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## Financial Assessment of Soil Conservation Incentives

**M. Tamilselvan<sup>1</sup>, S.Rameshkumar<sup>2</sup>**

Assistant professor, Department of Agriculture Engineering,  
Excel Engineering College, Komarapalayam,  
Tamil Nadu 637303

**M Nithyakalyani<sup>3</sup>, B. Yuvaraj<sup>4</sup>**

Student, Department of Agriculture Engineering,  
Excel Engineering College, Komarapalayam,  
Tamil Nadu 637303

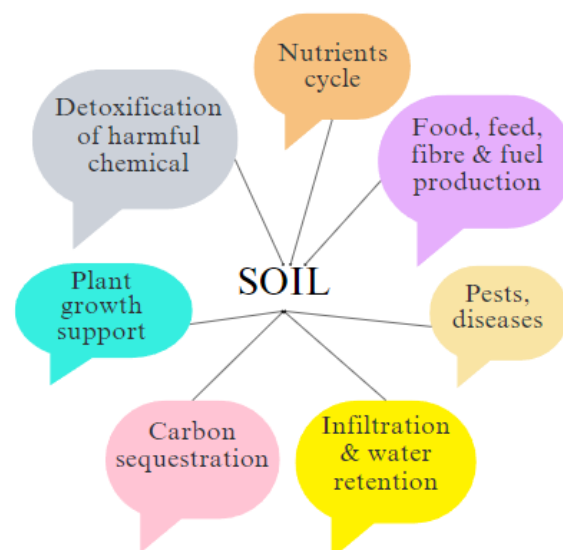
<b>Article History</b>	<b>Abstract</b>
<p>Received: Revised: Accepted:</p> <p>CC License</p>	<p><i>It's a complicated question whether and how governments should step in to promote the adoption of conservation measures. Effective policies to promote conservation cannot be developed without a thorough understanding of the motivations behind farmers' adoption of specific land use practises. This study examines the factors that lead farmers to choose a particular land use practise over another and considers the potential influence of government policies on farmers' adoption of more environmentally friendly practises. It does this by using a straightforward graphical model and data from semi-arid Kenya. Farmers are typically highly motivated to implement conservation measures when on-site productivity is the main priority. When farmers are prevented from adopting otherwise profitable conservation practises, or when there are discrepancies in the valuation of inputs and outputs, there is typically a divergence between privately optimal and socially optimal conservation behaviour. Incentive programmes are unlikely to work unless these issues are addressed head-on. There is no obvious motivation for farmers to take the necessary corrective measures when off-site repercussions are the main issue. In these circumstances, a subsidy programme might be necessary. Even in these situations, pricing distortions and any barriers to the implementation of conservation measures need to be closely monitored.</i></p> <p><b>Keywords:</b> adoption of conservation, practises, Incentive, graphical model, farmer.</p>

## 1. Introduction

Numerous governments have made an effort to promote soil conservation due to concerns about the effects of land degradation on agricultural output and issues like reservoir siltation. Some governments opted to subsidise the adoption of specific practises, particularly mechanical conservation structures like terraces, while others enacted laws and regulations meant to stop farmers from engaging in degrading activities or to force them to adopt conservation practises. These initiatives have frequently produced significantly less than expected outcomes. Because of the wide spatial distribution of agricultural operations and the frequently limited enforcement capabilities available to governments in developing nations, land use regulations have proven to be extremely difficult to implement. While subsidies have been successful in encouraging the use of conservation measures, once they stop being provided, farmers tend to stop using them and in some cases even deliberately demolish conservation structures. Other times, farmers have only grudgingly cooperated with conservation measures. This study looks at the factors that influence farmers to choose one land use strategy over another and the potential influence of government regulations on farmers' adoption of more environmentally friendly practises using a straightforward graphical model. The findings are then illustrated using data from Kenya.

