Soil and Water Conservation Practices
in Pagar Alam, Indonesia

Determinants and Impacts towards Sustainable Adoption

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Sustainable Upland Production Landscape
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Green Growth and Agriculture Policy

Green growth means fostering economic growth and development while ensuring that natural assets continue to provide the resources and ecosystem services on which our well-being relies
(OECD, 2011)

- A shift in the paradigm for economic progress to an approach which emphasizes environmentally sustainable development
- Government policy interventions to promote structural changes and facilitate adjustment
- Supports and fiscal incentives to green innovation, activities, businesses and jobs
- Indonesia has adopted Green Growth Program in 2013

Driving Factors of Land Conversion in South Sumatra

source: GGP Document South Sumatra

Land converted for	Factors that influence conversion
Agricultural land expansion	Food self-reliance program, increasing demand for agricultural land, and local economic enhancement
Building and road expansion	Infrastructure development, housing demand, investors
Deforestation	Timber demand, plantation demand, population growth
Agroforestry expansion – rubber and coconut	Land rehabilitation, expansion of commodity areas, and people's economic improvement
Plantation expansion	Local economic enhancement, government's policy to increase Regional Revenue (PAD), and land demand for monoculture cultivation

Key Policy

Green growth plan at national and provincial level

The vision of South Sumatra Province concerning Green Growth includes five areas of achievement adopted from national development goals:

1 Sustainable economic growth

2 Inclusive and equitable growth

3 Social, economic, and environmental resilience

4 Healthy and productive ecosystem providing ecosystem service

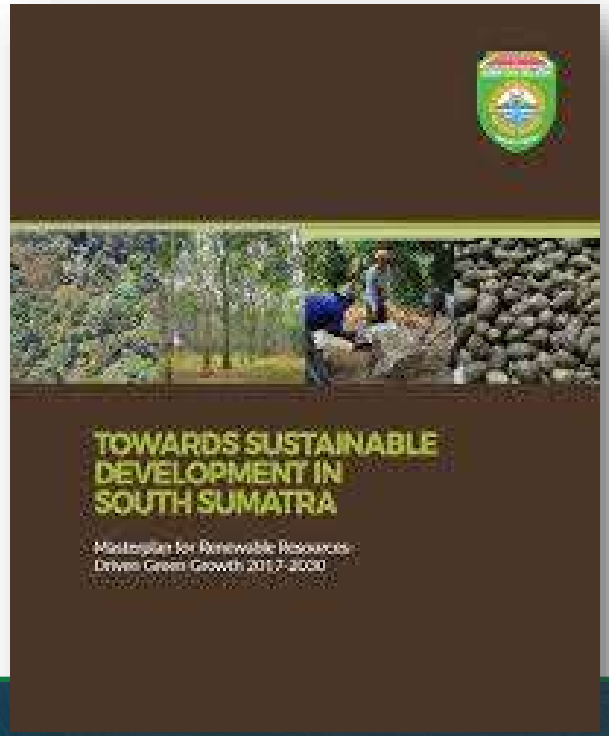
5 Reduction of Green House Gas (GHG) Emission

Masterplan for South Sumatra Green Growth

Governor Regulation No 21 Year 2017

The Masterplan for South Sumatra Green Growth comprises **seven strategies:**

1. Sustainable allocation and land-use planning to addresses gaps between land demand and supply;
2. Improve people's access to livelihood capital;
3. Increase productivity and diversification;
4. Improve value chain by ensuring fair distribution of benefits;
5. Improve connectivity and economic scale;
6. Restore degraded land and forests; and
7. Provide incentive for ecosystem services and innovative funding for sustainable commodities



Dewi S, Ekadinata A, Leimona B. 2017. Towards Sustainable Development in South Sumatra: Masterplan for Renewable Land-based Green Growth 2017-2030. Bogor: World Agroforestry Centre - ICRAF Southeast Asia Regional Office.

Scope of Green Growth

Green Growth covers Renewable Resources sector in South Sumatra that underlines contribution increase of five South Sumatra's primary commodities, namely coffee, rubber, oil palm, rice, and timber pulp & paper.

Objectives

1. To estimate the socioeconomic and environmental impacts of national and local policies in three upland catchments. (RQ1);

2. To estimate the socioeconomic and environmental impacts of alternative national and local policies influence socioeconomic wellbeing and environmental outcomes in three upland catchments. (RQ2); and

3. To assess the social, economic and environmental trade-offs and distributional consequences of alternative policies compared to existing policies. (RQ3).

