Alley Farming in the Humid and Subhumid Tropics

Proceedings of an international workshop held at Ibadan, Nigeria, 10–14 March 1986
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Alley Farming in the Humid and Subhumid Tropics

Proceedings of an international workshop held at Ibadan, Nigeria, 10–14 March 1986

Editors: B.T. Kang and L. Reynolds

Jointly organized by the International Institute of Tropical Agriculture, Ibadan, Nigeria, and the International Livestock Centre for Africa, Addis Ababa, Ethiopia

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Abstract / Résumé / Resumen

Abstract — An urgent challenge facing scientists working on upland food-crop production in many parts of the humid and subhumid tropics is the need to find viable, sustainable, and environmentally sound alternatives to the ancient shifting cultivation and bush-fallow, slash-and-burn cultivation systems. As a food-cropping and livestock-production technology, alley farming requires a low level of inputs and helps conserve soil resources while sustaining long-term farm productivity. This publication presents the results of an international workshop on alley farming in the humid and subhumid tropics. Held in Ibadan, Nigeria, 10–14 March 1986, the workshop was attended by 100 participants from 21 countries. The theme of this workshop was the development of more productive, sustainable farming methods with low inputs in the humid and subhumid tropics using alley farming techniques. This book reviews the present state of alley farming research and its application, discusses the use of woody species in tropical farming systems, highlights training and research needs, and proposes the establishment of channels for collaborative research.

Résumé — Les scientifiques s'intéressant aux cultures vivrières en zones d'altitude dans de nombreuses régions des tropiques humides et sub-humides doivent répondre à un besoin urgent : trouver des solutions de rechange viables, soutenables et environnementalement saines aux anciennes méthodes de rotation des cultures et mise en jachère et de culture sur brûlis. A titre de technique de culture et d'élevage, l'agriculture en couloirs ne nécessite que peu d'intrants et contribue à conserver les sols, tout en favorisant la productivité agricole à long terme. Cette publication présente les résultats d'un atelier international sur l'agriculture en couloirs dans les tropiques humides et sub-humides qui s'est tenu à Ibadan, au Nigéria, du 10 au 14 mars 1986 et qui a réuni 100 participants de 21 pays. L'atelier portait sur la mise au point de méthodes culturales plus productives et plus durables ne nécessitant que peu d'intrants pour les régions des tropiques humides et sub-humides, grâce aux techniques de l'agriculture en couloirs. Le livre fait le point sur la recherche actuelle en matière d'agriculture en couloirs et ses applications, discute de l'utilisation des arbres dans les systèmes agricoles en milieu tropical, met en lumière les besoins en matière de formation et de recherche et propose l'établissement de canaux aux fins de la recherche en collaboration.

Resumen — Un reto urgente al que se enfrentan los científicos que realizan investigaciones sobre la explotación de cultivos de montaña en muchas zonas húmedas y subhúmedas de los trópicos, es la necesidad de encontrar alternativas viables, sustentables y correctas desde el punto de vista del medio ambiente, al antiguo método de cultivos migratorios y a los sistemas de cultivo en barbecho y de corte y quema. Como tecnología utilizada para cultivos alimentarios y la producción ganadera, la agricultura de pasillo o entresurcos necesita pocos medios y ayuda a conservar los recursos del suelo en tanto mantiene la productividad agrícola a largo plazo. Esta publicación presenta los resultados de un grupo de trabajo internacional sobre agricultura de pasillo o entresurcos en las zonas húmedas y subhúmedas de los trópicos, celebrado en Ibadán, Nigeria, del 10 al 14 de marzo de 1986, y al que asistieron 100 participantes de 21 países. El tema de este grupo de trabajo fue el desarrollo de métodos de cultivo más productivos y sostenidos con pocos recursos en las zonas húmedas y subhúmedas de los trópicos, utilizando técnicas de agricultura de pasillo o entresurco. Este libro revisa la situación actual de la investigación sobre la agricultura de pasillo o de entresurco y su aplicación, discute el uso de especies maderables en sistemas de cultivo tropicales, subraya la necesidad de realizar investigaciones y dar cursos de capacitación y propone la creación de canales para la investigación conjunta.
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Economic returns of alley farming

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Abstract — To date, economic evaluations of alley farming have focused on how profitable it is for the individual farmer. However, the work of physical scientists indicates that the individual farmer can capture only some of the benefits; others accrue to society as a whole. The decision to invest in alley farming is an individual one. However, as farmers are aggregated to groups and groups to regions, the benefits and costs to these aggregates increase. This paper suggests mathematical programing as a method for the ex ante evaluation of alley farming at different levels of aggregation. Such models measure the benefits to society and information can be incorporated as it becomes available. Alley farming is compared with other technologies that maintain fertility and control erosion in the long term.

