Can Agroforestry Make a Difference as an Exit Strategy for the Starter Pack Scheme in Malawi?

F. K. Akinnifesi, and F. R. Kwestiga¹
SADC/ICRAF Agroforestry Project, P. O. Box 134, Zomba, Malawi
SADC/ICRAF Agroforestry Regional Programme, Harare, Zimbabwe

(Received December 12, 2001; accepted January 30, 2002)

Abstract

The magnitude of soil nutrient depletion and food insecurity in Malawi is enormous. In a situation where the productive land is diminishing in size, fertilizers are becoming unaffordable, soil fertility is fast depleting and off-farm income opportunities are limited, farmers must be provided with viable soil fertility management options in order to feed their families and ensure a prosperous livelihood. A critical mass of innovation and mobilization of on-farm and dissemination of agroforestry work, in recent times, has started to pay substantial dividends in southern Malawi. The science and developmental aspects of ICRAF’s work in Malawi are beginning to align themselves to show direct benefits for a substantial number of farmers in the pilot project areas. Over 9,000 farmers in the project areas are experimenting with, adapting and adopting agroforestry innovations. These farmers are becoming more and more confident and enthusiastic in sharing experiences with fellow farmers in a spontaneous farmer-to-farmer extension fashion. There is clear evidence that on-farm agroforestry technologies compare favourably with fertilizer-based initiatives in terms of benefits. Mixed intercropping with Gliricidia sepium, relay cropping and improved fallows with Sesbania sesban or Tephrosia vogelii are capable of doubling or tripling maize yield without fertilizer applications. In addition, farmers combining agroforestry technologies with the ‘Starter Pack Scheme’ have confirmed positive synergies in maize yield. A wide variety of policies directly and indirectly influence the ability of agroforestry systems to deliver benefits to the farmers and the society at large. This paper proposes to recommend the use of proven agroforestry technologies as an exit strategy to the “Starter Pack Scheme or the Targeted Inputs Programme (TIP)” in Malawi, as a prelude to practical agrarian transformation that will help lift the smallholder farmers out of the vicious cycles of poverty.

Keyword: agroforestry, exit strategy, starter pack scheme, targeted input programme, Malawi

Background

Food security has long been a major development objective in Malawi, with a focus on hybrid maize and fertilizer technology. Food security implies access to foods for a productive and healthy life (Shah and Strong, 1999). That is the ability of households to produce, purchase, or acquire an adequate amount of food to meet their biological requirements (UNICEF, 1993). Most smallholder farmers are currently faced with the problem of how to maintain soil fertility under continuous maize cropping on the same piece of land. The situation is even exacerbated in southern Malawi where the average landholding size is less than 0.5 ha. As a result of the decline in soil fertility, smallholder maize yields have dropped from one ton in the 1980s to 750 kg ha⁻¹ in the 1990s (Starter Pack Logistic Unit, 1999).
Rural poverty is inextricably linked with small land holdings, poor soil fertility and limited off-farm revenues. About 70% of all rural households have less than one hectare available for minimum food security. Thus, the current per capita maize production falls short of the required amount. The causes of low food productivity in the country include: (i) soil and water erosion due to: (i) insufficient soil coverage, (ii) inadequate fertilizer use, (iii) shortening of fallow periods (in the northern and central regions), and low land holding size averaging 0.4 ha per household (in the southern region where population density is as high as 300-450 people km$^{-2}$), (iv) soil acidification, and (v) continuous cultivation of marginal and sloping lands without adequate soil conservation measures.

A recent report estimated that in Africa, about 660 kg N ha$^{-1}$, 75 kg P ha$^{-1}$ and 450 kg K ha$^{-1}$ have been lost during the last 30 years (Smaling et al., 1997). Annual soil depletion of N, P and K has been estimated at more than 60 kg ha$^{-1}$, while fertilizer use to replace lost nutrients and augment yields generally is low. With continuous cultivation, large amounts of nutrients are exported from the fields through crop harvest. These soils, therefore, require inputs of N, P and K. The losses translate into a marked decline in crop yields, thereby amplifying the food insecurity and poverty levels for increasing numbers of smallholder farmers and their children. The present socio-economic conditions do not allow peasant farmers to use costly external inputs. In Malawi, most soils are inherently low in fertility. These soils are characterized by low cation exchange capacity (CEC) and buffering capacity, low soil organic matter content, and low structural stability. Soil acidification increases with N application, and the extent of acidification varies with fertilizer and dosage applied. Addition of soil organic matter could play a major role in maintaining soil productivity, by providing plant nutrients, enhancing soil buffering capacity, increasing soil moisture retention and increasing soil microfaunal activities (Agboola and Akinnifesi, 1991).