Research Questions

RQ 1: What are the economic, social and environmental consequences of existing local and national policies in the upland catchment study sites?

RQ 2: What are the socioeconomic and environmental impacts of alternative policies in the upland catchment study sites?

RQ 3: What are the trade-offs involved in changing from existing to alternative policies?

Pagar Alam

South Sumatra Indonesia



- About 26,000 ha (38%) protected forest area (BPS, 2019)
- Upstream area of Musi Watershed of South Sumatra
- Newly enacted decentralized town (in 2001), before it was part of Lahat District
- Total population: 135,000 persons (70 % work in agriculture)
- 5 municipalities and 35 sub-municipalities
- GDP from agriculture 23%
- Main commodities:
  - Perennial: Tea (PTPN VII), Coffee Agroforest, Rubber, Clove, (newly established) (smallholders)
  - Horticulture: Cabbage, Potato, Chili, Tomato, Carrot, Leek, Eggplant, Bean, Strawberry, Pepino (smallholders)
  - Rice field (smallholders)

Livelihood Strategy

- The major livelihood strategies are still dominated by coffee, although gradually replaced by seasonal crops
- Farmers prefer to combine both, although land availability might limit their diversification strategies
- Forestry-sector has less contribution to income
- Preliminary findings: farmers prefer short-term income (seasonal crops) than coffee
- Farmers are vulnerable to changes in commodity prices

- Musi Watershed (DAS Musi) is the biggest Watershed in South Sumatra
- Pagar Alam is one of the upstream area of Musi Watershed
- The hydrological indicator of Musi Watershed shows the decreasing function from 1990 – 2010

  ➢ *Increased surface run-off*
  ➢ *Increased sedimentation*

Land degradation and loss of watershed functions

- **Mismanagement of soil nutrients and poor site selection**
  - selection of loose soil and steep slopes for agriculture
  - parallel contour ploughing
  - ground cover clearing
  - slash-and-burn contributes to soil degradation and erosion.

- **Land degradation is most common**
  - Farmers are unaware of the perils of poor site selection
  - They face limited availability of fertile and flat farming lands.

- **Pagar Alam condition**
  - Almost half of the farmers claimed that the soil fertility on their agricultural land has decreased.
  - They apply chemical or inorganic fertilizers to increase production and assume that this practice will maintain and restore soil fertility.

- **Law 37 Year 2014**
  - Government at national, provincial, district/city levels are responsible for soil and water conservation planning
  - SWC implementation covers protected and agricultural lands through vegetative, agronomic, civil engineering.
  - Public and private sourcing of SCW financing, including PES

Pagar Alam City, South Sumatera

A major coffee centre in South Sumatra

Coffee	Pg Alam[2]	S-Sumatra[1]	Indonesia[1]
Area (ha)	8,385	249,510	1,223,277
Production (ton)	7,460	135,279	664,660
Productivity (kg/ha)	900	650	720

Other Commodities in Pagar Alam[2]

Commodity	Tea	Coffee	Rubber	Cabbage	Chili
Area (ha)	1,468	8,385	1,723	414	165
Production (ton)	3,638	7,460	358	5,465	711

Source:

[1]Indonesia Central Bureau of Statistic, 2016

[2]Pagar Alam Central Bureau of Statistic, 2017

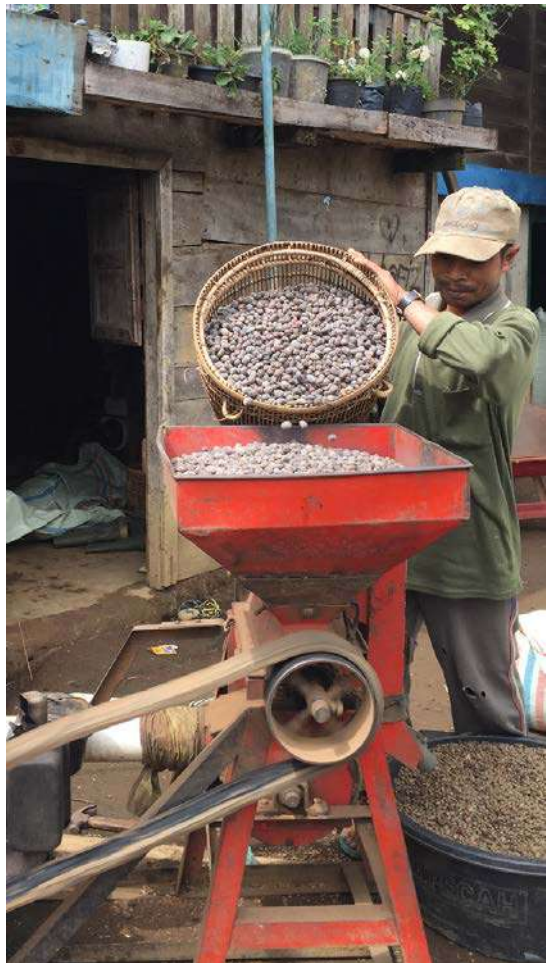
Vulnerability of Coffee Farmers

- **Fluctuations in coffee prices and changes in climate patterns** (prolonged droughts and rainy season) were the major shocks for smalholders
- Traditional coffee smalholders highly dependent to the local middlemen, with a very limited bargaining power for price
- Short term income, more intensive farming practices
- Limited new land availability ➔ conversion of coffee agroforestry into vegetables

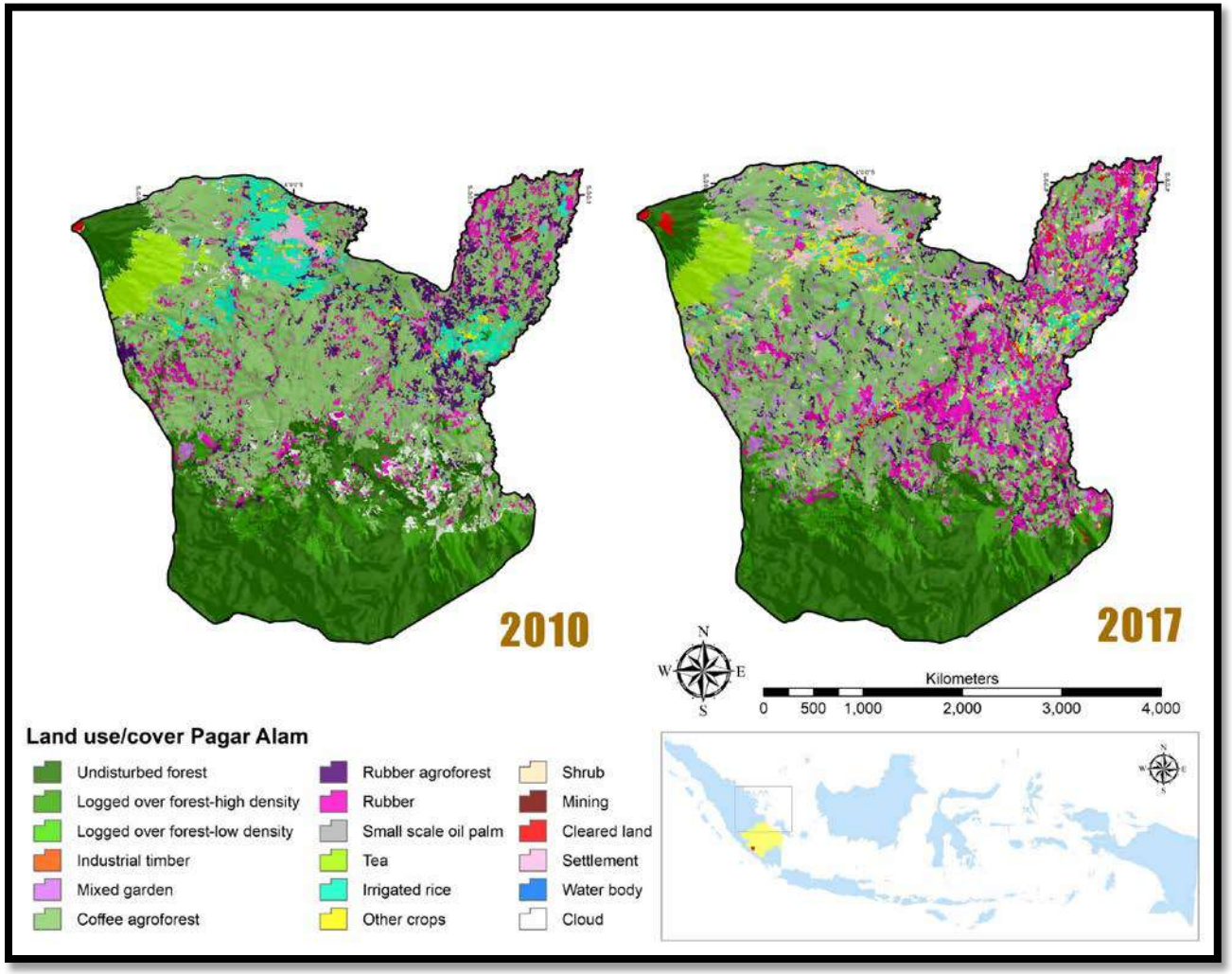
Maintaining and Improving the Values of Coffee Agroforestry for Conserving the Landscape and Local Livelihood

