the problem of food scarcity and poverty caused by the limited agricultural areas. In the meantime, the forest land could be used for plantation during the long waiting period of timber forest harvest. The established model offers possibilities for local people to generate additional income. Hence, it is expected that the similar forest condition may use or adapt the similar type of model.

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About the authors

Eva Banowati has completed her doctoral degree from Gadjah Mada University (UGM), Yogyakarta, Indonesia. She is a Lecturer at Universitas Negeri Semarang (UNNES) in the Department of Geography, Faculty of Social Science (FIS), Faculty of Geography, and, currently, she is also the Head of Department of Geography at the Faculty of Social Sciences. She is now also responsible for Ikatan Geograf Indonesia (IGI) from 2010 to 2018, focusing on education. She focuses her research on

empowerment of rural society, poverty alleviation, food availability, and agriculture. In addition, she has participated at National Strategic Research funded by Ministry of Research and Higher Education. She is the writer of the following books: *Geografi Indonesia* (2012) and *Geografi Agriculture* (2013). These two books have received Intellectual Property Rights from Ministry of Law and Human Rights of Indonesia. Eva Banowati is the corresponding author and can be contacted at: evabanowatigeografi@mail.unnes.ac.id

Sucihatiningsih Dian Wisika Prajanti is a Professor of Agriculture Economics at Universitas Negeri Semarang (UNNES). She has been teaching economics at UNNES for 20 years since 1996. She has also been actively involved in research and community service. Her research interest focuses on capacity building for agricultural extensionists. She has also successfully written journal articles, such as "The policy effectiveness of 'Go Organic 2010': a case study on implementation and efficiency organic vegetable cultivation" in Semarang Regency in 2012 in the *Journal of Sociology Study*; "Evaluation on benefit and development of information and communication technology (ICT) to improve the performance of agricultural extension agents in Central Java" in 2013 in *The International Journal of Organizational Innovation (IJOI)*; and "Strategy for controlling agricultural land conversion of paddy by using analytical hierarchy process in Central Java", published by Emerald (*Management of Environmental Quality*), in 2014.

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