Recognizing these problems in southern Africa, ICRAF has undertaken intensive research over the last 15 years, to search for alternative soil and nutrient management practices that maximize the use of local biological nutrient sources in order to reduce the need for costly fertilizer inputs, and minimize soil degradation and sustain crop production. This paper will discuss some achievements in agroforestry interventions over the years within the context of their suitability as an exit strategy for the “Starter Pack Scheme” initiative in Malawi.

The Starter Pack Scheme and the Targeted Inputs Programme

Major efforts to increase food production with the use of fertilizer inputs promoted by the Food and Agriculture of the United Nations (FAO) and the World Bank in the early 1980s and 1990s have not been successful in Africa (FAO, 1983). Since the mid-1980s, the Malawi agricultural sector has been characterized by a series of go-and-stop sequences, in terms of fertilizer and seed (Kherallah and Govindan, 1999). The fertilizer price subsidies were reduced in 1984-86, increased in 1987-93, reduced again in 1995/96 and increased since 1998-2000. This "go-and-stop" nature of the input-output market reforms have turned out to be the exact opposite of the optimal sequencing, which may precipitate into a muted response from the private sector (Kherallah and Govindan, 1999), and/or uncertainty to the rural farmers. An ex-post impact analysis of the structural adjustment programmes in Malawi showed that there was a conflict between the donors' emphasis on export diversification and commercialization, and government concern with food self-sufficiency, resulting in inadequately sequenced input and output price policies. Despite widespread use of hybrid maize and fertilizer, subsidies by the Zambian Government, such policies did not sustain
increases in food production in the peasant sector, and food production declined considerably as soon as subsidies were removed in the early 1990's during structural adjustment period (Kwesiga et al., 1999).

Recently, the Ministry of Agriculture and Irrigation (MoAI) in Malawi has implemented a programme of free fertilizer and seed inputs, called the “Starter Pack Scheme”, which benefited more than 2.86 million farm families per year in the last two seasons (1998-2000). This input comprised of 5 kg urea (23:21:0+4S), 2 kg of hybrid maize and 2 kg of a food legume (groundnut or pigeonpea) and limited distribution of other crops (Starter Pack Logistic Unit Report, 2000). The aim of the scheme was to provide 'every farm family' in the country with sufficient seed and fertilizer to plant 100 m² (i.e., 0.1 ha) of land, thereby serving as a short-term safety net measure to fill the food gap, promote crop diversification and improve soil fertility. Currently, the beneficiaries have been reduced considerably by targeting only 1.5 million farmers considered to be the poorest of the poor (the widowed, the aged, orphaned or disabled). At a potential yield of 3 t ha⁻¹, each farmer with a land holding of 0.1 ha will produce barely 300 kg of maize from each plot, whereas the per capita maize consumption in Malawi has been estimated at 232 kg maize per person per year (UNICEF, 1993), or a minimum requirement of 1,058 kg per household of five persons (Bunderson and Hayes, 1995). To ensure food security at both household and national levels, the current production must increase substantially. Since this scheme is donor driven, its sustainability depends on continued funding which may lead to farmers’ over dependence on external supports (Economist Intelligent Unit, 2000). It was envisaged that the scheme would create an opportunity to test “best-bet” and more sustainable technologies that can lead to greater productivity for these resource-poor farmers in the long run. Agroforestry is a candidate technology that can play this role without compromising the farmers’ livelihood systems.

**Alternative Nutrient Sources to Inorganic Fertilizers**

The use of inorganic fertilizers is obviously the easiest way of overcoming soil fertility depletion, and indeed to a large extent has been responsible for sustained increases in per capita food production, especially during the ‘green revolution’ era of the 1960s. FAO (1993) has estimated that 50% of future gains in food crop yields in Africa will come from fertilizers. Biophysically or environmentally, nothing is wrong with the use of fertilizers when properly used, as mineral fertilizers provide the same nutrients as organic sources; and plants cannot distinguish fertilizer sources (Sanchez et al., 1997). Despite a decrease in international fertilizer prices during the last 25 years, costs are still up to seven times higher in most African countries leading to sub-optimal fertilizer consumption. According to Donovan (1996), the cost of fertilizer is more than double the international price by the time it gets to rural farmers in Malawi, and this has been attributed to high transport, import-related and other costs.