### Private vs. social view of issues related to soil conservation

Two separate but connected concerns must be addressed in order to design policies that would successfully and sustainably improve conservation: what would farmers do in a different situation (a positive question) and what would society like farmers to do (a normative question). Ultimately, farmers, not social planners or governmental organisations, decide how to use their land. [1] Farmers make decisions on how to use their property based on their personal goals, available production options, and available limits. It is a positive question to understand what influences individual farmers' decisions about land use; to do this, study of farm-level costs and benefits valued in private terms is necessary. (Figure 1) This research should take into account the prices that individual farmers actually pay for inputs or receive for outputs. [2] The primary challenges in this situation are obtaining sufficient quantitative data on the technical linkages between various land use practises, long-term yields, and production costs; and comprehending the limits and preferences of the farmers.



**Fig 1 Conservation Agriculture**

Secondly, one needs to inquire as to what the public wants farmers to do. Contrary to popular belief, the answer to this issue is rather less clear-cut. It is frequently challenging to translate society's clearly stated social goals—like "sustainable development"—into concrete actions by individual land users, especially in light of the site-specificity of agricultural production, the issues associated with land degradation, the paucity of available data, and other factors. [3] To address this normative challenge, one must use the opportunity cost of products and services to society to analyse the national gains and losses resulting from various activities evaluated in social terms.[4] In order to complete this process, farm-level benefits must be revalued at social prices, and benefits arising from the decrease of various off-site damages must also be added and valued at social prices. [5] The primary challenges here include determining and quantifying the relationships between farm-level operations and downstream damages, as well as estimating the various damages, on top of the challenges already faced in comprehending farm-level situations.

The answers to these questions will determine the type of interventions required to guarantee the proper application of conservation measures—and, in fact, if any intervention is required at all.

### **Individual farmers' perspectives on the benefits of conservation through private analysis**

Decisions about how to use land result in land degradation. Appropriate policy recommendations cannot be given without a deeper comprehension of the factors that influence specific land use decisions. [6] Assuming farmers are reasonable, their choices about how to use their land are based on weighing the potential returns from each possible practise. Even though a variety of farming methods can cause soil degradation, taking steps to stop or slow this degradation—by altering crop and management strategies or implementing conservation techniques—will probably come at a cost, either directly in the form of increased investment costs or indirectly in the form of lost productivity. [7]

The crucial query that farmers must answer is whether the short-term advantages of less deterioration outweigh the associated expenses. A modelled decision between two land use practises—a degrading practise and a saving practise—is shown in Figure 1. [8] The flow of net returns to specific farmers for each practise is displayed in the upper left panel. Under the deteriorating practise, returns steadily decrease along with yields. After an initial investment, stable yields can be obtained under the preserving practise. Six It is crucial to factor in both expenses and advantages when calculating net returns for each practise.

[9] Overestimations of returns occur when the opportunity costs of land and family work are neglected or underestimated. Some advantages of specific land use practises are also frequently undervalued; in this instance, returns would be underestimated. [10] Examples of these advantages include crop by-products and the fact that they offer income or feed during periods when other sources are unavailable.

