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Selection of Soil Conservation Measures in the Indonesian Regreening Program

*Fahmuddin Agus**

ABSTRACT

'Regreening' is the Indonesian national soil conservation program, implemented on farmers' land with the aim of improving their prosperity and conserving natural resources. However, since its initiation in 1976, little success has been gained. Reasons for this include institutional complexity, complicated planning and procedures and, more seriously, inappropriate selection of soil conservation measures. This paper discusses the selection of field-level soil conservation measures. Currently, the most common measures recommended are tree planting, bench terracing, the leveling or vegetative reinforcement of existing bench terraces, improvement or excavation of new drainage channels, and building of drop structures. However, blanket recommendations are often made without consideration of the local conditions, such as soil properties, the numbers and kinds of existing tree stands, the complexity of farming systems, and farmers' preferences (despite the reported use of participatory approaches). In addition, the program being target- rather than demand-driven often leads to excessive and/or improper recommendations. Long-term and stepwise efforts must be taken to improve institutional capability. The short-term solution is to conduct intensive field training for extension workers, starting in high-priority watersheds, to allow selection of effective soil conservation measures that are relevant to site-specific problems and farmers' circumstances.

INTRODUCTION

The 'Regreening' and 'Reforestation' Programs, the main environmental protection programs in Indonesia, were initiated in 1976. While Reforestation aims to replant trees only on state-owned land, which had previously been cleared or denuded, Regreening involves a wider range of soil conservation measures, and is only conducted on 'critical' land owned by farmers. The criteria used to define 'critical' lands are rather ambiguous (Huszar, 1998) and include a high potential soil loss as predicted by the Universal Soil Loss Equation (Wischmeier and Smith, 1978) and a shallow soil depth. Considerations such as drinking water quality and quantity and impacts on hydroelectric plants, irrigation networks, and harbors also contribute to the classification of watersheds as 'critical'. In practice, critical land is characterized by an absence of vegetation, or a coverage of weeds such as bushes or *Imperata cylindrica* or when it shows clear signs of erosion. About 12.3 million of the 193 million ha total land area of Indonesia has been classified as 'very critical' land (CBS, 1997). Of this critical land, 3.6 million ha fell within the boundaries of State Forest land and 8.7 million ha was privately owned. A target of the government's Five Year Development Plan (1992 to 1997) was the rehabilitation (Regreening) of 0.9 million ha of the critical 'forest' land and 2.6 million ha of private farming land (CBS, 1997).

In practice, however, the success in implementing the rehabilitation measures within the target areas was variable. In evaluating the Regreening and Reforestation Programs, Santoso (1992) identified three consistent weaknesses: (i) poor quality and inappropriate technology, (ii) uncoordinated and non-participatory planning, and (iii) unaccountable and poorly supervised implementation. As a result, this project has been very inefficient, had limited impact, and wasted limited resources. The 'top-down' approach of the project did not take into account the complexity of farmers' situations, nor the key issue that conservation objectives should be linked to farmers' production objectives (Garrity and Agus, 2000). Usually, when working on farmers' lands, variation in farm sizes, cropping patterns, land tenure systems, soil properties and slopes need to be addressed in order to improve the effectiveness of soil conservation measures and enhance adoption by farmers outside demonstration areas (Agus et al., 1998).

To address the problems of (i) technology and (ii) planning (highlighted above), a study was made of the processes involved when choosing the specific soil conservation measures to be used in the field. This paper reports the results of this study. It considers firstly the institutional background that influences the choice of soil conservation measures, secondly the current 'top-down' approaches and recommendations used in the field, and thirdly improvements in participatory planning and technology-selection, which have been tried recently in the field. Recommendations are then made for improving the selection of appropriate and effective soil conservation measures in the Indonesian Regreening program.

The Regreening Program

The National Watershed Development Program channels around US$50 million annually to provincial and district level governments in Indonesia for Regreening and Reforestation projects. In theory, the program's objectives are to control erosion and floods, to improve land productivity and farmers' incomes, and to increase people's participation in conserving natural resources.