There is a general trend in African countries of instituting fertilizer subsidies by government. However, fertilizer prices have often tripled or quadrupled following the removal of subsidies when implementing structural adjustment programmes (Bumb and Baanate, 1996), as observed in Zambia (Kwesiga et al., 1999). Farmers are seldom able to apply them at recommended rates and at appropriate times because of high costs, lack of credit, delivery delays, and low and variable returns (Sanchez et al., 1997). Therefore, the problem with inorganic fertilizer is not only associated with its use but its sustenance also. The starter pack for instance provided farmers with about 5 kg urea fertilizer, just enough to fertilize 100 m² of land. Field observations have shown that 73% of all farmers in southern Malawi (with the
smallest landholding sizes) have larger than 100 m². The implication is that farmers will spread the fertilizer too thinly, at less than four times the recommended rates, thus making crop response more erratic and less profitable. Agroforestry aims at empowering resource-poor farmers on how to fertilize their crops with little or no inorganic fertilizer.

The exclusive use of organic nutrient sources, such as returning of crop residues (maize stover) back to soil, animal manure, and use of nutrients from tree prunings has been advocated as alternatives to the expensive fertilizers in Africa. However, there are problems associated with the large amounts of biomass required (Sanchez et al., 1997), and low rate of P release from organic sources. Nitrogen is the most limiting nutrient for grain production. Long-term experiments have shown that crops do not respond markedly to P fertilization in some Malawi soils, suggesting that P may be non-limiting in these soils (Ikera et al., 1999). It is reasonable to hypothesize that any soil fertility replenishment technologies that increases and/or maintains N capital in the soil over the long-term, and at an affordable cost, will improve the well being of rural farmers in Malawi.

The Contribution of Agroforestry Trees to Soil Fertility

Even with fertilizer application, the productivity of low-activity clay soils, which dominate Africa, declines with continuous and intensive crop production if no organic matter is also applied. In Malawi, less soil nourishment is put into the soil than is removed through cultivation, resulting into ‘soil mining’. Young (1997), suggested that at all levels of fertilizer, or farming inputs, there may still be need for a fallow phase or organic material additions. In recent times, there has been a growing interest in the use of alternative nitrogen sources to enhance N and C inputs through biological nitrogen fixation and recycling of tree biomass. Inclusion of N-fixing legumes can supply the much-needed N and organic matter for sustaining soil productivity in these soils. Kumwenda et al. (1995), cited by Bunderson and Hayes (1995), have suggested rotating cereal crops with grain legumes, agroforestry species in intercropped or rotational systems. Trees and shrubs have been identified as major soil resuscitants in mixed intercropping with *Gliricidia sepium* (Maghembe and Prins, 1994), improved fallows (Kwesiga et al., 1999) and relay cropping with *Sesbania sesban* (Kwesiga and Coe, 1994).

Several studies have shown that soil fertility and maize yields can be maintained at high levels when intercropped with *Gliricidia sepium* (Ikera et al., 1999) or relay cropped with or grown in rotation after *Sesbania sesban* (Jereje) (Kwesiga et al., 1999; Kwesiga and Coe, 1994). Optimal maize yield response requires an application of 100 kg N ha⁻¹ in Malawi (Kwapata et al., 1995). When farmers apply inorganic fertilizer in Malawi, they often apply 20-30% of the recommended rate (Kwesiga et al., 1999) due to the escalating cost of fertilizers.

The Msangu-Based Agroforestry System

The *Faidherbia albida* (Msangu)-based system is a notable traditional agroforestry system revered by farmers in southern Malawi (Saka et al., 1994; Weil and Mugogho, 1993; Chirwa, 2000) and elsewhere (Felker, 1978; Vanderbeldt, 1991). *Msango* can be intercropped with maize during the season with little or no tree-crop competition. Substantial benefits are expected from this traditional agroforestry system in which periods of peak resource use by trees and crop rarely overlap. In fields where millet yields of about 500 kg ha⁻¹ were obtained, the yield under *Msangau* trees were doubled or tripled (Bonkoungou, 1992). However, the major setback from *Msangau* is that it takes at least 10-15 years for the tree to be large enough.
to exert any positive effect on the fertility of the soil under it (Kang and Akinnifesi, 2000; Chirwa, 2000). Farmers tend to always prefer short-term impact species than long term. In addition, attempts to plant *Faidherbia* in farmers’ fields to increase total system productivity and crop yields have given mixed results (Vanderbelt, 1991; Bonkoungou, 1992; Weil and Mughogho, 1993), and there is concern that the ‘albida effect’ is not always positive and often influenced by environmental factors (Geiger et al., 1992; Kang and Akinnifesi, 2000). It has also been recently hypothesized that the ‘albida effect’, i.e., higher soil fertility under mature *Faidherbia* trees is caused not by the presence of the tree per se, but rather by the pre-existence of microsites favoring the establishment of the tree (Vanderbelt, 1992; Geiger et al., 1992). The hypothesis, once verified, will have a considerable impact on future actions. Further, studies are needed to better understand the factors affecting sustainability and productivity of natural and artificial stands of *Msangau*, especially in originally nutrient poor soils. A valid approach would be to set up *albida* trials along with other proven agroforestry species/technologies and monitor the biophysical as well as the economics of production for these systems over time, as well as to better understand the short-, medium- and long-term objectives of the farmers.