Introduction

Land degradation is one of the most pressing problems in tropical Africa. Alley farming, which has been tested over a wide range of environments, is one technology with the potential to overcome this problem.

The list of benefits from alley farming includes continuous cropping and fertility maintenance. This implies savings in land clearing, fertilizer costs, and potentially higher income through yield increases. The demand for new land may also slacken. As a result, valuable forest land will be saved. Alley farming also reduces erosion, thereby reducing on-site and off-site costs incurred by erosion damage. The trees used in alley farming can contribute to animal feed and stems can be used for yam staking and firewood production; meat production can also be increased.

This brief list shows that alley farming benefits individuals as well as society. There has been little discussion in the literature on alley farming of the benefits to society not captured by the farmer (positive externalities). This paper focuses on the benefits of alley farming to society. The development of a methodology to evaluate these benefits is emphasized. This will help to identify major gaps in the available data, thus pointing out areas for future research.
Review of previous work

A sizable body of literature on alley farming in tropical Africa has developed over the past few years. Major contributors include the International Institute of Tropical Agriculture (IITA), the International Council for Research in Agroforestry (ICRAF), and the International Livestock Centre for Africa (ILCA). This work has been reviewed by Sumberg et al. (1985).

The agronomic work indicates that alley farming allows continuous cropping with moderate, stable yields and is an alternative to the traditional bush-fallow system. The economic work has investigated the profitability of alley farming for different agricultural systems as viewed by individual farmers. Raintree and Turay (1980) focus on alley farming and rice production; Verinumbe et al. (1984), minimum tillage; Hoekstra (1982), alley farming under semi-arid conditions; Ngambeki (1985), alley farming in relation to the use of herbicides and nitrogen. All these studies conclude that the returns from alley farming, combined with various crop-production systems, are high enough to provide an incentive for farmers to adopt the technology.

Sumberg et al. (1985) investigates the economics of feeding prunings, which are in excess of soil fertility maintenance requirements, to small ruminants. They conclude that crop or livestock production from the excess foliage is about equally profitable. Francis (this volume) focuses on land tenure as a potential institutional constraint to adoption. He concludes that land tenure problems are important but that generalizations cannot be made because of the relative flexibility of customary law.

The economic literature suffers from several weaknesses. Most studies use experimental station data, data that may be unrealistic under farm conditions. Focusing only on the individual farmer, the studies ignore major benefits of alley farming on society, with several consequences. The real benefits of this technology are underestimated. Thus, alley farming does not receive the attention it deserves by researchers and policymakers. This may lead to a misallocation of resources. Also, economists do not provide physical scientists with feedback. Thus, research into profitable areas may remain unexplored.

This paper identifies inputs and outputs and formulates them into a general model for the evaluation of alley farming. This model is then modified to suit the purposes of each step of analysis.

Objectives

The objective of this paper is to develop a methodology suitable for measuring the benefits of alley farming to society. Management decisions at the farm level are generally analyzed in the context of maximizing expected net income over a certain time. Rational individuals calculate the amount of income they expect to receive over time and compare this to the expected income using the old technology (Lee 1980). Individuals may reach different investment decisions, depending on discount rate and the length of their planning horizon.
A farmer's decision on whether to adopt alley farming depends on the institutional environment in which that farmer operates. Whenever there is a divergence between individual (private) and total (social) benefits and costs, an externality is present (Dahiman 1979). When deciding whether to adopt alley farming, the farmer considers the additional quantity of, say, maize produced, the price of maize, and the change in production costs. The farmer will also estimate the number of years that more maize can be harvested and what the total additional crop is worth today. If this value is sufficiently higher than the value of the maize crop without alley farming, the farmer may decide to adopt alley farming.

Several key points may lead to this decision. The better the information on the potential of alley farming, the more accurate will be the farmer's assessment. Farmers only consider that portion of their income that they keep; they count only those costs that have to be paid. Thus, a farmer does not consider the off-site savings from alley farming. The farmer does not place any value on reduced erosion, which will lower the costs of maintaining irrigation canals, for example (Southgate et al. 1984). Also, if the farmer's right to use the land is limited to only a few years, the incentive to plant alleys will be reduced because the whole benefit of the investment will not be reaped (see Francis, this volume).

