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Analysis of Intensified Agrosilvopastoral Farming in Wiladeg Village, Karangmojo Sub-district, Gunungkidul Regency, Yogyakarta Province, Indonesia

Analisis Usahatani Intensifikasi Agrosilvopastura Di Kelurahan Wiladeg, Kapanewon Karangmojo, Kabupaten Gunungkidul, Provinsi Daerah Istimewa Yogyakarta

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Intensified agrosilvopastoral farming, AEV, NPV, on-farm, off-farm

ABSTRACT

This research aimed to analyze the increase in income from intensified agrosilvopastoral in Wiladeg Village, Karangmojo Sub-district, Gunungkidul Regency, Yogyakarta, Indonesia. This research employed Participatory Action Research (PAR) to collect data through four cycles of food crop production trials under forest stands. The on-farm trials used the submersible-well technology and lasted for three years. The Average *Equivalent Value* (AEV) analysis grouped the respondents into two strata based on land ownership. Stratum-1 consisted of respondents with an agrosilvopastoral area of ≤ 4000 m^2, while stratum-2 of > 4000 m^2. The off-farm intensification trials involved three cow fattening cycles and used Net Present Value (NPV) analysis. The results showed that on-farm trials contributed an increase in AEV, namely 692% on land strata-1 and 462% on land strata-2. The off-farm trials provided an NPV of IDR 14,679,000,00/year in the off-farm sector of cow fattening. Based on these results, intensified agrosilvopastoral was feasible to increase land productivity both on-farm and off-farm in Wiladeg Village.

KATA KUNCI
agrosilvopastura, analisis usaha tani, penelitian aksi partisipatif, on-farm, off-farm.

INTISARI

Penelitian ini bertujuan untuk menganalisis peningkatan pendapatan finansial intensifikasi agrosilvopastura di Kalurahan Wiladeg, Kapanewon Karangmojo, Kabupaten Gunungkidul, Daerah Istimewa Yogyakarta dengan Participatory Action Research (PAR) sebagai metode pengambilan data. Uji coba intensifikasi agrosilvopatura on farm dilaksanakan selama empat tahap produksi tanaman pangan di bawah tegakan selama tiga tahun. Untuk keperluan analisis, responden dikelompokkan menjadi 2 kelas. Starta 1 memiliki luas lahan agrosilvopastura ≤ 4000 m^2 sedangkan kelas 2 memiliki luas lahan agrosilvopastura > 4000 m^2 dengan average equivalent value (AEV) sebagai AUT. Sementara intensifikasi agrosilvoastura off farm ditetapkan pada uji coba penggemukan sapi dengan 3 kali pengulangan dan menerapkan nett present value (NPV) sebagai AUT. Intensifikasi on farm dilakukan dengan intervensi teknologi sumur celup. Hasil AUT uji coba on farm menunjukkan kenaikan pendapatan rata-rata tahunan (AEV) sebesar 462% pada kelas lahan 2 (>4000 m^2) dan AEV sebesar 692% pada kelas lahan 1(≤ 4000 m^2). Sementara itu analisis usaha tani pada sektor off-farm pada usaha penggemukan sapi berpotensi memberikan NPV sebesar Rp14.679.000,00/tahun. Berdasarkan hasil tersebut intensifikasi agrosilvopastura layak untuk dilakukan di Kalurahan Wiladeg sebagai solusi peningkatan produktivitas lahan baik on-farm maupun off-farm.

Introduction

Yogyakarta Special Province (DIY) hosts 19,133.5 Ha of state forests and 78,400.27 Ha of community forest areas (Yogyakarta Environment and Forestry Service 2019). Community forests have a dominant role as a supporting ecosystem in the province. Within DIY, Gunung Kidul Regency hosts the most extensive community forest area of around 44,110.87 Ha (Yogyakarta Environment and Forestry Service 2019). They can still increase to 55,627 Ha (Utomo et al. 2021). One of the farming systems used in community forest management is agrosilvopastoral, which combines different components, namely trees, seasonal crops, and forages, in the same space and time (Suhartati et al. 2021; Portillo et al. 2018).

The community forest in Gunungkidul has become an example of sustainable forest management (Yumi et al. 2012). Three farmer groups in Nglipar and Playen sub-districts have received the Sustainable Community-Based Forest Management certificate from the Indonesian Ecolabelling Institute (Lembaga Ecolabel Indonesia 2006). The certificate ensures that the community forest farmers have successfully managed their forest stands in ecology, economy, social, silvicultural, and yield regulation aspects. However, this agrosilvopastoral farming cannot meet farmers' subsistence needs (Awang et al. 2002). Fitri et al. (2017) reported that the average income of the forest farmers in the Ciliwung Hulu watershed was IDR 8,278,750/ha/year, and insufficient for a year's subsistence needs. An intensified agrosilvopastoral with horticultural commodities increased land productivity by 437% compared to seasonal dryland crops. The agrosilvopastoral with horticultural commodities, such as red chili, provided IDR 36,000,000/ha/year. In addition, Faradhana et al. (2019) revealed that the agrosilvopastoral system in Gedongwani Village, Bintang Sub-district of South Lampung, could increase income by 66.25%. Agriculture contributed 64,2%, while livestock and forestry contributed 0.69% and 1.36%, respectively. The agricultural sector has a shorter production cycle (three to four months). Therefore, farmers could have several production cycles in a year.