**Mixed Cropping with *Gliricidia* and Relay Cropping with *Sesbania***

With the advent of scientific and practical agroforestry, one decade of soil fertility replenishment research by International Centre for Research in Agroforestry (ICRAF) has proved that the additions of N-rich organic materials is essential in managing soil fertility (Maghembe et al., 1997; K웨siga et al., 1999; Ikerra et al., 1999; 2000), and these are best when generated *in-situ* (Sanchez et al., 1997). In southern Malawi, promising soil fertility replenishment technologies are the mixed intercropping with *Gliricidia sepium* and relay cropping with *Sesbania sesban* or *Tephrosia vogelii*. Ikerra et al. (1999) have shown that intercropping maize with *Gliricidia sepium* and the addition of prunings to maize significantly increased topsoil pre-season organic and inorganic N. In addition, they concluded that the combination of pre-season inorganic N and potential N liberalization provides a good estimate of N supply to maize in systems receiving both organic and inorganic N sources.

*Sesbania* is established at the same time with the maize crop and allowed to continue growing after maize harvest; and at the end of dry season, the leafy biomass is incorporated into the soil. Maghembe et al. (1997) showed that this system raised maize yields to 2,600 kg ha⁻¹ compared with 700 kg ha⁻¹ in the control plots. At a site in Kutambala area near Makoka, *Gliricidia sepium* and *Sesbania sesban* results showed that total nitrate-N in the topsoil under the *Gliricidia* plot was four times as much as the same maize plot without these (Table 1). Lower available P was found in the control plots, other than plots with *Gliricidia* and *Sesbania*, after crop harvest.

**Table 1:** Soil chemical properties before planting and after harvesting the maize experiment, 1998/99 crop season

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Pre-harvest</th>
<th>Post harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Sesbania</td>
</tr>
<tr>
<td>P (mg kg⁻¹)</td>
<td>10.6</td>
<td>11.3</td>
</tr>
<tr>
<td>K (coml. kg⁻¹)</td>
<td>0.29</td>
<td>0.28</td>
</tr>
<tr>
<td>Mg (emol kg⁻¹)</td>
<td>0.64</td>
<td>3.29</td>
</tr>
<tr>
<td>Ca (emol kg⁻¹)</td>
<td>10.09</td>
<td>9.98</td>
</tr>
<tr>
<td>N (mg kg⁻¹)</td>
<td>5.68</td>
<td>22.9</td>
</tr>
</tbody>
</table>

Key: Dash=Data not available.
Source: Ikerra et al. (1999).
Figure 1 shows the long-term synergetic effect of combined inorganic N and *Gliricidia* on maize yield in mixed intercropping at Makoka in Malawi. Maize yield declined steadily over 8 seasons under continuous sole maize cropping without fertilizer, and was generally less than 1000 kg ha\(^{-1}\), whereas yield was maintained at higher levels (2000 to 4000 kg ha\(^{-1}\)) with *Gliricidia*/maize intercropping without fertilizer input. Higher maize yields were maintained under *Gliricidia* mixed cropping amended with 50% fertilizer dosages than the control plot with the same levels of inorganic fertilizer amendment. The unfertilized *Gliricidia* plots were superior compared with the control with 25% dosage, except for the tree establishment year. In agroforestry plots, *Gliricidia* and *Sesbania* plots, the differences between 50% and 25% fertilizer dosages were not significant after the initial two-year study period. *Gliricidia* plots were not different with 50% fertilizer dosage during years of drought, and the agroforestry plot experienced greater drought resilience than the farmers' practice (control). This result suggests that short-term light irrigation may raise maize productivity during seasons with prolonged drought periods. *Gliricidia* foliage biomass was maintained at 2000-5000 kg ha\(^{-1}\) during the eight-year study period, without replanting. Makumba et al. (this volume) has also shown that the inclusion of pigeonpea (*Cajanus cajan*) into agroforestry systems with *Gliricidia* and *Sesbania* can increase farmer's income without negatively affecting the functioning of the technologies. Substantial amounts of N-rich organic materials are needed to make a significant impact on crop yields (Giller et al., 1997). Since crop yields may be lower than the potential yield under extremely impoverished soil conditions, strategic fertilizer application at low rates (e.g., 25 or 50% the recommended rate), have been found to be beneficial, and some farmers are already doing this with the starter pack inputs. This is an excellent innovation by farmers themselves aiming at optimizing the synergy between agroforestry and starter pack inputs. Used alone, chemical fertilizers can lead to, or exacerbate, problems of soil acidification unless corrective measures are taken (Saka et al., 1994). Organic inputs from trees provide soluble C that is necessary to reduce N depletion.