Smallholder perceive coffee farming as their culture, inherited from their ancestors

Seasonal crops (vegetable) as the alternative responses to shock



Land Cover Change (2010 – 2017)

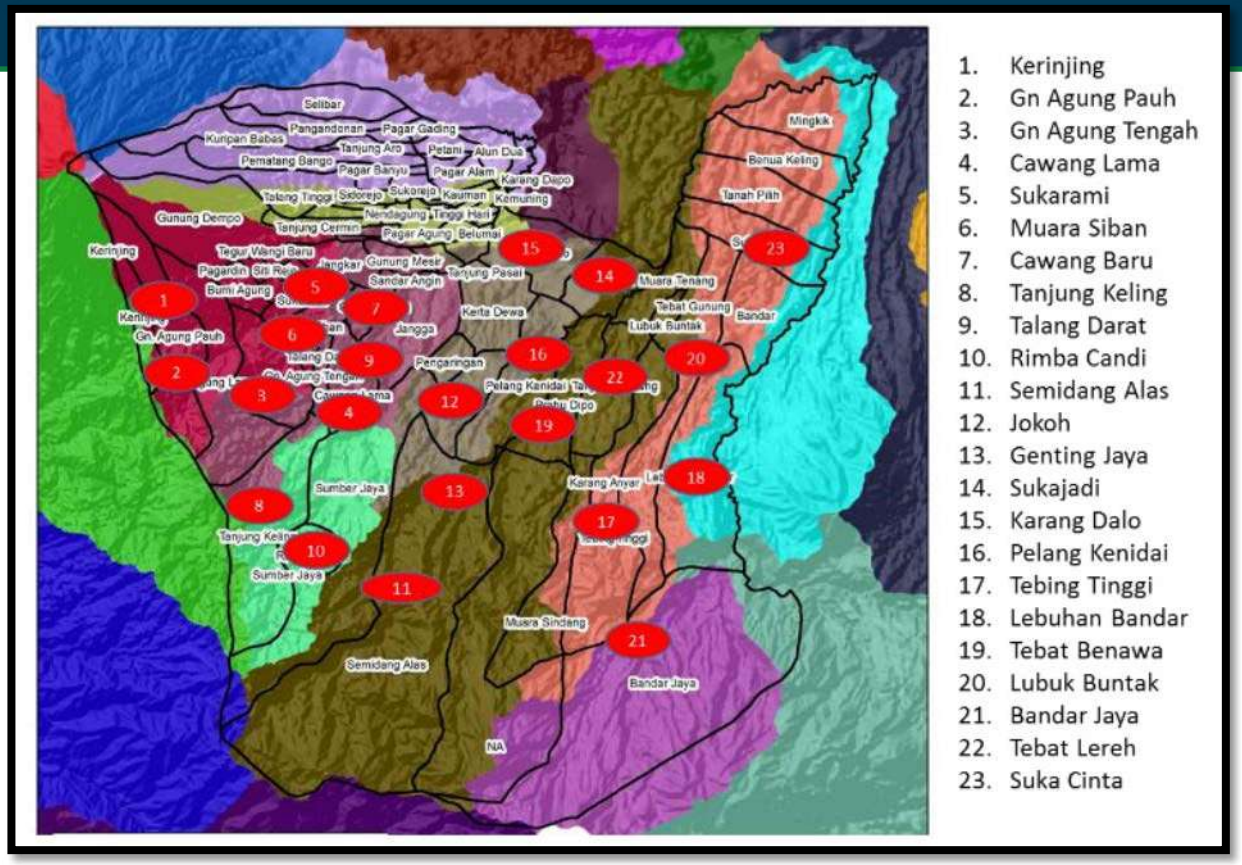


From	To	% of the original area
Primary Forest	Coffee agroforestry	7.2
Secondary Forest		20.2
Rubber Monoculture		69.1
Mixed Systems		14.1
Rubber Monoculture	Coffee agroforestry	69.1
	Rice	4.4
	Settlement	3.9
	Annual crop	3.7
	Grassland/Open land	2.8
	Rubber Agroforestry systems	2.6
Primary and Secondary Forest	Coffee agroforestry	9.2
	Shrubs	1.6
	Mixed systems	1.1
Rice	Settlement	19.0