Although horticultural commodities can increase farmers' income, Gunungkidul Regency has limited irrigation. For this reason, farmers cultivate dry lands merely during the rainy season. In addition, farmers mainly cultivate low selling values commodities such as rice (*Oryza sativa*), corn (*Zea mays*), cassava (*Manihot esculenta*), and peanuts (*Arachis hypogaea L*) (Sabastian 2019). Livestock and forest stand become medium-term and long-term savings in case of a large and urgent need. To meet the whole family's needs, community forest farmers in Gunungkidul have to work outside the city (*mboro*) during the dry season (Awang et al. 2002). In addition, most farmers were also members of revolving fund groups to obtain soft loans when there was an urgent need (Amar 2010).
The COVID-19 pandemic in Indonesia has infected 6,050,000 people, with 156,000 deaths as of May 17, 2022 (John Hopkins University 2021). The high number of cases has led to the Enforcement of Restrictions on Community Activities (PPKM) (Minister of Home Affairs 2021). Consequently, several private companies and state-owned enterprises have terminated the contract of their employees (Juaningsih 2020; Muslim 2020). The Gunungkidul community who work in the city also experienced layoffs, which made them return to their villages (ruralization). In Ngricik and Karangnongko hamlets, Kalurahan Wiladeg, Karangmojo Sub-district, Gunungkidul Regency, seven family heads were laid off and had to return home. Although they knew their narrow land had low productivity and was insufficient to meet their family needs, they were obliged to cultivate the land. Seeing this financial difficulty, the housing developers and industries quickly acquire the

dry land to build residential and industrial areas. In this case, the Wiladeg Village Government acts as a broker or intermediary and receives a service fee of 3% of the purchase price. Based on initial observations, in 2020, a housing developer acquired around 1.6 ha of dry land and community forests managed with the agrosilvopastoral system in the village. The price ranged from IDR 170,000/m^2 to IDR 180,000/m^2. Until April 2021, the housing developers and industries tried to acquire 10 ha of dry land through the village government.

Dry land is an essential part of the agrosilvopastoral system in the Wiladeg Village, of which 75% is in the form of community forest, while the remaining is home gardens (BPS Gunungkidul 2019). In 2021, its size was 361.66 ha. Around 1.6 ha of it was sold to the housing developer, and another 10 ha was in the negotiation process. Upon successful negotiation, the dry land conversion rate to housing and industrial areas was 11.66 ha/year. With this conversion rate, all the dryland in Wiladeg Village would become built-up areas in 31 years. However, dry land and community forest owners could halt the conversion when they earn a decent income from their lands, such as through intensified agrosilvopastoral. For this reason, there is still a need for research on land intensification to increase community forest productivity with high-selling value commodities.

This research aims to analyze the increase in income from intensified agrosilvopastoral. In this research, community forest farmers deliberatively and gradually implement intensified agrosilvopastoral. Farmers also practiced traditional agrosilvopastoral using their tacit knowledge. This research employs Participatory Action Research (PAR) in data collection. The analysis includes Average *Equivalent Value* (AEV) and Net Present Value (NPV) to compare farmers' income from traditional and intensified agrosilvopastoral. The analysis will result in the intensification options for the highest income.

Methods

Time and Location

This research was carried out from January 2018 to March 2021 in Kalurahan Wiladeg, Karangmojo Sub-District, Gunungkidul Regency, Yogyakarta Province, Indonesia (Figure 1). The Wiladeg farmers had implemented intensified agrosilvopastoral. Therefore, the village was purposively selected for the analysis. Wiladeg was one of the villages that

Figure 1. Study location map

experienced ruralization, and the land conversion rate was high. Increasing land productivity through intensified agrosilvopastoral to increase farmers income could reduce the land conversion rate.

Participatory Action Research (PAR)

This research employed Participatory Action Research (PAR) for data collection. The PAR was an approach that focused on humans as actors of social action based on new values that were built collectively (Chevalier & Buckles 2013). PAR consisted of a participatory social approach, identification, planning, and testing that took a relatively long time (Awang & Widayanti 2012). The approach took dynamic risks of evidence-supported social reflection and well-documented learning through action (Kindon et al. 2007). PAR was a collaboration of two schemes of the learning process, where the first consisted of planning, investigation, and evaluation, while the second comprised action, research, and training (Chevalier & Buckles 2013).