![Graph showing maize yield over seasons](image)

Figure 1. Long-term synergetic effect of combined inorganic N and *Gliricidia* on maize yield in mixed intercropping at Makoka in Malawi.
Improved Fallow Systems

Improved woody leguminous fallows have been shown to provide excellent options of managing soil fertility and meeting the demands for N in southern Africa (Kwesiga et al., 1998; Kwesiga). *Sesbania sesban*, an indigenous N-fixing tree is widely distributed in the region (Kwesiga et al., 1999). In Zambia, woody biomass of 15-32 t ha\(^{-1}\) have been obtained from *Sesbania sesban* after 3 years (Kwesiga and Coe, 1994), while 2-year fallow seems to be capable of increasing maize yield dramatically under *Sesbania* and *Gliricidia*. Hybrid maize yield under *Sesbania* fallow was 5,400 kg ha\(^{-1}\) as compared with 4,000 kg ha\(^{-1}\) in fertilized maize (at 112 kg N ha\(^{-1}\)), and 900 kg ha\(^{-1}\) in control with neither fertilizer nor trees. The high maize yields following fallows are due to the improvement in N input by the fallows (Table 2). In the trials, one– and two– year fallows generated 78 and 92 % more revenues, respectively, than the control with continuous unfertilized maize (Kwesiga et al., 1999). The high yield and economic potentials of improved fallows of *Sesbania sesban* have excited thousands of farmers in Zambia. In Malawi, the improved fallow technology with *Sesbania* and *Tephrosia* has spread to Kasungu, where 600 farmers are testing the technology and another 100 farmers have raised their nurseries for the 2000/01 season. The farmers in Kasungu confirmed that improved fallows with *Sesbania* doubled their maize yield last season (Chirwa, 2000).

Uptake of Agroforestry Technologies by Farmers

On-farm research is the crucial link between on-station research and dissemination arms of agroforestry development. Two distinct types of on-farm research, experimental (Types I & II) and developmental (Type III and dissemination), are being applied in the project. According to Atta-Krah (1995), farmer’s input is structured in order to obtain comparable data from a number of trials.

Table 2: Maize grain yield for the first (1993/94) and second (1994/95) season after one and two year fallows, and other cropping systems, Chipata, Eastern Province, Zambia

<table>
<thead>
<tr>
<th>Land use before maize</th>
<th>Maize grain yield (kg ha(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1993/94</td>
</tr>
<tr>
<td>1 year pigeonpea</td>
<td>2400</td>
</tr>
<tr>
<td>2 years pigeonpea</td>
<td>2800</td>
</tr>
<tr>
<td>1 year Sesbania sesban</td>
<td>3400</td>
</tr>
<tr>
<td>2 years Sesbania sesban</td>
<td>5400</td>
</tr>
<tr>
<td>1 year Tephrosia vogelii</td>
<td>2800</td>
</tr>
<tr>
<td>2 years Tephrosia vogelii</td>
<td>3200</td>
</tr>
<tr>
<td>Groundnut-maize rotation</td>
<td>1900</td>
</tr>
<tr>
<td>Continuous unfertilized maize</td>
<td>1100</td>
</tr>
<tr>
<td>Continuous fertilized maize</td>
<td>4000</td>
</tr>
<tr>
<td>SE (+)</td>
<td>1100</td>
</tr>
</tbody>
</table>

Key: SE (+) = Standard Error of the difference in means
Adapted from Kwesiga et al. (1999).
On the other hand, the on-farm type III is development-oriented and much less tightly controlled and/or structured, building on the long years of on-station and on-farm type I trials, as prelude to full-scale dissemination and accelerated impacts. ICRAF has been testing several agroforestry technologies with farmers in Malawi, and these include: mixed intercropping with *Glicidica sepium*, relay cropping with *Sesbania sesban*, undersowing with *Tephrosia vogelii*, improved fallows with *Sesbania* and *Tephrosia*, fodder banks with diverse species, and fruit tree domestication. Farmers are allowed to design, experiment and manipulate the technologies. This helps to understand the relevance, workability and acceptability of the technologies with a framework of research development interactions (Atta-Krah, 1995), and to gauge farmer's reactions and dissemination pathways.