Nationwide policies

	Issues	Policy
1	Forest tenure conflict	Community Forestry (Hutan Kemasyarakatan/HKm) Ministry Regulation no. 83 Year 2016
2	Reservoir construction	Government facilitates coffee farmers to develop irrigated paddy fields from their coffee plantation in four sub-districts
3	Soil and water conservation	• Government at national, provincial, district/city levels are responsible for soil and water conservation planning • SWC implementation covers protected and agricultural lands through vegetative, agronomic, civil engineering. • Public and private sourcing of SCW financing, including PES Law 37 Year 2014
4	Low quality coffee	• Prepare incentives scheme for good quality coffee • Price transparency and market access • Extension and capacity building through collaboration between BDC, a local government enterprise unit, offtakers • Coffee Geographic Indication Programs (ongoing initiative) Ministry Regulation 18 Year 2018: Corporate Farming • Tree-grafting to improve tree productivity and bean quality (mostly self-initiated by farmers)

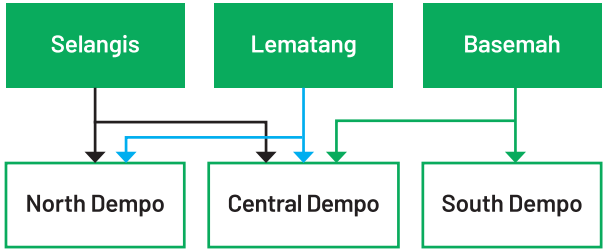
Village distribution in Pagar Alam for the household survey



1. Kerinjing
2. Gn Agung Pauh
3. Gn Agung Tengah
4. Cawang Lama
5. Sukarami
6. Muara Siban
7. Cawang Baru
8. Tanjung Keling
9. Talang Darat
10. Rimba Candi
11. Semidang Alas
12. Jokoh
13. Genting Jaya
14. Sukajadi
15. Karang Dalo
16. Pelang Kenidai
17. Tebing Tinggi
18. Lebuhan Bandar
19. Tebat Benawa
20. Lubuk Buntak
21. Bandar Jaya
22. Tebat Lereh
23. Suka Cinta