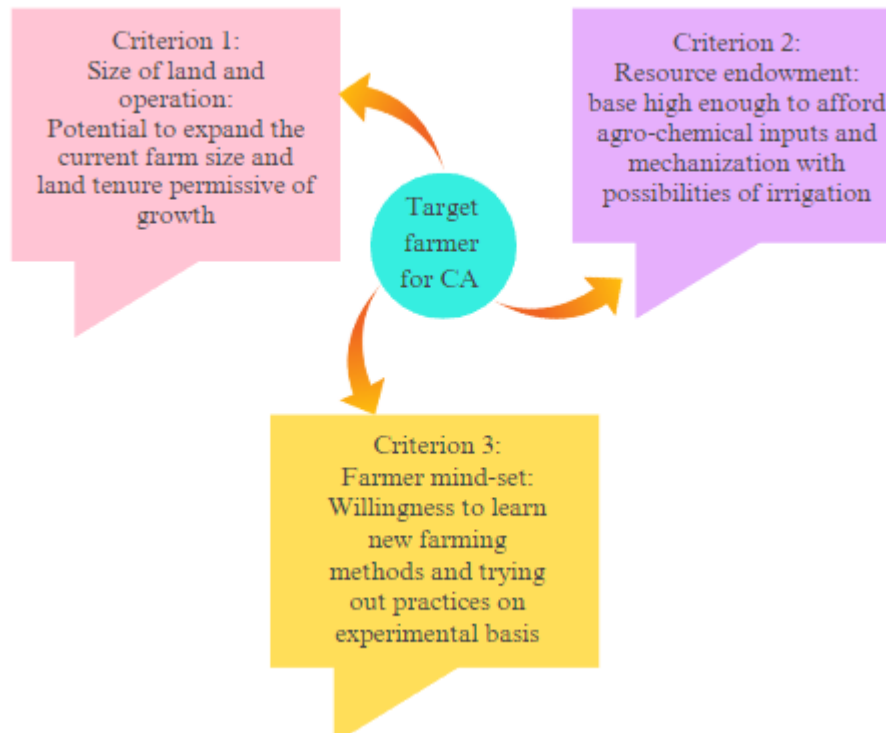


Fig 2 Conservation agriculture

The discounted net returns for each practise are displayed in the bottom left panel. The immediate expenses and long-term advantages of implementing the conservation practise can be directly compared in this panel. [11] We expect the practise to be embraced if the long-term benefits outweigh the short-term losses, barring any constraints. (Figure 2) The personal advantages of adopting a conserving practise can not always outweigh the drawbacks. For example, the degrading practise might not do much harm, or the conserving practise might not significantly increase productivity; low prices could make productivity gains insufficient to cover costs; credit restrictions or poverty could prevent necessary investments; and insecure tenure could discourage farmers from making investments whose returns will only be seen in the short term. [12] Given the wide variations in both socioeconomic and agro-ecologic environments, it is not unexpected that the degree of adoption can also vary significantly. [13] The private analysis excludes the potential off-site costs associated with each practise, such as river sedimentation. These expenses are externalities in the eyes of the farmers, and they will not be considered. It's not that farmers are unaware of these effects—they very well may be, particularly if they happen far downstream—but rather that it is not in their best interests to deal with them.

[14] Numerous studies have proven that farmers' perspectives on the economics of conservation measures play a crucial role in their adoption. Adoption rates typically tended to be low in cases when conservation measures were implemented, according to an evaluation of the costs and benefits of soil conservation measures in six Central American and Caribbean countries. In certain instances, like Tierra Blanca in Costa Rica, low rates of soil degradation were the cause of low profitability; in other instances, like Patzité in Guatemala, the costs of the suggested conservation measures were excessive in comparison to their advantages. [15] On the other hand, places with high estimated profitability also had high adoption rates. Similar to this, the Kitui/Machakos region of Kenya has seen a large adoption of locally constructed terraces known as fanya juu; as the illustration below illustrates, these terraces are probably beneficial for farmers in a variety of circumstances.

Of course, there are a lot of other issues, like poverty, lack of credit, and unstable tenure, that will influence farmers' conservation decisions. These variables may alter the costs and benefits that certain farmers perceive, in which case they might be explicitly included in the profitability study. The cost of investments will be higher, for instance, if the only source of financing is pricy informal moneylenders. By include the finance costs with the adoption costs of the conservation measure, this can be included in the study. However, because they cannot be certain they will reap the long-term rewards of their efforts, farmers with insecure tenure would severely underestimate such prospective benefits. In other situations, farmers will have more options. Naturally, a lot of other things will influence farmers' decisions on conservation. Adopting specific practises, for instance, could not be possible if the necessary inputs are unavailable. No matter how profitable it might be for them to do so, farmers cannot restore soil nutrients if fertilisers are not available. In these situations, the research may be restricted to looking at the options that farmers actually have. To ascertain the advantages of removing the restriction, it is frequently intriguing to conduct the profitability analysis as though it did not exist.