The number of farmers testing and/or adopting agroforestry in the project sites is 9,782 (where 835 are women). Agroforestry was diffused to 3863 of these farmers through some partners. The number of actual adopters is based on those farmers who have expanded their original plots for more than one season. Because of the importance of agroforestry to farmers in on-farm research areas, about 40% of all farmers have expanded their original plots at least once at an average of 271 m² per plot (Makumba et al., this volume). Of the 188 farmers assessed (70% women), 64% of all women had expanded their plots up to four times during the last four years, i.e., expanding annually. None of the men have expanded more than thrice. About 78% of on-farm farmers have experienced benefits from soil improvement using agroforestry technologies. Others who did not benefit were the new adopters who were testing the technologies for the first time. The number of farmers adopting agroforestry in the project areas has increased by 327% this year, but new users will need one more season to experience and confirm the benefits. Mixed intercropping with *Gliricidia* normally does not exert much impact on the soil during the initial two years of the tree establishment phase.

In terms of species preference, farmers who cultivate well-drained soils prefer *Gliricidia*, whereas farmers cultivating wetter and clay soils prefer *Sesbania sesban*. It has been established that *Sesbania* performs best when the clay content is equal to or greater than 20% (Kwesiga, personal communication). Although the adoption of agroforestry is still low, the take-off point is not far away, especially if agroforestry can be linked with the Starter Pack Scheme or the TIP initiative. The dissemination approach of the project is at providing farmers with guidance about the payoffs they are likely to obtain from using agroforestry technologies alone or in combination with other soil fertility management practices.

**Farmer Innovation of Agroforestry Technologies**

Farmer innovation of agroforestry technologies has improved, as farmers have taken their own initiative to decide on several management practices, e.g., tree pruning frequencies have often been based on labour availability and shading of crops by trees. Some farmers in southern Malawi have used stakes from existing stands to establish *Gliricidia sepium* as seeds become scarce to procure. Unlike in Zambia where rhizobia inoculation renders the use of staking ineffective, farmers noticed no problem in establishing *Gliricidia* because maize is traditionally inter-cropped with pigeonpea (*Cajanus cajan*). In general, the care that a farmer commits to any activity depends largely on perceived benefits he/she expects. Crop diversity has also increased to include pigeonpea, cassava, groundnut and pumpkin. Farmers who received the a starter pack package have used their own initiative to apply the inorganic fertilizer to the most infertile portions of the plot, determined by poor maize growth over the years (i.e. continuously cropped, degraded, no-tree plots). Some farmers even experiment by
supplementing agroforestry with half or quarter dosage of inorganic fertilizer and have confirmed positive synergies.

**Benefits and Impact of Agroforestry Technologies**

Agroforestry has increased maize yield by two- to three-folds in various trials, likewise farmers’ income from maize production alone has increased two- to three fold in agroforestry targeted areas. These results compare well with maize yield increases obtained under the well-managed Sasakawa Global 2000 fertilizer-based demonstration plots in five African countries during eleven years (Quinones et al., 1997), where maize yields have been 2-3 times higher than those obtained in the control plots or farmers’ traditional practice (Table 3). To avoid dependence on external aid, farmers often pay 50-100% of input costs. The improved technological packages in the Sasakawa G 2000 initiative include (i) the use of the best available commercial cultivars or hybrids, (ii) improved agronomic practices that assure proper rates, dates and methods of planting, timely weed control, efficient use of available soil-water, and when needed, crop protection chemicals, (iii) proper application at moderate levels of appropriate fertilizers to restore plant nutrients in the soil, and (iv) improvement in on-farm post-harvest handling.