The Regreening approach includes demonstration of soil

*Fahmuddin Agus, Center for Soil and Agroclimate Research, Jln. Juanda 98, Bogor 16123, Indonesia. *Corresponding author: f.agus@bogor.wasantara.net.id.

conservation measures using Soil Conservation Demonstration Units in areas with permanent agriculture and Sedentary Farming Demonstration Units in areas under shifting cultivation, and also construction of check dams and gully plugs. The demonstration units, along with village nurseries, are central to the Regreening Program and are the focus of this paper.

Demonstration Units

Each demonstration unit consists of an area of about 10 ha and involves between 15 and 50 farmers depending on farm size. Farmers are given incentives in the form of annual food-crop seeds, fertilizers, seedlings of timber, fruit and leguminous trees, and even some wages for working on their own land. In the surrounding 100 ha of land, only seedlings of perennial trees and extension services are provided, whereas in the next 1000 ha zone only extension services are offered and farmers are expected to mimic the technology in the demonstration units on their own. Thus, the success of Regreening depends to a large extent on farmers' participation.

Institutional context

Regreening is conducted by the district-level Regreening and Soil Conservation Service (DPKT). This institution produces annual technical plans for farmer groups under its jurisdiction. These annual plans are based on national level technical guidelines, fifteen- and five-yearly watershed-level soil conservation and land rehabilitation plans (see explanation below), and DPKT's own analyses of local problems.

DPKT personnel include a few technical staff having an undergraduate-level education in agriculture, forestry or related fields, but the majority are extension agents having a high school level education. Currently there are about 6000 Regreening extension agents in the country and they are the key actors at grass roots level. They may have received additional training, but this was usually theoretical and classroom-based rather than practical in nature, and this did not necessarily enable them to identify environmental problems in the field or to find solutions.

Reference materials, which are mostly developed at the national level, are available for some extension workers, but the availability varies from one district to another. It is impossible for the centrally developed reading materials to address the specific problems of each district. Therefore, it is the ability of local staff to identify problems such as accelerated erosion and water shortage, to find alternatives to address the problems, to communicate with farmers on the possible alternatives, and to facilitate farmers' own decision-making that determines the quality of technology selected.

There are two other institutions that have a large influence in determining soil conservation interventions. Firstly, at the watershed level, is the Institute for Land Rehabilitation and Soil Conservation (BRLKT), which produces fifteen- and five-yearly plans for soil conservation and land rehabilitation. These involve compilation of thematic maps of target areas and identification of technology options for Regreening and reforestation. However, it takes much further effort by DPKT to turn these watershed-level recommendations into workable plans at the field level, because of the large variation in land conditions and farming practices.

The second institution, at the national level, is the Secretariat of Central Guidance Team, which issues annual 'Technical and Operational Guidelines for Regreening and Reforestation'. These contain a list of approved technology options and their definitions, and also instructions for administrative arrangements between farmer groups and the government (DPKT). For example, the guidelines define a Soil Conservation Demonstration Unit as around 10 ha land used for the demonstration of bench terraces, vegetative conservation techniques using perennials/trees, improved waterways, etc. This definition has often been regarded as a blueprint, such that almost all demonstration units include every measure mentioned in the guidelines, even though they may not be relevant to the local problems.

Current Approaches to Field-Level Technology Selection

Participatory rural appraisal - a survey technique in which farmers and extension workers communicate interactively about the local farming systems, including the prospects and constraints – has officially become a standard procedure in the technology-selection process. However, in practice, recommendations found in many demonstration units have not reflected the diverse biophysical and socio-economic backgrounds of farmers. Tree planting, regardless of the type of current farming system, exists in almost every technical plan. Slope gradient has been regarded as the main criterion for determining the number of trees per unit area. Lands with slopes gentler than 25%, between 25 and 40%, and steeper than 40% are 'reinforced' with 100, 200 and 400 trees ha^{-1} to give 25%, 50% and 100% tree canopy cover, respectively (unpublished 1996 Regreening and Reforestation Guidelines issued by the Central Guidance Team of Regreening and Reforestation). This is an example of a blanket recommendation, which does not take the local conditions into account. Wider issues, such as existing tree stands, subsistence mode of farming, insecure land tenure that forces farmers to invest in activities with fast returns, and inaccessibility to markets, have also not been fully considered in technology selection. Tree planting is acceptable to farmers as long as it does not distort existing annual crop based farming. For those with insecure land tenure, however, getting a fast return on their investment is a lot more important than any other consideration.

