Agricultural Land Soil and Water Conservation Techniques in Pagar Alam

Foto: Isnurdiansyah/World Agroforestry (ICRAF)

1. Foreword

Pagar Alam is a city located upstream of the Musi River, the largest watershed in South Sumatra covering nearly the entire this province. Pagar Alam is the target of two national policies, namely Social Forestry and Food Self-sufficiency (especially rice), through the construction of dams and irrigation reservoirs, which will have significant impacts on agricultural practices and landscapes in the city. The two policies take different approaches, i.e., conservation for Social Forestry and intensification for Food Self-sufficiency.

Social Forestry promotes planting of perennial tree crops, in accordance with the regulations of Social Forestry programme. Food Self-sufficiency focuses on three annual crops, namely rice, soy, and corn, in order to support the achievement of national food security targets.

In general, production-oriented policies often promote land expansion to pristine areas with abundant resources, which may disrupt biodiversity, water management, and the environment. It is important to achieve a balance between conservation and agricultural development progress, particularly in upland areas, to ensure environmental services sustainability in the long-term.

Key Message

- Pagar Alam farmers actively maintain soil fertility and use Soil and Water Conservation (SWC) techniques in agricultural land management, particularly in upland areas. Short-term soil fertility restoration is focused on the use of chemical fertiliser. Technique options and suitability for preventing erosion and landslide to ensure long-term sustainability are severely limited.
- Pagar Alam farmers' positive attitudes should be balanced with information SWC technique options suitable to agricultural land conditions, farming systems, local knowledge, and wisdom, ensuring their easy adoption to maintain long-term soil fertility and water supply.
- Chemical/inorganic fertiliser in agriculture should be used only when necessary or recommended, and alternative options of eco-friendly fertilisers should be considered.
- Agroforestry systems with commercial commodities, such as coffee in Pagar Alam, can support farmers' livelihood. Agroforestry system is an agronomic and vegetative SWC technique that, when combined with civil engineering (another SWC technique), can optimally maintain and enhance environmental services in the agricultural landscape.

Based on its elevation, Pagar Alam is a mountainous area with medium plains (350-700 metres above sea level) and uplands (> 700 metres above sea level). Based on Regulation of the Minister of Agriculture No. 47/2006 on Guidelines for Agricultural Cultivation in Mountainous Areas, slope is one of the factors causing erosion in mountainous area. The steeper the slope, the greater the possibility of erosion and landslide, as the volume and speed of surface runoff increases, potentially causing erosion that eventually leads to landslide.

Pagar Alam upland forests and agricultural landscape make significant social, economic, and environmental contributions. Approximately 35% of Pagar Alam landscape is classified as protection forest, which mainly serves as a protection area for life-supporting systems such as water management, flood prevention, erosion control, and soil fertility. The functions of Pagar Alam protection forest have been threatened in recent decades by the increasing land use change in the area (Amaruzaman et al., 2021). Annual crop agricultural activity is also common in the Pagar Alam upland areas, which are prone to landslides and erosion, indicating that SWC techniques must be prioritised with the ultimate goal of reducing negative environmental impacts.

Based on the Law No. 37 of 2014, Soil and Water Conservation (SWC) is an effort to protect, restore, enhance, and preserve soil functions on land in accordance with land carrying capacity and land use to support sustainable development and livelihood. Soil and water conservation are inextricably linked. Land management will affect soil and water conditions of the land and its surroundings. Soil conservation in a narrow sense refers to an effort to prevent soil degradation and restore eroded soil. Water conservation refers to efficient use of water and the reduction of wastage or unnecessary usage through, for example, efficient use of rainwater falling to the ground, water distribution, water regulation to prevent floods during rainy season and sufficient water supply during dry season. In the context of agricultural land, degraded land can be prevented and restored by using the recommended SWC techniques, allowing it to continue functioning properly.

Pagar Alam upland areas outside forest area are productive agricultural lands. Most of the farmers have applied various SWC techniques after the land clearing. However, they need to use the appropriate techniques for the land condition and slope to ensure the continuation of agricultural activities.