[16] When doing the study, any government subsidies obtained in exchange for the adoption of conservation practises would be counted as part of the activity's earnings. The complete net returns curve for the subsidised practise will rise if the subsidy is given annually. Only the first portion of the net returns curve is moved upward if, as is more typical, the subsidy is only provided for a brief amount of time. Similarly, by utilising the subsidised prices to value the inputs, the analysis would take into account the impact of indirect subsidies, such as lower prices for certain inputs.

## 2. Social analysis: societal perceptions of the benefits of conservation

The corresponding social analysis of the identical choice of activities is displayed in Figure 1's right-hand panels. The benefits of each activity on-site are displayed in the top panel. Because inputs and outputs are evaluated at their societal opportunity cost rather than their market values, these may differ from those that are recognised by individual farmers. Substantial divergences may arise if observed market prices are distorted by government actions or market failures. For instance, the social value of agricultural commodities will exceed the market price that farmers see if government policies maintain low prices for such commodities, as has traditionally been the case in developing nations. Since they are transfers from the government to farmers (or vice versa in the case of a tax), any direct subsidies to farmers or taxes paid by farmers—including subsidies for the adoption of conservation measures or taxes imposed on the use of degrading measures—should not be included in this analysis.

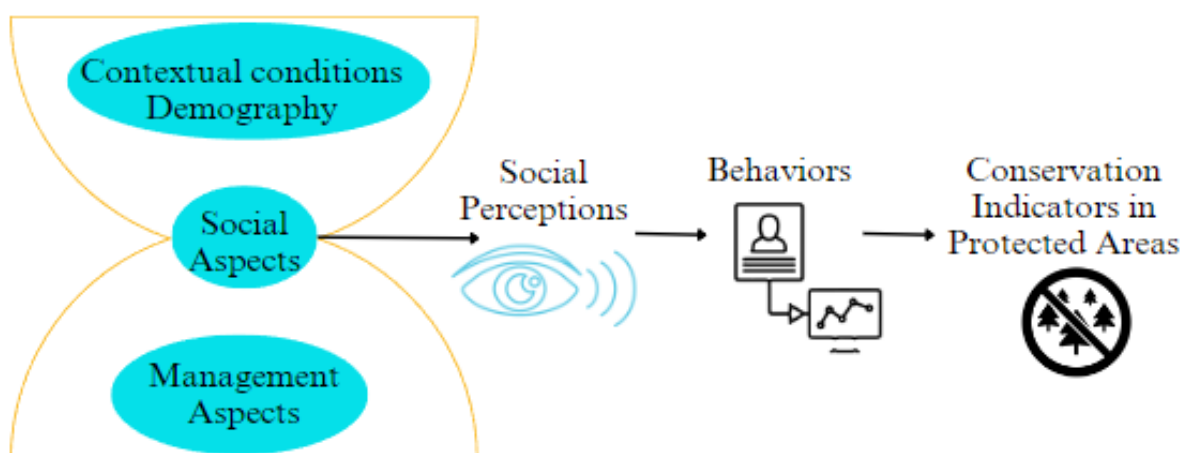


Fig 3 Social perceptions and conservation

The off-site expenses linked to each activity are then displayed in the middle panel. (Figure 3) For the sake of demonstration, it is assumed that the conserving practise results in substantially lower levels of off-site damage while the degrading practise results in a constant level of off-site damage, such as by contributing to reservoir siltation. Since the causes are frequently spread out throughout time and place, it can be challenging to establish obvious cause-and-effect links, making these costs difficult to evaluate.