Community forests or dryland owners became the subject of this research. The researchers acted as the investors for intensified agrosilvopastoral trials. This research involved local leaders willing to conduct on-farm and off-farm intensified agrosilvopastoral trials and were also financially disadvantaged community forest farmers. The local leaders served as role models for the surrounding communities in practicing intensified agrosilvopastoral. Two local leaders volunteered to participate in the trials. The first was a community forest farmer with senior high school education who was below the poverty line and had skills in the cultivation of shallots (*Allium cepa L.*). The second had three years of experience in traditional cow fattening. This study also collaborated with two partners and assistants who helped the local leaders. The first partner provided dry land for trials, and the second partner provided cow sheds for trials. Both local leaders conducted on-farm trials with shallots (*Allium cepa L.*) and off-farm with cow fattening. The surrounding community forest farmers could directly observe the trial processes. They could also discuss, ask questions, provide suggestions, and assess the trial processes. Their suggestions became the inputs for the later stages of the trials.

In addition, this research also interviewed 30 traditional agrosilvopastoral farmers that practiced on-farm and off-farm activities. The on-farm activities included rice (*Oryza sativa*) and seasonal dry land crops, while the off-farm comprised cow and goat fattening and breeding with fodder forage as their primary feed source.

On-farm Intensification

This research employed participatory decision-making for the on-farm intensification trials. The on-farm intensification trials used shallots (*Allium cepa L.*) because the first local leader had the ability and experience to cultivate the commodity. Furthermore, it was a staple with high value and a short production period of 60-70 days. In one year, farmers could three times produce and harvest shallots (Pujiati et al. 2017).

The on-farm intensification trials applied Sustainable Intensification (SI) and Low-External-Input and Sustainable Agriculture (LEISA). The SI and LEISA were organic farming practices that paid attention to seed selection, spacing structures, irrigation optimation, the use of organic fertilizers, pesticides, local knowledge, and wisdom (Adhikari et al. 2018; Salikin 2003). This research used high-quality seeds from Nganjuk, East Java. Manure and coconut coir soaking water substituted NPK and KCl fertilizers, while tobacco stew became a natural caterpillar pesticide to reduce investment costs. See Table 1 for the summary of the on-farm intensification trials using shallots.

Table 1. On-farm intensification trial activities using shallots (*Allium cepa L.)*

Trial Stage	Production location	Production period	Production area	Main infrastructure	Knowledge and technology input	Actor	Constraint	Solution
BM_{I}	Dryland *Local leader* 1	June-July 2019	600 m^2	Dipping well (Submersible)	Application of shallot (*Allium cepa L.*) farming with knowledge of local leader 1	Researchers as investors & observers Local leader 1 as the cultivator Profit sharing local leader 1: researchers (60:40).	The high cost (seeds, chemical fertilizers, and insecticides)	Comparative study on shallot (*Allium cepa L.*) farmers in Nganjuk Organic system cultivation refers to SI and LEISA on BM_{II}
BM_{II}	Dryland *Local leader* 1	August-September 2019	100 m^2	Dipping well (Submersible)	Organic systems referring to SI and LEISA	Researchers as investors Local leader 1 as the cultivator Profit sharing local leader 1: researcher (60:40)	Unsatisfactory resultsIt is necessary to expand the area for planting shallots (*Allium cepa L.*) to obtain greater financial benefits	Repetition of activities in the BM_{III} trial
BM_{III}	Dryland *Local leader* 1	October-November 2019	100 m^2	Dipping well (Submersible)	Organic systems referring to SI and LEISA	Researchers as investors Local leader 1 as the cultivator Profit sharing local leader 1: researcher (60:40)	Crop failure due to heavy rain	Repetition of BM_{II} actions in wider locations during the dry season in the BM_{IV} trial
BM_{IV}	Dryland *Local leader* 1	September-October 2020	2000 m^2	Dipping well (Submersible)	Organic systems referring to SI and LEISA	Researchers as investors Local leader 1 as the cultivator Partner 1 as land owner worked under the direction of local leader 1 (expansion of action through knowledge transfer) Profit sharing: the local leader got a daily salary, Partner 1 got 20% profit sharing	-	Become new knowledge (episteme) for the residents of Wiladeg Village in intensive agrosilvo-pasture management with shallot (Allium cepa L.) food crops

Remarks: BM_{I-IV} = shallot farming trial for I-IV cycles
SI = sustainable intensification
LEISA = low-external-input and sustainable agriculture

Off-farm Intensification

Cow fattening became the off-farm intensification trials because this livestock business had a relatively shorter production period compared to breeding. Cows were relatively easier than goats because they easily adapted to feed and had better body resistance. Therefore, the cost of their feed was measurable, and their selling price was relatively stable throughout the year (Apriyadi & Hutajulu 2020; Sulastri et al. 2017). See Table 2 for the summary of the off-farm intensification trial activities.

Researchers and local leaders took note of every success and failure in implementing on-farm and off-farm intensification trials. The notes became the inputs for the analysis of intensified agrosilvopastoral farming (Andayani 2006). The results of the farming analysis became the inputs for the financial income performance assessment of the current trial. The next trial should also consider the results of the current trial.