Photo 1. Coffee agroforestry combined with several trees

2. Land Clearing and SWC Techniques

Based on the study of farmers' households conducted by ICRAF IndoGreen Project (Isnurdiansyah et al., 2021a) in 950 plots surveyed, most of respondent farmers have flat and wavy lands (with slope of less than 15%). Meanwhile, 31% of the plots are located on hilly terrain (with a slope of 15-30%), while the remaining 11% are on mountainous lands (with a slope of > 30%). Erosion and landslides often occur in hilly and mountainous areas, particularly those with a slope more than 40%.

Land elevation and slope determine the type of land use and commodity suitable for planting. The agroforestry system that combines various type of tree with annual crops in one landscape, is the appropriate SWC technique for lands with slopes greater than 15%. Most of farmers in Pagar Alam are already aware of the suitability, a demonstrated by numerous land uses for coffee agroforestry in the landscape (Table 1). As land slope increases, the proportion of agroforestry land use system rises.

Vegetable farming system (FS) is commonly practised (12%) in Pagar Alam on lands with a slope of 15-30%, and it is quite high (5%) even on lands with a slope of more than 30%. Although vegetable FS enhance farmer's economy, it must be followed by quality improvement and wider adoption of SWC techniques to protect soil from erosion and landslide, which may remove farmers' ability to earn a living from the land.

Currently, farmers generally do not clear their lands immediately after owning them. Farmers clear their lands primarily by slashing and burning (Table 2). On the other hand, more than half of farmers believe their lands' fertility has been degraded, although the majority have used SWC techniques and applied fertiliser to their lands.

3. The Use of SWC Techniques

Soil serves as a provider and storage of nutrients and water, a medium for water regulation, and a life-supporting system. Soil function restoration is aimed to restore soil function and ability on critical or degraded lands. In this case, the restoration should be done in a sustainable and cross-sectoral way, with support from Pagar Alam Government as the conservation policymaker and implementer. Farmers'

Table 1. Percentage of farmers' land use in Pagar Alam by land slope

Land Use Type	Land Slope (Percentage)		
	< 15% (n = 500)	15-30% (n = 294)	> 30% (n = 101)
Coffee agroforestry	67.2	79.3	88.1
Rice field	14.6	5.1	0.0
Vegetable crops	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

Table 2. Agricultural land clearing methods and SWC techniques

	Total (% from = 895)
Land clearing right after owning land	
Yes	31
No	69
Land clearing method	
Slash and burn	73
Slash without burn	27
Land fertility degradation	
Yes	50
No	50
The use of SWC techniques	
Yes	90
No	10

experiences with SWC techniques vary, and most use more than one technique. In cultivating agricultural land, 85% of farmers use 3-6 SWC techniques and some even use 9 techniques (Figure 1).

Farmers use SWC techniques in the cultivation area in accordance with the Government's recommendations, which are divided into three categories: vegetative method (planting grass, trees, or ground cover plants); agronomic method (fertiliser application, mulching, or enrichment planting); and civil engineering (water storage, simple drainage, tillage, terraces, or sediment traps). Most farmers (61%) have installed water storage units in their farm to address water scarcity (Figure 2).

Farmers in North Dempo Subdistrict use the most chemical and organic fertiliser compared to farmers from other subdistricts. Their proportion of water storage, manure, tillage, simple drainage, and mulches is also the highest. Due to its sloping landscape and rapid development of vegetable FS, North Dempo has more intensive farming management techniques.