It is usually argued that more secure property rights are an incentive to investment in resource conservation. Southgate et al. (1984) point out that the institutions have to be such that the activity of asserting private-property rights does not generate environmental damage as a by-product.

Looking at the benefits and costs of adopting alley farming within a region, it is apparent that what does not benefit the farmer may benefit the inhabitants of the region. Similarly, costs not paid by the individual may be paid by people within the region. Suppose that a whole village has adopted alley farming and that surplus maize is marketed in a nearby town. The increase in maize output will raise farmers' income and consumers in the town will benefit from lower prices. Similarly, the development costs of the new technology are likely to be paid from outside sources. If the extension service is supported from local funds, however, each farmer would pay a share.

This example shows that costs and benefits can be internal or external depending on the level of aggregation, i.e., whether an individual, a village, a region, or a country is considered a unit. As the level of aggregation increases, more of the costs and benefits become internal. At each level, inputs and outputs must be listed and it must be decided which costs and benefits are internal and which are external.

For the purposes of evaluation, all benefits from a new technology are assumed to accrue to society rather than to individuals. There are at least two reasons for this view. First, the decision to adopt is made by individuals who only consider their private costs and benefits. The aggregate benefits of adoption go to all farmers; as individuals, however, farmers are only concerned about their own share. Second, the sum of the benefits expected by each farmer is usually not equal to the benefits that are actually received. Each farmer may expect returns to increase when more fertilizer is applied. However, a decline in prices because of the increase in total output may result in lower returns. For policy analysis, it is useful to assume that decisions are made by individuals and that benefits go to society.
From this example, it is clear that society gains from a portion of the benefits, whether additional returns or reduced costs; which portion of the benefits the farmer can retain depends on the institutional environment in which that farmer operates. The institutional, economic, and political environment also determine the farmer’s planning horizon.

Evaluating alley farming

A general technique for evaluating the economic benefits of a new technology is presented here. The procedure is developed in steps corresponding to the level of aggregation (i.e., farmer, regional, or national level). This level reflects the adoption process of the technology. The effects of adoption on the economy also change with the level of aggregation, thus requiring adjustments to the model. Similarly, the benefits and costs, whether internal or external, are identified at each level in the suggested evaluation procedure.

Evaluating the benefits

Two procedures are typically used to evaluate the benefits of agricultural research: the economic surplus (or index number) approach and the production function approach (Martinez and Sain 1983). Both procedures are retrospective evaluations.

The economic surplus approach is more appropriate for two reasons. First, it is less data demanding and, second, there are methods that allow for previous evaluation of investment into research. This approach is based on the concept of producers’ and consumers’ surplus.

Fig. 1. Supply and demand curves and the measurement of consumers’ and producers’ surplus.
Benefits to consumers (in the form of surpluses) are measured by the area under a demand function (DD') down to the equilibrium price line (PA). Benefits to producers (producers' surplus) as measured by the area above the supply function (OS) up to the equilibrium price line (Fig. 1). The sum of both surpluses represents the benefit to society. Externalities on the demand side are not accounted for here; thus, this is only a partial analysis.

The introduction of a new technology may increase productivity; this would shift the supply function to the right. The change in area represents the increase in benefits to society (Fig. 2). The change in consumers' surplus is given by the areas $P_oACP_n$ plus $ABC$. The gain is due to a decline in price from $P_o$ to $P_n$ and an increase in quantity from $Q_o$ to $Q_n$. The change in producers' surplus is given by the area $OCB$ minus $P_oACP_n$. Both the supply and the demand functions can be estimated econometrically. The supply function contains a research variable, which measures the function shift attributable to research expenditures. The change in consumers' and producers' surplus is then calculated. It has been shown that, regardless of the mathematical form of the function, the key value to be estimated in this model is the percentage change in the value of production attributable to research.

**Model requirements**

The described procedure has been used mainly for retrospective (ex post) evaluation of technology. To help the agricultural policymaker in making decisions, however, an estimate of the potential (ex ante) benefits to alley farming is required. An ex ante evaluation model must be able to represent at least some of the aspects of the physical, biological, and human environment in which the farmer operates. It should be possible to capture some major reasons for farmers' decisions. The model should be flexible in that it should be able to evaluate a large number of production-technology alternatives and be applied at each level of aggregation. However, the
model should accommodate changes in assumptions. It should be inexpensive to run, the output should be easy to interpret, and the data requirements should be manageable.