Types of Data

Primary data

Primary data were obtained from on-farm and off-farm intensification trials and interviews with 32 agrosilvopastoral farmers who were selected purposively. The respondents consisted of two local leaders and 30 traditional agrosilvopastoral farmers who had dry land, teak stands (*Tectona grandis*), and cows or goats. For analysis, the respondents were grouped into two strata based on their land ownership. Stratum-1 consisted of respondents with an agrosilvopastoral area below the average, while stratum-2 of above the average.

The researcher and local leaders observed and recorded the primary data collected at each stage of the trials. Primary data collected through interviews consisted of demographics, farming data, and responses to agrosilvopastoral intensification. The demographic data included name, age, type of work, education level, number of dependents in the family, and farming experience. The data on farming consisted of land area, cultivated plants (timber and non-timber), number of livestock (cows and goats), production factors or inputs used, production results or output obtained, and information on input and output prices. The data obtained from the intensification trials and farming business became the inputs for farming analysis. Response to agrosilvopastoral intensification (agree or not) indicated its adoption possibility in Wiladeg Village.

Secondary data

Secondary data were collected from the relevant government or non-government agencies. It included demographic data and an overview of study locations obtained from the Central Statistics Agency 2018-2020.

Farming Analysis (FA)

Farming analysis (FA) analyzes the production process on a farmer's land, managed by an individual or a group of farmers, using synergetic inputs in the form of capital, labor, natural resources, skills, and technologies (Suratiyah 2022). The FA was commonly used for short-cycle agricultural commodities (two-four months). Hence, the inflation rate could be ignored. All cost and revenue components became the present values. The subtraction of total expenditure from the total income resulted in profit or loss. The positive result became profit, and the negative result became loss (Andayani 2006).

FA used cash flow reporting, with the main components being inflows and outflows. Cash inflows consisted of money received by community forest farmers after selling agricultural commodities such as seasonal dryland crops, livestock, and teak wood (*Tectona grandis*). The inflow also came from the

Table 2. Off-farm intensification trial activities

Trial Stage	Production location	Production period	Number of cow	Main infrastructure	Knowledge and technology input	Actor	Constraint	Solution
Stage I	Cage of Local leader 2	January-October 2019	three bulls	Permanent cow shed	- Indigenous knowledge of local leader two (Wet feed method and a small amount of dry feed) - Drinkconsisted of dry protein one to two kg pollard, beer dregs, and 30 liters of water - Drinks and forage were given two times a day	Researchers as investors Local leader 2 focused on managing the entire system on the farm. Profit sharing: local leader 2 got a daily salary	Unsatisfactory results IDR 181.307/month	Comparative study on senior farmers in Ngoro-oro Pathuk Gunungkidul and apply to trial 2
Stage II	Cage of Local leader 2	May-August 2019	three bulls	Permanent cow shed	- Making feed from cassava hump and kleci potato (*Coleus tuberosus*) using the dry feed method without forage - Drinking water available for 24 hours	Researchers as investors Local leader 2 focused on managing the entire system on the farm Profit sharing: local leader 2 got a daily salary	Unsatisfactory results IDR 75,211/month Prices of feed ingredients and their availability fluctuated	- Feeding with Indonesian National Standard (SNI) and dry protein (PK) above 13% - Purchased factory feed Nutriafeed BC 134 with stable availability and price -Providing forage every afternoon - Selecting the best quality cow for beef production - Collaborating with the Karangmojo Animal Health Center for health care
Stage III	Cage of Local leader 2	August-December 2019	three premium breed bulls	Permanent cow shed	- Purchased factory feed Nutriafeed BC 134 with stable availability and price - Providing forage every afternoon - Selecting the best quality cow for beef production - Collaborating with the Karangmojo Animal Health Center for health care	Researchers as investors Local leader 2 focused on managing the entire system on the farm Animal Health Center Involvement as Supervisor Profit sharing: local leader 2 got a daily salary	-	Become a new episteme for local leader 2 and researchers as well as provide a study center for cow fattening farming on the Wiladeg village scale

financial value of Kolonjono forage (*Bauhinia mutika*) and goat feed, which values were estimated based on market prices. The total agricultural commodity sales in a certain period became the total income (TR) (Andayani 2006).