SAMPLING SELECTION

Three Major SUB-WATERSHEDS



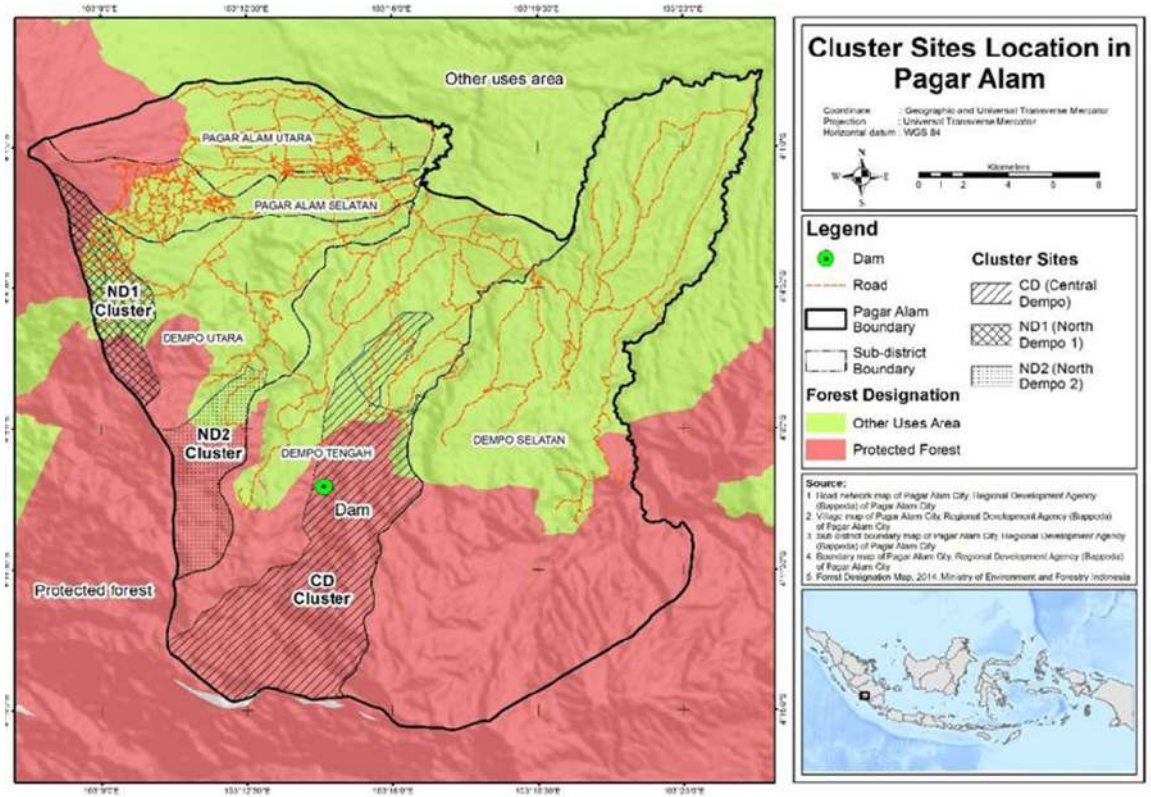
SUB-DISTRICTS

Villages with Slope **> 15:**
TOTAL 46 VILLAGES

Kerinjing	Sukajadi	Tebat Benawa
Gn. Agung Pauh	Pelang Kenidai	Lubuk Buntak
Gn. Agung Tengah	Karang Dalo	Tebing Tinggi
Sukarami	Jokoh	Tebat Lereh
Muara siban	Semidang Alas	Bandar
Cawang Lama	Rimba Candi	Lebuhan Bandar
Cawang Baru	Genting Jaya	Suka Cinta
Tanjung Keling		
Tanjung Darat		

23 RANDOM VILLAGES
Cut-off 50% of 46 villages

Village clusters in Pagar Alam, South Sumatera



No.	Cluster	Policy	Population type	Sub-district	Village
1	Cluster North Dempo 1 (ND1)	Social Forestry	Native and temporary migrants	Agung Lawangan	Gunung Agung Pauh
2					Kerinjing
3	Cluster North Dempo 2 (ND2)	Social Forestry	2nd and 3rd generation Javanese migrants of the colonial period	Burung Dinang	Tanjung Taring
4					Tanjung Keling
5	Cluster CD1	Social Forestry Irrigation reservoir	Transmigrants	Candi Jaya	Rimba Candi
6				Jokoh	Semidang Alas
7	Cluster CD2	Social Forestry Irrigation reservoir	Native and local migrants	Jokoh	Jokoh
8				Jokoh	Genting Jaya

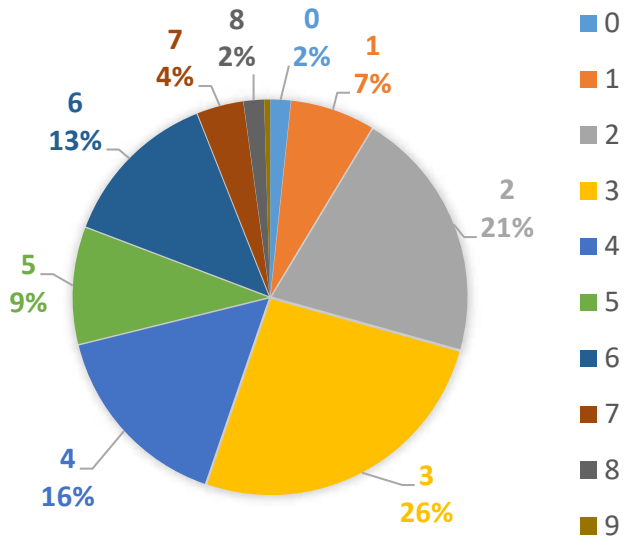
Land-use and slope

Type of Land Use	Slope		
	<15% (n=500)	15-30% (n=294)	>30% (n=101)
Coffee agroforestry	67.2	79.3	88.1
Ricefield	14.6	5.1	0.0
Vegetable field	15.0	12.2	5.0
Rubber	2.4	2.0	3.0
Timber	0.4	0.7	0.0
Shrub	0.4	0.7	4.0
Total	100	100	100