Mathematical programming, a technique that has been widely used, fulfills these requirements (for a review of recent developments in mathematical programming, see Anderson et al. 1977; Norton and Solis 1983; Vogel 1984). The benefits from alley farming could be evaluated in three steps representing three levels of aggregation (Table 1).

This paper discusses only the basic rationale of some model specifications. These are the basic linear programming (LP) model at the farm level, the farm model including risk, and the regional model with internalized demand functions and risk. All models are extensions of the farm-level LP specification. The reformulations are an attempt to include more of the farmers' goals and to capture changes in price behaviour at higher aggregation levels.

**Basic model for the individual farmer**

The basic LP model can be written as follows:

$$\text{Max } II = p'y - c'x - F$$

subject to $Dx \leq b; x \geq 0$

where $II$ is the profit, $p$ is an $n \times 1$ vector of market-clearing prices, $y$ is an $n \times 1$ vector of yields, $c$ is an $n \times 1$ vector of unit costs of inputs, $x$ is an $n \times 1$ vector of enterprise levels, $F$ is fixed costs, $D$ is a $k \times n$ matrix of input coefficients, and $b$ is a $k \times 1$ vector of resource and restrictions.

This model assumes that prices, quantities, and coefficients are nonstochastic; i.e., the model does not consider risk. The farmer maximizes profits and is risk neutral. Other goals such as self-sufficiency in food requirements could be incorporated and would appear as restrictions in the technology matrix. Many alternative technologies could be specified and evaluated, and many resources could be incorporated. Labour, capital, and demands for food and its availability could be specified by time period; land could be specified by soil type and slope.

**Table 1. Models with levels of analysis and their programing features.**

<table>
<thead>
<tr>
<th>Level</th>
<th>Model features</th>
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<tbody>
<tr>
<td>Farm</td>
<td>LP</td>
</tr>
<tr>
<td></td>
<td>LP + risk</td>
</tr>
<tr>
<td>Region</td>
<td>LP</td>
</tr>
<tr>
<td></td>
<td>LP + risk</td>
</tr>
<tr>
<td></td>
<td>Internalized demand functions + risk</td>
</tr>
<tr>
<td>Nation</td>
<td>Several regions as LP</td>
</tr>
<tr>
<td></td>
<td>Several regions as LP + risk</td>
</tr>
<tr>
<td></td>
<td>Several regions with internalized demand functions + risk</td>
</tr>
</tbody>
</table>

*LP, linear programming.
Rotation requirements could also be included. The farmer could consider output prices as given; i.e., they do not change as the quantity that is marketed increases or decreases (the demand curve is horizontal). This implies that this model can only measure producers' surplus, which, in this specification, is identical to private profit. In the early stages of adoption, when alley-cropping farmers are few and scattered, this is a realistic assumption. Only one time period is considered in an LP model. Discounting must be done separately or a multiperiod model has to be developed.

**Included benefits and costs**

An increase in the gross income of producers has two sources: an increase in crop and livestock production and from the value of the trees to the farmer. Crop output can increase for two reasons, area expansion or increased land productivity. In several regions, crop output is regulated by farm size, which is limited by the scarcity of labour during land-clearing and weeding. Alley farming first reduces and finally frees the labour tied up in land clearing. It increases labour demand for pruning but reduces it for weeding (Table 2). Both tasks fall into the same period. Ngambekei and Wilson's study (1984) on pruning labour is inconclusive on the net effect. This topic needs more on-farm investigation. Perhaps the technology can be modified such that a decline in labour requirements is guaranteed.

Kang and co-workers have demonstrated that productivity may be improved through higher fertility levels, increased water-holding capacity, and reduced erosion (Kang et al. 1981; Kang et al. 1984; Kang et al. 1985). For comparison, data relating crop yield to erosion (Lal 1983) could be employed to estimate yields without alley farming.