The cash outflows consisted of fixed and variable costs. The fixed costs included expenses, such as land taxes, equipment depreciation, and animal health check. Direct investments were money spent to procure seeds, fertilizers, tractors, transportation, and wages (Andayani 2006). The depreciation cost was estimated using equation (1). The on-farm depreciation costs included agricultural equipment (*gathul* and sickle), submersibles, pipe, and hoses. In the off-farm sector, it comprised the depreciation of the cow sheds. Total cost (TC) was the sum of fixed costs and direct investment (Andayani 2006).

$$D = \frac{(BP - NS)}{N} \quad (1)$$

Where:
D : Equipment depreciation cost (IDR/year)
BP : Cost (IDR)
NS : Estimated residual value (IDR)
N : Estimated service life (years)

The net present value (NPV) was the relative profit rate of the production process, which consisted of the interest rate element to adjust the value of inputs and outputs in the past. In a cash flow, money's current and future value was the same because the future value was time-adjusted (Blocher et al. 2010). The interest rate played an essential role in the concept of money's time-adjusted value because it became the primary variable used to estimate money's current and past value in the NPV calculation. Hasibuan (2020) suggested that NPV was the total of business cash flows that considered money's time-adjusted value during the production period, as shown in equation (2).

$$NPV = \sum_{t=0}^{n} \frac{(B_t - C_t)}{(1)+i^t} \quad (2)$$

Where:
NPV : Net present value (IDR)
B_t-C_t : Profit in year t (IDR)
$(1+i)^t$: Factor discount for the social interest rate *I*
n : Production year (year)

In FA, the NPV was equal to the short-term profits from on-farm and off-farm activities because income and investment were obtained in the same year, namely year "o", and disregarding the discount factor. However, in long-term farming activities such as teak (*Tectona grandis*) stands and breeding, the NPV was still considered the discount factor because the production period was more than one year. The NPV value could estimate the Average *Equivalent Value* (AEV). The AEV predicted the future average annual income after one production cycle and cash flows completed within a specific interest rate (Giraldo et al. 2017). The AEV became the required information for farmers, investors, and other stakeholders to plan and decide on their future farming. Dividing NPV with the Present Worth Factor (PWF) would result in AEV. The PWF was the NPV divisor factor considering the time (n) and interest rate (i). The PWF was estimated using Equation (3) (Andayani 2006).

$$PWF = \frac{(1+i)^n - 1}{i(1+i)^n} \quad (3)$$

Where:
PWF : Present worth factor
i : 1.68% current real interest rate (BPS 2020)
n : Period of cash flow analysis (25 years)

Most agrosilvopastoral had joint costs because they produced two or more products (joint products) at a particular market price during the process. The joint products of on-farm activities included teak stand (*Tectona grandis*) and its seasonal hedge plants, such as talikancu (*Bauhinia purpureako*), turi

(*Sesbania grandiflora*), lamtoro (*Leucaena leucocephala*), and kolonjono (*Bauhinia mutika*). Each plant had a different joint product volume, unit, harvest period, and selling price (Tayyari et al. 1992). For example, peanuts were sold in various forms, such as dry, wet, and peeled, while teak was in standing stands, and kolonjono (*Bauhinia mutika*) was in bunches. They also had different production periods. Teak (*Tectona grandis*) had 25 years production period, while peanut (*Arachis hypogaea L*) had three months, and rice (*Oryza sativa*) had four months. Teak, kolonjono (*Bauhinia mutika*), and goat feed had positive NPV, although they got no special budget allocation for tending, often higher than seasonal dryland plants. Therefore, the on-farm joint cost could be determined using the actual cost percentage incurred by agrosilvopastoral farmers for each cultivated on-farm commodity.

Based on the cost allocation profile, agricultural costs comprised 100% seasonal dryland crop production, and the joint costs for kolonjono (*Bauhinia mutika*), fodder, and teak were undefined. However, this research assumed that kolonjono (*Bauhinia mutika*), goat feed, and teak stand got a joint cost of 3%, 2%, and 1% of the total cost of agriculture, respectively, because of their spatial proximity to the seasonal dryland crops.

To co-create knowledge (*episteme)* and experience (*techne*), farmers and researchers applied PAR and FA simultaneously during the trials. The AEV and NPV became the indicator for on-farm and off-farm activities, respectively. A successful intensification trial would provide greater AEV or NPV than traditional agrosilvopastoral. An unsuccessful trial provided knowledge and experience for improvement in subsequent trials.

Results and Discussions

Asian and African countries had a high dependence on food imports, and sustainable intensification became an effort to address the threat to global food security (Peña et al. 2020). The concept was about increasing productivity and ensuring ecosystem security through the LEISA approach, but it was also supposed to address the farmers' welfare (Sarkar et al. 2020; Liao et al. 2018). This section presented a detailed analysis of the intensified agrosilvopastoral financial contribution in Wiladeg Village.

On-farm Intensification

FA of Shallots

Table 3 showed the results of on-farm intensification with shallots for four cycles. The fourth cycle gave an AEV value of IDR 89,936,250, where labor, investors, and landowners received higher financial benefits than in the previous three trials. In the fourth cycle, land owners got 20% profit sharing of the total shallots sales, local leaders were paid IDR 1,800,000 for two months of maintenance services, and investors got a profit of IDR 4,796,0000. The landowner got the most significant increase in financial income. Before the intensification trials, the land was unproductive during the dry season (IDR 0). After the intensification trials, the landowner shared the profit of IDR 1,199,150 within 60 days, equal to an annual rent

Table 3. Results of on-farm intensification with shallots (*Allium cepa L.*)