In an extremely dramatic situation, one Type III farmer, Mr. Majoni, in the Makoka area harvested 3500 kg ha\(^{-1}\) in his *Gliciridia*/maize continued cropped plot compared with sub-optimal yield (8 times lower) in the unfertilized no-tree control (Maghembe et al., 1997). Before Mr. Majoni started to experiment with trees four years ago, the soil was unable to yield half a ton of maize (500 kg ha\(^{-1}\)). This dramatic yield increase was a result of his four years of using the agroforestry technology. He has since trained a good number of other farmers. This is an example of restorative efficiency of agroforestry on degraded soils. Similarly, about 78% of all agroforestry farmers observed yield increases ranging from 100 to 300% (Makumba et al., this volume).

**Table 3:** Average yield increases over farmers’ practice under selected soil fertility improvement interventions in Africa

<table>
<thead>
<tr>
<th>Technology</th>
<th>Country</th>
<th>No. of cropping seasons</th>
<th>Mean yield (kg ha(^{-1}))</th>
<th>Farmers practice (t ha(^{-1}))</th>
<th>% Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sasakawa (F1 hybrid)(^1)</td>
<td>Ghana</td>
<td>8</td>
<td>3300</td>
<td>1300</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>Tanzania</td>
<td>6</td>
<td>4400</td>
<td>1400</td>
<td>208</td>
</tr>
<tr>
<td></td>
<td>Ethiopia</td>
<td>3</td>
<td>6500</td>
<td>1700</td>
<td>220</td>
</tr>
<tr>
<td>Improved fallow (F0)(^2)</td>
<td>Zambia</td>
<td>2</td>
<td>5500</td>
<td>1600</td>
<td>244</td>
</tr>
<tr>
<td>Improved fallow (F1)</td>
<td>Zambia</td>
<td>2</td>
<td>7600</td>
<td>1600</td>
<td>375</td>
</tr>
<tr>
<td>Mixed intercropping (F0)(^3)</td>
<td>Malawi</td>
<td>8</td>
<td>2700</td>
<td>1200</td>
<td>125</td>
</tr>
<tr>
<td>Mixed intercropping (F1)</td>
<td>Malawi</td>
<td>8</td>
<td>3800</td>
<td>1200</td>
<td>217</td>
</tr>
<tr>
<td>Starter pack+Gliciridia (mixed intercropping on farm)</td>
<td>Malawi</td>
<td>4</td>
<td>3500</td>
<td>400</td>
<td>775</td>
</tr>
<tr>
<td>Faidherbia (Hybrid+F1)(^4)</td>
<td>Malawi</td>
<td>NA</td>
<td>2900</td>
<td>1200</td>
<td>142</td>
</tr>
<tr>
<td>Faidherbia (Local F0)</td>
<td>Malawi</td>
<td>NA</td>
<td>2100</td>
<td>1200</td>
<td>75</td>
</tr>
</tbody>
</table>

Key: \(F_0\) = No. inorganic fertilizer application; \(F_1\) = Fertilized plots;

1. Sasakawa Global 2000 Initiative (inputs of fertilizer+improved seed and good management; farmer repays 50 to 100% of input costs),
2. Improved fallow using *Sesbania sesban*,
3. Mixed intercropping with *Gliciridia sepium*,
4. Improved seed, fertilizer and improved management practice plus the use of *Gliciridia sepium*,
5. Use of hybrid seed, fertilizer on maize grown under *Faidherbia albida*.

The 1999/00 crop season results show that farm level incomes from maize production due to agroforestry increased by 208%, thus fetching on average an additional $47.00 USD in income over the farmers’ practice. Analysis of 18 on-farm farmer-designed and farmer
executed trials during 1998 showed that gross income and gross margin under *Glicidia* mixed intercropping was 24% higher than *Sesbania* relay cropping and 203% greater than control without trees (Table 2).

*Glicidia*-maize mixed intercropping seems to require more labour for tree pruning. However, the gross margin in *Glicidia* was the highest. About USD 100.00 was accrued from woods in 1999 and more undetermined income probably accrued from the sale of seed. Although, maize yields in the 1999/00 crop season were low due to prolonged drought (maize received about 150 mm less than the 40-year rainfall average), it has been demonstrated that agroforestry has a strong buffering capacity against shortfalls in yield and price, poor rainfall, market glut from the Starter Pack Scheme, and high fluctuation in exchange rates and other economic crises. It needs to be realized that agroforestry, like all other sustainable systems, are designed to address constraints of soil fertility, deforestation and carbon sequestration, among others, whose benefits extend beyond the boundaries of an individual farm, and may not be easily appreciated as such.