**Table 2. Benefits and costs measured by a farm-level linear programing model.**

<table>
<thead>
<tr>
<th>Included in model</th>
<th>Excluded from model</th>
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<tbody>
<tr>
<td><strong>Benefits</strong></td>
<td></td>
</tr>
<tr>
<td>Improved fertility (higher average output)</td>
<td>Foreign currency savings for fertilizer and its distribution</td>
</tr>
<tr>
<td>Shift to nitrogen-responsive crops (?)</td>
<td>Area expansion in the region because of reduced risk (?)</td>
</tr>
<tr>
<td>Area expansion because of net effect of land clearing, weeding, pruning, and labour (?)</td>
<td>Reduced rate of off-site erosion and land degradation</td>
</tr>
<tr>
<td>On-site erosion control, if reflected in lower costs to the farmer and higher prices for the crop</td>
<td>Value of conserved land</td>
</tr>
<tr>
<td>Stakes and firewood from trees</td>
<td></td>
</tr>
<tr>
<td><strong>Costs</strong></td>
<td></td>
</tr>
<tr>
<td>Loss of land to trees</td>
<td>Contribution to technology development by international and national research institutions</td>
</tr>
<tr>
<td></td>
<td>Extension service</td>
</tr>
</tbody>
</table>

*These savings could be calculated using a subroutine.*
The benefit to the farmer from fertilizer depends on the responsiveness of the crop to this input. It can be expected, for example, that alley cropping farmers will increase maize production by demanding maize varieties most responsive to nitrogen.

Alley farming may reduce risk in two ways. Under drought conditions, maize planted in alleys suffers less from moisture stress than other maize (J. Mareck, personal communication). This may reduce yield variability and extend the growing season in both cropping seasons. Farmers view this as a reduction in cost and may respond by increasing plant population or area.

Another risk for most farmers is the unreliability of fertilizer supply. This may cause risk-averse farmers to avoid fertilizer-responsive varieties. With alley farming, fertilizer comes directly from the trees; because of the assured supply of fertilizer, the farmer may then choose to plant fertilizer-responsive varieties. If the risk factor of unreliable fertilizer supply is ignored, the model may overestimate production and the farmers’ use of fertilizers and chemicals.

Potential benefits from increased production of livestock, yam stakes, and firewood (from the trees) in an alley farm can be measured by including sales in the objective function. In general, the value of a resource increases with scarcity. The value of land and the output derived from it are higher in densely populated than in sparsely populated areas. The price of labour in these areas will be lower relative to the price of crops, stakes, and firewood. Landowners will thus retain more of the profits from their crops and have more wood to sell. The market will reward this practice. This will create an incentive to adopt alley farming.

The costs internal to this model are associated with the loss of crop land to trees. Returns per hectare will be lower. However, Sumberg et al. (1985) argue that farmers now plant at low densities and that plant population could be increased without a sacrifice in yield.

Excluded benefits and costs

The model does not account for some benefits to society. Consumers’ surplus, if there is any, is not measured and the estimate of change in producers’ surplus is likely to be too low because the risk-reducing effects of alley farming are not included.

A benefit to society from fertilizer savings is the decline in foreign currency expenditures for fertilizer imports, petrol, and vehicles. An estimate of these savings can be obtained by calculating how much fertilizer would be needed to produce the additional output. There will be savings in the costs of labour, but these will be in domestic currency. Other savings may include a reduced rate of off-site erosion (e.g., lower costs of maintaining irrigation canals). Deforestation is slowed; this, in turn, may slow desertification. The list of such benefits can be extended, but they will be difficult to quantify. Costs external to this model are those of technology development and extension.

In summary, this model accounts for a considerable portion of the benefits of the new technology. Some additional benefits can be estimated using the information generated by the model. The model overestimates producers’ surplus from risky crops and ignores the risk-reduction effects of alley farming on these crops. However, these effects are likely to be small compared with the benefits from
fertility gains. In total, it can be assumed that this model underestimates the benefits of alley farming.

**Basic model for the risk-averse farmer**

Small farmers, especially subsistence farmers, are usually averse to risk. It is typically assumed that risk can be measured by the variance of net returns.

When risk is included in the model, the objective function must be reinterpreted. The farmer is now assumed to maximize utility rather than profit. Aggregated utility can be considered a benefit to society. Prices and yields are assumed to be stochastic and distributed normally. The model for the individual farm becomes as follows:

\[
\text{Max } U = p'Mx - c'x - \varnothing (x'\Omega x)^{1/2} - F
\]

subject to \( Dx < b; x > 0 \)

The changes in rotation are as follows: \( U \) is utility, \( p \) is an \( n \times 1 \) vector of expected prices, \( M \) is an \( n \times n \) matrix of expected yields, \( \varnothing \) is the risk-aversion coefficient, often assumed to equal 1, and \( \Omega \) is an \( n \times n \) variance–covariance matrix of prices and yields.

The additional feature of this specification is the variance–covariance matrix of prices and yields. The matrix accounts for the effect of prices and the quantities of output, which may move together or in opposite directions. The farmer has some notion about the distribution of prices and yields; however, any particular outcome is a random event.