In many parts of Java, steep uplands have been terraced during the earlier (1980s) phase of Regreening. Currently, bench terracing is also demonstrated in the majority of demonstration units in the outer islands of Indonesia even though it is often unsuitable, due to a shallow soil depth, unstable soil structure, or very acid subsoil. For example, bench terraces were observed at several demonstration plots on shallow and unstable soils in Central and South Sulawesi, and in East Nusa Tenggara provinces (Agus et al., 1998). When bench terraces are technically unsuitable for the site they could actually increase the rate of mass translocation and expose infertile subsoil. Furthermore, labor required for

Table 1. A modified 'technical plan' for soil conservation: site description, planned conservation measures, and field observations and comments for a proposed demonstration unit at Cinisti Village, Bayongbong Subdistrict, Garut District, West Java Province.

Site description	Planned conservation measures	Observation/Comment
Area: 8.5 ha: Slope : < 25 % : 1.5 ha 25-40% : 6.0 ha > 40 % : 1.0 ha Altitude 700-1500 m Soil : Andisol Soil depth: deep (>90 cm) **Fertility: Moderate** **Level erosion damage: Moderate** Present land use:	**Tree planting:** For slopes < 25%: 100 *Parkia speciosa* trees per ha. For slopes 25-40%: 100 trees of *Parkia speciosa* and 100 treea of *Albizia falcataria.* For slopes >40%: 400 trees of *Albizia* per ha.	Existing crops include tobacco (*Nicotiana tabacum*), corn (*Zea mays*), cassava (*Manihot utilissima*), and soybean (*Glicine max*). Tree crops such as *suren* (*Toona sinensis*), *africa* (*Maesopsis eminii*) scattered on most farmers fields with densities of 30 to 100 trees per ha. Additional tree planting may not be necessary for land with slope gentler than 40 % since it could cause too much shade to the annual crop growth and production. Farmers prefer *Parkia speciosa* to *Albizia* due to theft and susceptibility to stem borer of the latter. Land with slopes steeper than 40 %, from environmental view point, should be devoted to permanent tree cover but in reality is being used for intensive annual food or vegetable crops. Regulation may have to play a role in this case.
6.0 ha for annual crop. 2.5 ha used for combination of perennial and annual crops Farm size : 0.3 ha/house hold.	**Bench terrace rehabilitation** for slopes <40 %: back sloping of existing forward-sloping terraces and digging waterways at the base of the terrace.	Backward sloped terrace may not do any better than current terrace because it would expose the less fertile B-horizon and that means a lower crop production for a few years after the rehabilitation.
Monthly rainfall: Jan: 278 Feb: 332 Mar: 280 Apr: 311 May: 58 Jun: 269 Jul: 0 Aug: 0 Sep: 0 Oct: 138 Nov: 248 Dec: 12	Construction of new **waterways** to give a total length of 510 m, and construction of 190 **drop structures** made of bamboo or of rocks.	This length and numbers seem exessive. Existing waterways, mainly near field borders seem sufficient and only about 50 drop structures are needed; these should be concentrated in parts of undermined waterways.
(June rainfall was atypically high. Data may have come from short term observation)	Planting of elephant grass *Pennisetum purpureum*) on terrace edges.	Planting of fodder grass as a terrace stabilizer is the most preferred measure for erosion control among those having ruminants.