No	Trial name	Area (m^2)	Costs (IDR)	Costs per year (IDR)	Income (IDR)	Income per year (IDR)	Gross profit (IDR)	AEV(IDR/ha/year) (IDR)
1	BM 1 Trial	600	1,490,250	4,470,750	3,600,000	10,800,000	6,329,250	105,487,500
2	BM 2 Trial	1000	2,090,550	6,271,650	7,200,000	21,600,000	15,328,350	153,283,500
3	BM 3 Trial	1000	1,505,250	4,515,750	825,000	2,475,000	(2,040,750)	(20,407,500)
4	BM 4 Trial	2000	8,704,250	26,112,750	14,700,000	44,100,000	17,987,250	89,936,250

Remark: The symbol () indicates a negative value

of 2000 m^2 of land.

The first three cycles resulted in new knowledge for successful intensification. First, appropriate irrigation using a submersible pump would prevent crop failure, particularly during the dry season. Second, using organic fertilizers as a substitute for NPK and KCL, such as manure and coconut coir soaking water, could reduce production costs. Third, intensification with shallots should avoid the rainy season to reduce the risks of crop failure, as observed in the third cycle. Fourth, involving investors, local leaders, and the community in the intensification process using a profit-sharing scheme upon agreement enhanced the co-creation of knowledge and experience. Therefore, the fourth cycle applied SI and LEISA concepts simultaneously.

FA of Teak and Forage Plants

Table 4 showed the results of on-farm intensification with forages, including legume turi (*Sesbania grandiflora*), lamtoro (*Leucaena leucocephala*), and talikancu (*Bauhinia purpurea*). They grew along the border of the teak stands. The size of the trial plots I and II were 1000m^2 and 2000m^2, respectively. The intensification profit consisted of shallots and forages, which had a short production period. The profit from teak was separated because they required joint maintenance costs every year until they were ripe for cutting at the age of 25 years (Arinah 2020).

Comparison of On-farm Traditional and Intensified Agrosilvopastoral

Traditional agrosilvopastoral consisted of rice (*Oryza sativa*) and secondary crops, such as peanuts (*Arachis hypogaea*), corn (*Zea mays*), teak stands (*Tectona grandis)*, kolonjono (*Bauhinia mutika*) and brubuh (*Sesbania grandiflora*, *Leucaena leucocephala*, and *Bauhinia purpurea*). The land size significantly influenced the production of the crops.