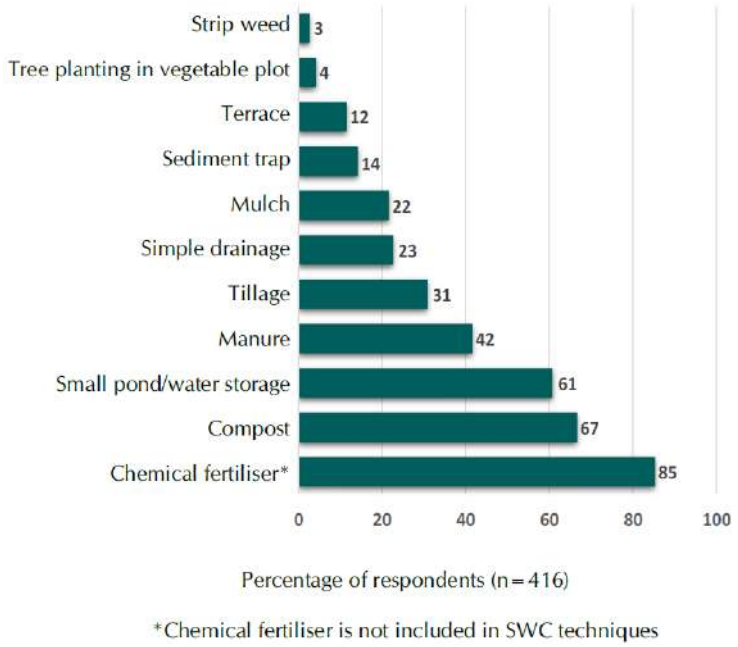
Statement	Total (% from n=895)
Land clearing immediately after land is owned	
Yes	31
Not	69
Land clearing method	
Slash with burn	73
Slash without burning	27
Decrease in soil fertility	
Yes	50
Not	50
Application of soil and water conservation techniques	
Yes	90
Not	10

- Smallholders practice coffee AF in high-slope lands.
- Farmers practice fallow systems after they acquire their lands
- 73% of the farmers practice slash and burn land clearing method
- 90% of the farmers apply soil and water conservation techniques

Number of SWC techniques applied by respondent



Applied SWC techniques and chemical fertilisers in Pagar Alam



Main purpose of application	% respondents who agreed
Maintain soil fertility	98
Maintain soil fertility	98
Improve water supply	84
Maintain soil fertility	95
Plant management	69
Improve water supply	57
Plant management	93
Maintain soil fertility	92
Prevent erosion	79
Prevent erosion	65
Cattle fodder	46

The application of KTA techniques by farmers to prevent erosion and landslides on land with slopes of more than 15 percent is still low and the options for KTA techniques applied are still limited.

Determinant of soil-water conservation techniques adoption

Note: Blue highlight is positive and significant, red highlight is negative and significant.

Terrace Siring	Beds	Ditch	Drainage channel	Mulch	Elephant grass	Water storage	Manure	Compost	Chemical fertilizer	Plant trees on vegetable fields	Other
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Vegetables	Coffee plot simple	Income	Javanese	Coffee plot simple		Lahat	Javanese	Lahat	Javanese	Primary information	
Rice field	Vegetables	Number of plots	Self-decision	Vegetables		Credit (1=Yes)	Senior	Undergraduate/graduate	Junior	Vegetables	
Dry land	Pump ground		Vegetables	Gravity		Organization (1=Yes)	Coffee plot simple	Credit (1=Yes)	Undergraduate/graduate	Other	
Gravity	Owned and not Self-managed		Dry land	Pump ground		Self-decision	Vegetables	Primary information	Risk adverse	Dry land	
Slightly steep (15-30%)			Manually Number of plots	Slightly steep (15-30%)		Other	Other	Vegetables	Coffee plot simple	Pump surface	
Steep > 30 %						Simple irrigation	Simple irrigation	Rice field	Vegetables	Not owned and Self-managed Land Tenure (in Year)	
						Gravity	Ranfed	Other	Rice field		
						Owned and not Self-managed Land Tenure (in Year)	Pump surface	Forest land (1=Yes)	Other		
						Plot size	Pump ground	Gravity	Forest land (1=Yes)		
							Steep > 30 %	Pump ground	Gravity		
							Owned and not Self-managed	Slightly steep (15-30%)	Pump surface		
							Not owned and Self-managed Land Tenure (in Year)	Steep > 30 %	Owned and not Self-managed		
							Number of plots	Owned and not Self-managed	Not owned and Self-managed		

- Indigenous farmers practice soil beds techniques, while migrant farmers practice agroforestry.
- Most farmers gain information from direct, primary sources to get knowledge and practice agroforestry farming.
- Migrant farmers (and those involved in farmer groups) apply water conservation more, such as water storage and drainage.
- Drivers for applying water conservation practices are mostly income and productivity.

The econometric specifications $SWC_p = \alpha_p + M_i\beta_1 + N_p\beta_2 + \varepsilon_p$
SWC=Soil-Water-Conservation practices vector; M=Household characteristics vector, N=Plot characteristics vector, i=individual, p=plot, ε=error term. $\beta_1, \beta_2, \beta_3$ are the coefficients, and α is constant.