Source: Adapted from Tala'ohu and Agus (1998).

establishment of bench terraces is 662man days ha^{-1} and this is much higher than the 227 and 116 man days ha^{-1} required for establishing contour bunds and contour hedgerows, respectively (Haryati et al., 1995). Such a high initial investment and subsequent maintenance costs run counter to the reality of smallholder agriculture. The success of bench terracing has therefore been limited to parts of Java and Bali where there is extreme land pressure such that labor is not limiting. In addition, there have been more projects in Java and Bali compared to the other islands and they usually come with incentives for bench terrace construction.

Planting a thin line of fodder grass along terrace edges is the technique most easily adopted by farmers. Vetiver grass (*Vetiveria zizanioides*) has been proven to be very effective in erosion control and has showed almost no signs of competition with food crops (Haryati et al., 1995), and so has been widely promoted to famers. However, in reality, farmers in Indonesia prefer the competitive Napier grass (*Pennisetum purpureum*) (Agus et al., 1999) simply because of its fodder value.

Improvement of Technology Selection

In June 1998, a new approach to technology selection was tried. Groups from central and local level agencies, under the coordination of the Research and Technology Development Working Group of the Central Guidance Team, studied technical plans of 12 of the 40 or so sites planned for Fiscal Year 1998 demonstration units in Upper Cimanuk Watershed, West Java. The activity involved farmers, researchers, extension workers, representatives of non-government organizations, and technical staff from the DPKT and BRLKT. Each group, which consisted of 6 to 8 members including 3 to 5 farmers and 3 facilitators, conducted the following steps in technology selection:

- Review of each technical plan.
- Field check to match field actual conditions with that in the technical plan description.
- Evaluation of each proposed technical plan based on expert judgment and on related literature.
- Evaluation of farmers' involvement in the previous decision-making process, through a series of interviews. The farmers were asked whether they were aware of the existence of technical plans and how they perceived the plans.
- Evaluation of indigenous practices and a discussion on how those could be improved.
- Restructuring of an interim technical plan by adding new measures and removing less appropriate or less preferred measures.
- Explanation to farmers of the advantages and disadvantages of the proposed measures and facilitating farmers to evaluate the revised plan.
- Refining of agreeable measures based on farmers' decisions.

During the discussion with farmers, a few outstanding (key) farmers often came up with reasonable explanations about promising alternative techniques, although they had not implemented them due to limited capital and technical skills. A few of their ideas were immediately included for improvement of the technical plan if they appeared to be scientifically reasonable and were acceptable to other farmers in the group.

Table 1 gives an example of a typical technical plan for a demonstration unit, along with the group's comments and recommendations. Similar tables were drawn up for all study sites (F. Agus and S.H. Tala'ohu, unpublished). In general, the techniques suggested in the previous technical plan did not sufficiently address the local problems and thus improvements were made as described below.

Cropping Pattern

In vegetable crop-based farming areas, the recommendation of evenly distributed tree planting was no longer employed because it resulted in suppression of growth of shade-intolerant vegetable crops and thus a decline in productivity.

Land tenure

The land tenure systems in the area studied include ownership, rental, shareholding, and use of absentees' land. Several farmers farm on public land without any tenure documents. Farmers having no certainty of long-term tenure are not likely to invest in long-term erosion control measures such as tree planting and bench terracing. In the demonstration units farmers may accept planting of perennial tree crops regardless of their land tenure systems because of the incentives they receive, but in the outer zones, tree planting is very unpopular if they do not have the security of long-term tenure. In that case, the planting of fodder grass along terrace edges is a low-input measure that is often acceptable to those farmers owning animals.

Farm size

If farm size is relatively large (> 2 ha), there is a greater likelihood that part of the land is already devoted to perennials/trees because of a family labor shortage for cultivation of annual crops. In that case, tree planting may be more acceptable than in the case of a small land holding, where all available land is used for food production, and farmers are very unlikely to plant trees. For small farms, contour hedgerow planting may possibly be more acceptable.