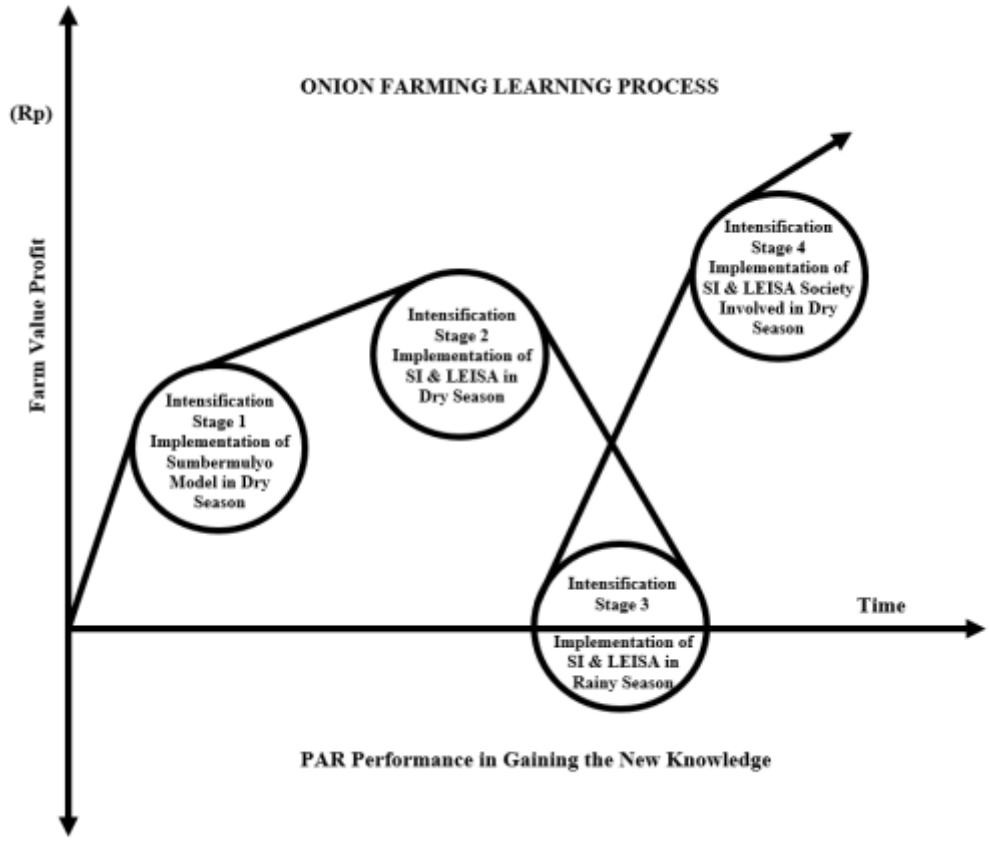

Figure 2. On-farm intensification with shallots for four cycles

Table 4. Results of on-farm intensification with shallots and forages

Name	Dry land area (m^2)	T1-T24 (Constant value) (IDR)	T25 (IDR)	Total cash flow 25 years (IDR)	Net NPV (IDR/Sil)	Farm family NPV (IDR/Ha)
Trial plot I 1000m^2	Profit on farm intensification per year	8,993,625	8,993,625	224,840,625		
	Joint cost of teak (*Tectona grandis*)	(130,564)	22,400,000	19,266,470	244,107,095	2,441,070,952
Trial plot II 2000m^2	Profit on farm intensification per year	17,987,250	17,987,250	449,681,250		
	Joint cost of teak (*Tectona grandis*)	(261,127)	30,800,000	24,532,940	474,214,190	2,371,070,951
				Net NPV (IDR/Sil)	359,160,643	
				NPV/ha (IDR)	2.406,070,952	
				PWF i=1,68%	24	
				AEV (IDR/Ha/year)	98,358,894	

Remarks: The symbol () indicates the value of the cash outflow; T1-T24 is the cash flow of the farm from year 1 to year 24 T25 is cash flow in the year 25; PWF value at i=1.68% and n=25 years.

In this research, the average land size managed by 30 respondents was 4000 m^2 with a standard deviation of 2101,92 m^2. The analysis grouped the respondents into two groups based on land ownership. Stratum-1 consisted of 20 farmers with land ownership ≤ 4000m^2, while stratum-2 comprised ten farmers with land ownership > 4000m^2. Table 5 presented a comparison between traditional and intensified agrosilvopastoral in each stratum.

The on-farm intensified agrosilvopastoral had the highest AEV value of IDR 98,358,894/ha/year, followed by stratum-1 traditional agrosilvopastoral with an AEV value of IDR 21,271,247/ha/year, and stratum-2 traditional agrosilvopastoral with an AEV value of 14,218,405/ha/year. The duration of the analysis was 25 years on similar dryland characteristics. The on-farm intensification with shallots provided 462% and 692% more profit than stratum-1 and stratum-2 traditional agrosilvopastoral, respectively.

Off-farm Intensification

The three cycles of trials on cow fattening resulted in six points of episteme. First, It was required to select high-quality calves for the fattening program. Second, Balanced and sufficient feed concentrates were critical for cow fattening. Third, cow fattening should pay excellent attention to livestock health. Fourth, the cleanliness of the cow sheds could influence livestock health. Fifth, an experienced cow shed personnel would significantly contribute to the success of the cow fattening. Sixth, the cow fattening required adequate capital. Figure 2 depicted the three cycles of off-farm intensification with cow fattening.

The first fattening cycle took 6.3 months and generated IDR 2,170,000/head/year profit, while the second cycle generated IDR 9,025,000/head/year profit. The third cycle became the most effective and provided the highest profit of IDR 14,260,335 /head/year. This cycle used dry concentrate feed for practicality and collaborated with the animal healthcare center to monitor livestock health and minimize death risks.

Table 5. Comparison of on-farm traditional and intensified agrosilvopastoral

Activity	NPV/ha(IDR)	PWF	AEV(IDR/ha/year)
Traditional on-farm area 4000 m^2 (Stratum-1)	520,340,633	24	21,271,247
Traditional on-farm area 4000 m^2 (Stratum-2)	347,812,897	24	14,218,405
Intensive on-farm 200 m^2	2,406,070,952	24	**98,358,894**