Nearly all farmers using organic or chemical fertilisers want to maintain soil fertility. Tillage and mulch are applied to vegetable FS. More than half of

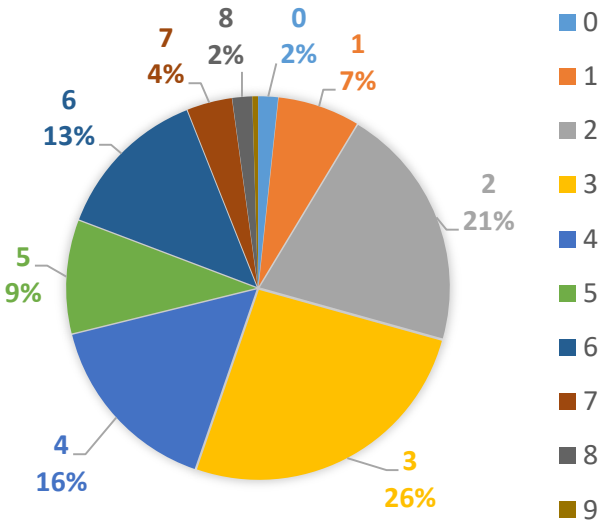

Figure 1. Number of SWC techniques applied by respondent

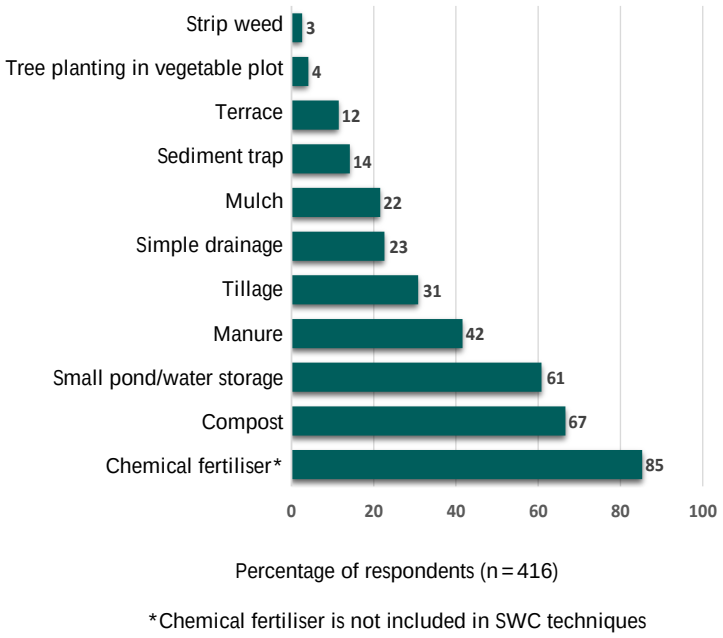

Figure 2. Applied SWC techniques and chemical fertilisers in Pagar Alam.

the farmers have used water storage technique in their farms to maintain water supply as a form of agricultural management both for perennial and annual crops. Some farmers have used simple drainage for water management, but only a few (11 to 48 respondents,) intentionally used SWC techniques to prevent erosion, such as terracing, tree intercropping, and strip weeding (Table 3).

4. SWC Technique Selection Suitability

Based on the findings of this research, farmers still believe that chemical fertiliser is an effective method to maintain soil fertility. The use of chemical fertiliser is in congruent with conservation objectives. Repeated application in excess or above the recommended dose may reduce or even damage soil quality, such as declining soil organic matter, making land vulnerable to erosion, reducing the population of soil microbes, and decreasing soil permeability (regulation of water and air distribution in the soil). The overuse of chemical fertiliser also pollutes water sources and rivers. Organic fertiliser, on the other hand, can restore soil organic matter and maintain

Table 3. Main reasons in applying of SWC techniques and fertiliser use

SWC technique and fertiliser use	Number of farmers applied (n = 416)	Main purpose	Percentage of farmers applying the techniques
Chemical/inorganic fertiliser	356	Maintaining soil fertility	98
Compost	277	Maintaining soil fertility	98
Water storage	253	Improving water supply	84
Manure	173	Maintaining soil fertility	95
Tillage	128	Managing crops	69
Simple drainage	94	Improving water supply	57
Mulch	90	Managing crop	93
Sediment trap	59	Maintaining soil fertility	92
Terrace	48	Preventing erosion	79
Tree planting in vegetable plot	17	Preventing erosion	65
Strip weed	11	Providing fodder	46

soil fertility, improve soil physical, chemical, and biological nature, as well as protect the environment by not polluting water sources and rivers with chemicals.