The bottom right panel then aggregates these costs and benefits and displays the flow of discounted total costs and benefits once more, this time from the viewpoint of society. Once more, the key question is whether the short-term expenses of moving from a degrading practise to a conserving one are justified by the long-term advantages. It is not always the case that the conservation option will yield greater societal returns.

### **3. Formulating suitable reactions**

No intervention is required if the answer to the normative question of what would be socially ideal for farmers to do is the same as the answer to the positive question of what farmers will do. Farmers will not engage in conservation at the socially ideal rate if their responses to these two questions are not the same, i.e., if privately optimal behaviour varies from socially optimal activity. Then, the issue of how to balance socially and privately optimal conservation behaviour emerges. Recognising the differences between the two is an essential first step.

Up until recently, the majority of developing nations had policies that severely discriminated against agriculture. A number of strategies have been used to syphon off resources from agriculture, including price controls, protective measures for rival industries, excessive direct taxes, and overvaluation of currency rates. It has long been believed that these distortions serve as a disincentive to conserve. In actuality, it is challenging to determine in advance whether a certain policy will tend to promote or discourage conservation due to the large range of policies and agro-economic circumstances. However, the proper course of action is to eliminate policy-induced pricing distortions if that is the main cause of farmers' inability to implement socially desirable conservation measures. Implementing such a reform would be a "win-win" approach since it would increase overall efficiency of Conservation.

One may assume that prices could be changed to promote conservation since price policies can have a significant impact on the incentives to adopt conservation measures. But this is an extremely dull tool. If the tax or subsidy is not specifically designed to apply just to inputs used in conservation efforts, it is likely to have an impact on activities that are much outside of its intended scope. This could result in significant budgetary expenditures and inefficiencies in other areas of the economy. Furthermore, the payment may even work against conservation efforts if caution is not exercised.

If farmers' judgements on how to use their property deviate from socially optimal decisions because of unaccounted-for externalities, there is a case for compensating farmers for their appropriate behavior—or taxing them to discourage improper behaviour. If a conservation measure results in a positive externality (such less damage to reservoirs and streams downstream), then the minimal amount of subsidy needed to encourage adoption of the measure is the same as what would be needed to make adoption profitable for farmers. The quantity of the downstream benefit being produced is the maximum subsidy that ought to be given.

#### 4. In theory, this is straightforward, but in reality, there are a lot of issues:

First off, it is frequently quite challenging to link particular upstream changes in land use to downstream changes in costs and benefits. Second, farmers have significant incentives to misrepresent these expenses, and planners typically have very limited information about the true costs and advantages of farming. Third, site-specific factors will probably cause both the on-farm expenses and the off-farm benefits to differ significantly. Finally, payments to farmers themselves must be sustained over time, as land use changes will only produce advantages downstream if they are maintained. Farmers are encouraged to pocket the subsidy and then return to their original practises because it is customary to pay the entire subsidy over a fairly short period of time.

#### In Kenya's semi-arid regions, terracing adoption and incentives

An illustration of the scope and direction of the effects of policy-induced price changes on incentives to implement conservation measures may be found in data from the Eastern Kenyan districts of Kitui and Machakos. In this semi-arid area, maize is the predominant food crop and agriculture is mostly focused on subsistence farming. The region's soils are often shallow, low in organic matter, and lacking in phosphate and nitrogen. The area's soils are susceptible to erosion due to low infiltration rates and a vulnerability to sealing, especially since the strongest rains occur early in the growing season when there is little ground cover. Building fanya juu terraces is the advised course of action to avoid this menace (alternative remedies, like waste lines or live barriers, tend not to be effective due to the paucity of fodder and termite problems). (Figure 4) Adopting fanyajuu terraces doesn't alter farming methods other than the need to build and maintain physical structures.