**Proposed ‘Win-win’ Strategies and Conclusions**

The goal of increasing household food security through maize production is vital, but becomes elusive as farms shrink in size, soils become exhausted, and the ability of farmers to purchase inputs decreases. Based on comparative impacts, strategies can be prioritized to help smallholder farmers escape poverty and hunger that visit them too often and stay for too long. The food security scenario is rather complex and threatens a dependency on foreign aid. There is urgent need to take stock of the retrogressive trends in *ad-hoc* agricultural subsidies, in terms of re-orienting policy reforms more closely, with a long-term strategic vision, towards rapidly changing needs and priorities of farmers.

<table>
<thead>
<tr>
<th>Cropping systems</th>
<th><em>Glicidia</em></th>
<th><em>Sesbania</em></th>
<th>No tree (control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize seed</td>
<td>1950</td>
<td>1950</td>
<td>1950</td>
</tr>
<tr>
<td>Seedlings</td>
<td>1850</td>
<td>1850</td>
<td>-</td>
</tr>
<tr>
<td>Labour for pruning</td>
<td>98</td>
<td>98</td>
<td>-</td>
</tr>
<tr>
<td>Labour for planting</td>
<td>1436</td>
<td>492</td>
<td>-</td>
</tr>
<tr>
<td>Total variable costs</td>
<td>5335</td>
<td>4391</td>
<td>1950</td>
</tr>
<tr>
<td>Yield (kg ha⁻¹)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td>3270</td>
<td>2930</td>
<td>1240</td>
</tr>
<tr>
<td>Wood</td>
<td>1000</td>
<td>1130</td>
<td>-</td>
</tr>
<tr>
<td>Gross income</td>
<td>33030</td>
<td>26570</td>
<td>16200</td>
</tr>
<tr>
<td>Gross margin</td>
<td>28875</td>
<td>23313</td>
<td>14250</td>
</tr>
</tbody>
</table>

Key: Dash=Data not available or applicable.  

According to Bunderson & Hayes (1995), factors limiting agricultural diversification in Malawi include: inappropriate policies, including agricultural pricing, marketing, credit and trade policies; limited or expensive transport within and outside the country; weak institutional support (including slow adaptation and dissemination of new technologies); shortages of skilled entrepreneurs and managerial capacity; and inexperience in meeting standards of quality, and timeliness required by external markets. Although maize is the dominant staple crop, and occupies 75% of total land cultivated area (UNICEF, 1993), it is imperative that crops need to be diversified for home consumption and for the markets. A strategy that combines fertilized hybrid maize with agroforestry is ideal. However, the
solution lies not only in improved soil fertility and hybrid maize, but a diversification of species, agroforestry technologies and a wider menu of options for farmers to choose from (e.g. dairy livestock, improved cultivars, fruit trees, diverse crop species and irrigation).

Recommendations

The following specific recommendations for a development-led strategy to improve rural livelihoods can be made:

1. The ‘Starter Pack Scheme’ or “TIP” should be properly tied to proven agroforestry technologies as an appropriate exit strategy, in a way that farmers can be gradually weaned-off from their dependency on external aid,

2. The challenges in terms of the enormity of the task involved and quantities of seed required should not be underestimated. Large-scale adoption of these technologies by farmers is often hampered by limited seed supply. The supply of quality planting material falls short of projected demands, and often fails to consider farmer priorities. This ‘win-win’ fertilizer-agroforestry combination strategy will require not only a multidisciplinary and pluralistic approach, but also a thoughtful conceptualization and implementation of activities. The proposed strategy should carefully plan for seed requirement for the different agroforestry species. The National Seed Center and the Forestry Research Institute of Malawi (FRIM) should take the lead in this, in order to overcome the seed problem. Seed of promising soil fertility improving species, such as Gliricidia sepium, Sesbania sesban, Tephrosia vogelii, Faidherbia albida, should be provided to farmers on a large-scale,

3. To be attractive, the exit strategy must ensure that farmers and development agents get the right information about the technologies and adequate germplasm they need to implement these flagship technologies, and

4. Short-term horizons often characterize decision making at both farmer and policy levels. A wide variety of policies directly and indirectly influence the ability of agroforestry systems to deliver benefits to the farmers and the larger society. Understanding how these interacting policies influence the agroforestry decisions of small, semi-subsistence farmers in rural agricultural communities with different social and cultural environments, remains a daunting challenge to agroforestry developers. Policy priority for agroforestry should include strategies that: raise the household income and food security; reduce migration to fragile lands without compromising the quality of life of the rural farmers; encourage institutional reforms; and introduce pricing policies and incentives that encourage the adoption of sustainable land-use practices, that also provide infrastructural and institutional support for marketing agroforestry tree products.

References