Intensive soil tillage can also cause land degradation. However, only a few farmers use SWC techniques to prevent erosion and landslides even though they understand that agricultural cultivation on steep slopes can lead to disasters. The Ministry of Agriculture has developed conservation cultivation technology, which includes integrated agricultural land management that takes slope factors into account. In addition to civil engineering, the vegetative method can also be implemented by planting a combination of annual and perennial crops, or by using an agroforestry system with a composition based on the complete guide provided in Table 4.

Photo 2. Vegetable farming practice in slooping land.

Table 4. Guide on SWC Techniques using integrated Civil Engineering and Vegetative/Agronomical Methods

Slope (%)	Civil engineering SWC	Vegetative and agronomic SWC	
		Recommended maximum crop proportion (%)	
		Annual	Perennial
15-25	Bench terrace, alley cropping, hedges, silvopasture, ground cover plants, silt pit (rorak), and strip weeding	50	50
25-40	Bench terrace, alley cropping, hedges, and ground cover plants,	25	75
> 40	Individual terrace and cultivation terrace	0	100

5. Conclusion and recommendation

Conclusion

- Almost half of farmers suggest their agricultural lands' fertility has decreased. They believe that applying chemical or inorganic fertilisers to increase production will maintain and restore soil fertility.
- Farmers' use of SWC techniques for preventing erosion and landslides on lands with slopes greater than 15% is poor, and SWC technique options are limited.
- Agroforestry system with coffee as the primary commodity is a practical application of agronomic and vegetative SWC techniques on which Pagar Alam farmers rely naturally. These techniques are proven to have been able to prevent various negative impacts on environment, such as erosion and landslide, which may disrupt farmers' sources of livelihood. Agroforestry system should also be supported by civil engineering SWC techniques to make it more effective.

Recommendation

- It is crucial to raise farmers' awareness of the negative impacts of continuous and excessive use of chemical/inorganic fertiliser. Knowledge and insight Farmers should also be made aware on eco -friendly fertiliser application and soil fertility restoration practices by maintaining organic matters in the soil.
- SWC techniques should be improved in Pagar Alam in accordance with the Ministry of Agriculture guidelines, particularly on lands with a slope greater than 15%. It is highly recommended to use an agroforestry system as SWC technique option.
- Pagar Alam Government should develop policies and programmes to promote integrated use of organic fertilisers and SWC techniques in agricultural lands on upland areas to restore degraded lands and increase production without clearing new lands.
- Agroforestry system is a form of multifunctional agricultural landscape that can increase and stabilise farmers' income while also preserving and enhancing environmental services. Agroforestry systems with commercial commodities such as coffee should be developed more strategically from upstream to downstream sectors (Isnurdiansyah et al., 2021b).
- Conservation measures implemented in a single landscape will be more effective than those implemented sporadically. Conservation technique options should be tailored to existing land use systems, local knowledge, and local wisdom, to make adoption easier for farmers.

References

Amaruzaman S, Isnurdiansyah, Nugraha M, Lusiana B, Leimona B. 2021. *Profile of the production landscape of Pagar Alam: towards sustainable upland agriculture.* Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program.

Isnurdiansyah, Amaruzaman S, Lusiana B, Leimona B. 2021. *Production-landscape characteristics and vision through the lens of upland smallholders in Pagar Alam*. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program.

Citation

Isnurdiansyah, Amaruzaman S, Lusiana B, Leimona B. 2023. Agricultural Land Soil and Water Conservation Techniques in Pagar Alam. Brief No. 120. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program.

For more information:
Isnurdiansyah@cifor-icraf.org

World Agroforestry (ICRAF) Indonesia Program
Jl. CIFOR, Situ Gede, Sindang Barang, Bogor 16115
[PO Box 161, Bogor 16001] Indonesia
Tel: +(62) 251 8625415 | Fax: +(62) 251 8625416
Email: icraf-indonesia@cifor-icraf.org
icraf_indonesia icrafindonesia
World Agroforestry
www.worldagroforestry.org/country/Indonesia
www.worldagroforestry.org/agroforestry-world

Layout: Dwiati Novita Rini, Riky Mulya Hilmansyah