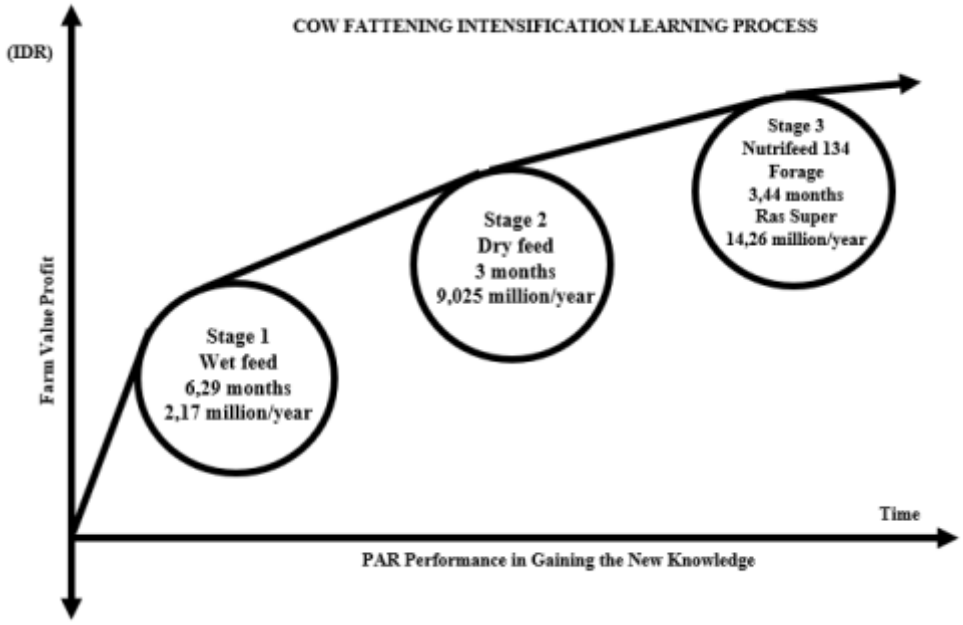

Figure 3. Off-farm intensification with cow fattening in three cycles

Table 6. Results of off-farm intensification using cow fattening for three cycles

Types of Off-farm activities	Average maintenance period (Months)	Average profit per month IDR)	Average profit per year (IDR)
Intensification cycle 1	6.3	181,307	2,175,689
Intensification cycle 2	3.0	752,133	9,025,600
Intensification cycle 3	3.4	1.188,361	14,260,335

Table 7. Results of each off-farm activity in traditional agrosilvopastoral

Types of Off-farm activities	Average maintenance period (Months)	Average profit per month IDR)	Average profit per year (IDR)
Cow Breeding	33.9	278,306	3,339,669
Cow Fattening	14.2	51,912	622,939
Goat Breeding	26.5	121,756	1,461,068
Goat Fattening	9.01	119,163	1,429,958

Off-farm Traditional Agrosilvopastoral

Traditional community forest farmers in the Wiladeg Village commonly had cows or goats, of which 29 out of 30 respondents owned cows. They had a special connection with livestock because they cultivated dry land to produce fodders, such as kolonjono (*Bauhinia mutika*) for cows and brubuh (*Sesbania grandiflora*, *Leucaena leucocephala*, and *Bauhinia purpurea)* for goats. They also used agricultural waste, such as hay and peanut leaves, as a source of fodders during the dry season. The farmers also used manure as essential fertilizers for seasonal dryland crops (Sulastri et al. 2007).

Cow breeding provided IDR 3,339,668 per year profit within 2.83 years (see Table 7). Cow breeding could be profitable when the heifer gets pregnant immediately and bear good quality bull calves (Simmental or Limousine cows). However, only a small number of farmers practiced cow breeding in Wiladeg Village. In addition, only five out of 30 respondents practiced cow fattening, of which three gained profit while the other two lost because the cows' growth was not as expected. However, they continued the cow fattening using their savings. The average profit of cow fattening was IDR 737,144 for 1.18 years, equivalent to IDR 622,939 per year.

On average, farmers gained IDR 1,461,068/year from goat breeding because the fodders were available all year without requiring external feed. In addition, the natural mating process occurred easily using the pen breeding method, where bucks/rams were put in a pen of does/ewes to facilitate mating. Although goat breeding was consistently profitable, farmers tended to choose goat fattening because of its shorter production period, despite its requirements for high protein inputs, such as pollard (wet feed). However, this additional cost was very affordable, namely < IDR 3,000 per day, because goats had small-size rumen.

Intensified Agrosilvopastoral Adoption

After these trials in Wiladeg Village, a new local leader adopted the on-farm intensification using shallots. He used the Regional Drinking Water Company (PDAM) as the water source to make the on-farm activities possible the whole year. Two landowners did drilling to irrigate their dry land for corn and kolonjono (*Bauhinia mutika*) production. The off-farm traditional agrosilvopastoral was generally profitable, although the yield was lower than the intensive one. However, the investment in cow fattening required additional feed costs that were relatively large. For this reason, the off-farm traditional agrosilvopastoral activities were more realistic to be carried out in Wiladeg Village, provided the cow types should adjust the fodder availability. Capital was an essential factor in farming, but changing the cultivation paradigm into intensive management was equally crucial for the success of the action research (PAR). With this, a social movement began to carry out intensified agrosilvopastoral in the village.

Conclusion

This research employed interviews and PAR in data collection for traditional and intensified agrosilvopastoral. The on-farm activities used AEV, while the off-farm used NPV to measure the profit from each activity. The on-farm intensification with shallots provided higher profit than the traditional one. The intensification applied SI and LEISA during the dry season and used a submersible pump for water supply. This trial increased the AEV by 462% and 692% compared to traditional agrosilvopastoral stratum-1 and stratum-2, respectively. Meanwhile, the off-farm intensification with cow fattening provided IDR 14,260,335/year NPV.

The combination of PAR and FA became the platform for the community in Wiladeg Village to exchange their practical experience and co-create knowledge in intensification activities. This knowledge is accessible to the surrounding communities to increase voluntary practices on sustainable intensive agrosilvopastoral for a significant social change in the village.

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