Existing tree stands

In food crop-based smallholder farms, it is very common to find various kinds of trees, ranging in number from 30 to 200 trees per ha. Farmers regularly prune the trees to obtain firewood and forage for their ruminants and to reduce shading effects on their annual crops. The existing trees must be considered, as they may already be close to the maximum density that the under story food crops can tolerate. Simply following a blanket recommendation to plant 100 new trees per hectare on land that has a slope of less than 25%, for example, is not logical if a large number of trees are already present.

Tree position is far more important than the percentage of tree cover. Fifty per cent tree coverage could be as effective as 100 % coverage in terms of sediment-load reductions in waterways (van Noordwijk, et al., 1998) as long as the trees are placed properly in the watershed (for example in buffer zones along river banks, or planting on steep slopes where high erosion is likely to occur).

Soil properties

Soil structure and high Al content in the B horizon determine whether bench terracing or "rehabilitation" of bench terraces is appropriate. The rehabilitation under the Regreening program involves making a channel at the terrace base and leveling off or even reversing the terrace slope from the original slope orientation. While this practice may reduce surface runoff, it exposes infertile subsoil layers with high Al content, which, in consequence, affect plant growth.

Suggestions For Future Land Management

This review paper as well as earlier studies (such as Tala'ohu and Agus, 1998) and field observations revealed that there has not been adequate consideration of environmental and farmers' circumstances by the Regreening Program agents when selecting technology for soil conservation. While the implementation runs fairly smooth with the use of incentives in the demonstration units, its scaling-up on the larger portion of the catchment using farmers' own resources is questionable.

Technology options should not be limited to a very narrow range, but a wide range of technical innovations could be blended from the literature, previous related projects, and farmers' indigenous practices. These include mulching, construction of small sized sediment pits (Purwanto and Bruijnzeel, 1998), contour hedgerow planting (Agus et al., 1999; Garrity and Agus, 2000; and Haryati et al., 1995), tree planting at farm borders, conservation tillage, use of cover crops during the dry season, strip cropping with fodder grass or legumes, fertilization and organic matter management, planting of adaptive crop species and varieties and building drop structures. It appears that in many situations low-cost vegetative conservation measures can be applied. There is a need to integrate perennial tree crops and livestock with food crop production within the farming system (Garrity and Agus, 2000), but the subsistence nature of farming must be considered. A livestock component on farm will open up opportunities to introduce vegetative reinforcement to structural investments such as bench terraces, roads and drainage works and for intensification of shifting cultivation on steep land. Planting of fodder grass and/or legumes is relatively easy to adopt and has the least conflict with farmers' interests (Tala'ohu and Agus, 1998).

Offering a 'best-bet' menu of techniques, i.e. a set of the most promising technical innovations, to farmers must then be followed with explanation of the advantages and disadvantages and subsequently a demonstration of how selected options could be implemented. Full attention should be given to farmers' livelihoods and priorities in addition to environmental concerns, and farmers should have the right to select the most appropriate technology.

If given the opportunity, farmers are more than willing to express their views about soil conservation (as tested in Section 4), and are able to diffuse the new technology among themselves. If farmers are empowered and not restricted, this will revamp the conventional model of conservation (Garrity and Agus, 2000).

CONCLUSIONS

1. At present, technology introduced in the national soil conservation program has not adequately addressed site-specific problems. Technology selection is mainly based on simplicity and a requirement to cover the target areas.
2. Building on indigenous practices will improve the selection procedures. Refinement of existing techniques is much easier than introducing options from outside.
3. Farmers should be given more opportunity to understand and respond to each proposed measure and make their own decisions in managing their land. Responsible agencies should be aware of farmers' interests in maximizing on-farm benefits. Separation of production and environmental management objectives often makes the demonstrated technology unpopular and non-adoptable.
4. Extension agents should be given hands-on field training, as opposed to purely classroom-based theoretical training, and this should include soil conservation, agronomy, and participatory communication skills. With these backgrounds they should further be trained in identification of problems in the field, selecting and proposing alternative counter-measures and improving indigenous practices.

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