Fig 4. Terrace Farming in Agriculture

The benefits of installing fanya juu terraces on fields in the Kitui/Machakos area with a 15% slope are depicted in Figure 4. According to estimates, the installation of fanya juu terraces on these areas will break even in the private sector. Since erosion causes more damage on steeper slopes, conservation benefits would be larger there; conversely, conservation benefits would be lower on gentler slopes. The fact that conservation methods are widely used in the area despite the lack of any official support programmes attests to their financial viability from the farmer's private standpoint. The government's involvement was restricted to providing technical guidance for the layout of the terraces and, on occasion, tools to women's self-help (mwethya) groups engaged in environmental conservation.

Because there aren't many reservoirs and canals in this location, external costs aren't taken into account in the sociological analysis shown in Figure 2. If external costs existed, would subsidies have been appropriate as a way to mitigate them? The likelihood is that in this instance, they wouldn't. As previously mentioned, adoption of conservation measures on steeper slopes, where erosion is more likely to occur, is justified by the high level of private incentives for conservation. However, as these fields typically create relatively little sediment, incentives to encourage farmers to take conservation techniques would have little impact on any externalities since they would simply modify the private returns to conservation, which are lower on the shallower slopes and may not justify adoption.

It may seem unexpected that conservation in Kitui and Machako should have spread so widely without government assistance, considering the significant financial outlays needed for terracing and the lost output due to the smaller effective area. Furthermore, the region's credit markets are essentially nonexistent. Despite these possible obstacles, a number of systems have made it possible for farmers to invest in conservation. The use of women's labour exchange (mwethya) groups helped to lower the financial cost of terracing, but possibly most significantly, remittances from family members who worked off the farm served as a source of funding. By taking part in these organisations, farmers can get the labour they need for terracing without having to spend a lot of money. However, because mwethya groupings entail reciprocal labour exchange duties, the employment they supply is neither free nor inexpensive. Farmers are essentially borrowing labour because mwethya organisations act as a stand-in for the absence of credit markets. Though fanya juu terraces are profitable, farmers might not have been able to build them if mwethya organisations and remittances had not offered an alternative to missing credit markets. However, rather than supporting the building of terraces, the first-best solution in this circumstance would have been to try to create other finance options.

Restrictions on land tenure are likewise insignificant in Kitui and Machakos. Most farmers are comfortable with their tenancy even if few of them own title deeds. In addition, farmers stated that they were reluctant to pledge their land as security for loans because they were afraid of losing it in the event that unfavourable weather produced subpar harvests. Therefore, since they wouldn't improve tenure security or financing availability, interventions like land titling would have minimal impact on the adoption of conservation in this situation.

This case study just as an example of how farmers are encouraged to implement conservation measures. Because land degradation issues are typically quite site-specific, the outcomes in different situations may differ significantly. Variations in agroecological and socioeconomic factors can lead to significant variances in farmers' motivation to use conservation measures, even within a given area.

## 5. Conclusion

It's a complicated question whether and how governments should step in to promote the adoption of conservation measures. Only with thorough knowledge of every unique circumstance can appropriate policies be created. Farmers' conservation practises may diverge from socially desirable practises for a variety of reasons. It seems doubtful that a successful policy to promote the adoption of conservation measures can be developed without a thorough grasp of the motivations behind farmers' acceptance of specific land use practises. When the long-term productivity of their land is threatened by land degradation, farmers are typically highly motivated to implement conservation measures. Divergences between privately optimal and socially optimal conservation behaviour are typically present when degradation is of concern largely because to its influence on on-site productivity. Any incentive



programme is unlikely to succeed unless these issues are addressed head-on. Conversely, farmers lack a direct motivation to take the necessary corrective action when degradation is a worry primarily due to its off-site implications. In these circumstances, a subsidy programme might be necessary. Even in these situations, pricing distortions and any barriers to the implementation of conservation measures need to be closely monitored. It becomes less likely that suitable incentive programmes can be developed if this isn't done.

### **Competing interests**

The authors declare that they have no competing interests.

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Not applicable

### **Ethics approval and consent to participate**

Not applicable

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Author A supports to find materials and results part in this manuscript. Author B helps to develop literature part.

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