Impact of Soil-water-conservation Practices on Income
Dependent variable: Income

Note: *, **, ***, and **** indicate statistical significance at the 10%, 5%, 1%, and 0.1% levels, respectively.

	NNM	PSM
Terrace Siring	-0.1718	0.3895
Ridge	0.39794**	0.6648*
Ditch	0.42022**	0.2628
Drainage channel	0.03903	0.0154
Mulch	0.57666***	0.7330*
Elephant grass	-0.83038**	-0.6214*
Water storage	-0.00308	0.0145
Manure	0.15903	0.0432
Compost	0.14173	0.3240***
Chemical fertilizer	0.03459	0.3122**
Plant trees on vegetable fields	0.05265	0.0530
Other	-0.71672	-0.3220
None	-0.44540***	-0.4308**

At general concept, below the expression of income equation:

$$Y_i = y(X_i, Z_i, \varepsilon_i)$$

Then, below the econometric specifications in this study:

$$LnY_p = \alpha_p + SWC_i\beta_1 + X_i\beta_2 + Z_p\beta_3 + \varepsilon_p$$

Where, Y=Income or Revenue, SWC=Soil-Water-Conservation practices vector, X=Household characteristics vector, Z=Plot characteristics vector, i=individual, p=plot, ε=error term. $\beta_1, \beta_2, \beta_3$ are the coefficients, and α is constant.

Summary: Impact of Soil-water-conservation Practices on Revenue
Dependent variable: Revenue

Note: *, **, ***, and **** indicate statistical significance at the 10%, 5%, 1%, and 0.1% levels, respectively.

	NNM	PSM
Terracing	0.20994	0.5497*
Ridge	0.50699****	0.5471*
Ditch	0.19881	0.1656
Drainage channel	0.09599	-0.0581
Mulch	0.77072****	0.6043**
Elephant grass	-0.306	-0.1270
Water storage	0.11323	0.1522
Manure	0.26801***	0.1718
Compost	0.08886	0.3173***
Chemical fertilizer	0.26450***	0.4321***
Plant trees on vegetable fields	0.26259	-0.0442
Other	-0.1329	0.5174
None	-0.65316****	-0.5067***

- Positive impacts on income and revenue
  - Terracing
  - Ridge
  - Ditch
  - Mulch

  Soil conservation
  - Manure
  - Compost
  - Chemical fertiliser

  Soil health
- Negative impacts on income and revenue
  - Elephant grass
  - No practices
- Main purpose to maintain soil conservation and soil health: lucrative and marketable vegetable farming
- SWC contributes to income and revenue

Key Messages

- Pagar Alam farmers are active in maintaining soil fertility and applying Soil and Water Conservation (KTA) techniques.
- Farmers practice chemical fertilizer as a short-term strategy for restoring soil fertility, while other more environmentally friendly efforts are very limited in terms of choice and suitability of techniques.
- The positive attitude of Pagar Alam farmers needs to be followed by additional information on technical options for KTA – contextual to the land conditions, farming systems, local knowledge, and local habits to be adopted in maintaining land fertility and water reserves in the long term.
- The use of chemical/inorganic fertilizers on agricultural land needs to be adjusted to the needs/recommendations, and it is necessary to consider alternative options for environmentally friendly fertilizers.
- Agroforestry practices with commercial commodities, such as coffee in Pagar Alam, can contribute toward farmers' incomes.
- Agroforestry system is a form of agronomic and vegetative KTA techniques that, when combined with construction and technical KTA techniques, can optimally maintain and improve ecosystem services from agricultural landscapes.

Recommendations

- Increase farmers' awareness about the dangers of excessive and continuous use of chemical/inorganic fertilizers, and the use of organic fertiliser.
- The application of the KTA technique in Pagar Alam needs to be improved based on the guidelines of the Ministry of Agriculture of the Republic of Indonesia, especially on land with slopes above 15 percent. The application of an agro-forestry system as an option for the KTA technique is highly recommended.
- The Pagar Alam City Government needs to develop policies and programs that encourage the integrated application of organic fertilizers and KTA techniques on highland agriculture, with the aim of improving degraded land so that production can be increased without clearing agricultural land.
- Agroforestry is a multifunctional agricultural landscape, with dual goals: farmers' livelihood and ecosystem service provisions.
- Lucrative agroforestry practices, consisting of commercial commodities such as coffee, need to be developed more integrated, starting from upstream to downstream businesses.
- Conservation actions that are carried out within one whole plot will be more effective than doing it sporadically. Conservation technique options must adapt to existing land use systems, local knowledge and customs so that farmers can easily adopt them.