A farmer averse to risk would consider variance a cost and will attempt to minimize the variance of total net returns of the farm for any given expected net return. For example, if two activities are expected to have the same net returns, the farmer may choose the one with the lower variance. Also, if the farmer knows that the net return of one crop may increase when those of the other decrease, or vice versa, both crops may be planted to minimize risk. This is part of the rationale for intercropping. If alley farming reduces the risk of, say, maize yield, more maize may be grown but not necessarily at the expense of other crops.

The variance–covariance matrix can be obtained from detrended time-series data of enterprise net returns. The deviations from the mean serve as an approximation of the variance (Hazell 1971). The approximation procedure allows the use of inexpensive LP algorithms.

This model requires more information. Only private benefits for a year are measured. The results do, however, represent the behaviour of farmers more accurately. Changes in producers’ surplus as a result of changes in risk, which are external in the first model (Table 2), are fully accounted for in this model.

**Benefits of alley farming in a region**

Most of the benefits from the adoption of alley farming will be internal to the larger region. The specifications of the models can remain unchanged, but two problems must be given attention. The first is aggregation bias. The second arises
when the region is large or the number of adopters is great. In that case, information on demand has to be incorporated into the model. A regional model is described here.

When farmers are aggregated to groups or regions, constraints faced by individual farmers may not show up as constraints for the group or the region. For example, if farms with surplus land but a labour constraint and farms having surplus labour but a land constraint are aggregated, neither individual constraint may show up as an aggregate constraint. Therefore, the results of aggregate models tend to overstate the production of the most profitable and least risky crops. This can be avoided, to some extent, by aggregating farms facing the same constraints (Frick and Andrews 1965; Miller 1966).

When larger regions are considered, the assumption that changes in output have no influence on price becomes unrealistic. Information on demand should be incorporated. An estimate of elasticity would be sufficient. The output-price component of the second equation is then replaced by a linearized consumer-surplus function (Hazell and Scandizzo 1974).

This type of model has two advantages. First, they limit aggregation bias. Because output price is functionally related to quantity, an increased output of one crop leads to a decline in its price and makes the other crops more profitable. Resources are reallocated to the production of these other crops. Second, both producers' and consumers' surpluses can be calculated.

Which model specification should be used for a regional or national situation depends on the available information. From a theoretical standpoint, LP models that include risk are appropriate for regions or countries as long as changes in output have a negligible influence on price. If that is not the case, the demand functions should be incorporated.

Table 3. Benefits and costs measured by a regional or national programming model (internalized demand functions + risk).

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<tr>
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<tbody>
<tr>
<td>Benefits</td>
<td>Changes in producers' and consumers' surpluses because of the costs and benefits listed for the basic, individual-farmer model (see Table 2) and because of area expansion as a result of reduced risk</td>
<td>Foreign currency savings for fertilizer and its distribution Reduced rate of off-site erosion and land degradation Value of conserved land</td>
</tr>
<tr>
<td>Costs</td>
<td>Contribution of regionally or nationally financed institutions to technology development and extension</td>
<td>Costs paid by international centres and donors</td>
</tr>
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</table>

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Which of the benefits and costs from alley farming are internal to the region or country will depend to a great extent on regional size. Whether these costs and benefits can be accounted for in the model again depends on available information. Assuming that aggregation bias can be limited, it seems that even complex models underestimate the benefits of alley farming (Table 3).

**Rate of adoption**

The suggested models provide a rough estimate of producers’ and consumers’ surpluses for any given year. These benefits accrue over time, however, and investment or subsidy decisions should be made on the basis of net present value in relation to other investment opportunities. The net present value of alley farming depends largely on its rate of adoption. This, in turn, is influenced by the farmer’s assessment of alley farming. Investment in extension can play a critical role in whether alley farming is adopted. Demonstrating the many potential benefits of alley farming to policymakers may help to encourage such investment.

**Conclusions**

Considering the available information on alley farming, the estimate of its benefits is likely to be conservative. The discovery and assessment of more benefits, to both the farmer and society, will provide policymakers with the incentive to allocate more funds to research and extension. Subsidizing alley farming may be a worthwhile investment if the enterprise benefits society as a whole, even though it may be unprofitable for individual farmers.

When assessing the benefits, an interdisciplinary approach is necessary.

In the coming years, more information will be collected and the assessment of at least some benefits will begin. The results will have to be compared with other techniques capable of maintaining soil fertility in the long run.

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**References**


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