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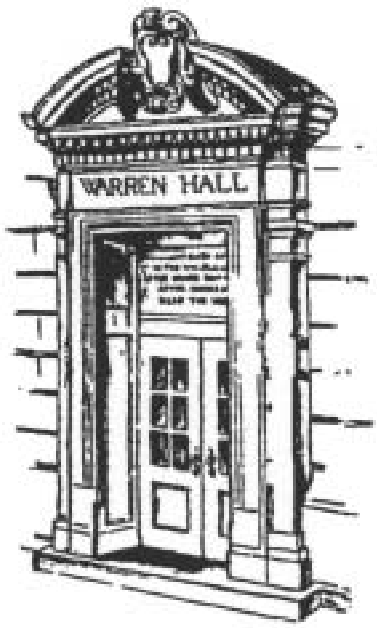

Working Paper

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Food-for-work for Poverty Reduction and the Promotion of Sustainable Land Use: Can It Work?

Stein Holden, Christopher B. Barrett, and Fitsum Hagos

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April 2003 First Draft

I. Introduction

Food-for-work (FFW) programs are commonly used both for short-term relief and long-term development purposes. In the latter capacity, they are increasingly used for natural resources management projects. Barrett, Holden and Clay (forthcoming) assess the suitability of FFW programs as insurance to cushion the poor against short-term, adverse shocks that could, in the absence of a safety net, have permanent repercussions. In this paper we explore the complementary question of FFW programs' potential to reduce poverty and promote sustainable land use in the longer run through induced changes in investment patterns.

FFW programs commonly aim to produce or maintain potentially valuable public goods necessary to stimulate productivity and thus income growth. Among the most common projects are road building, reforestation, and the installation of terracing or irrigation. In the abstract, public goods such as these are unambiguously good. There is a danger, however, that such programs could discourage private soil and water conservation and crowd out private investment. How important are such effects and when are these effects small or large and when and how can they be reduced? How do

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market characteristics, timing and design of FFW programs affect this? When, where and how can FFW programs more efficiently reduce poverty and promote more sustainable land management? The paper aims to answer these questions.

Much recent empirical research has focused on the shorter-term targeting issue of whether FFW and related workfare programs efficiently target the poor (Dev 1995, Von Braun 1995, Webb 1995, Subbarao 1997, Clay et al. 1998, Devereux 1999, Jayne et al. 1999, Ravallion 1999, Teklu and Asefa 1999, Atwood et al. 2000, Gebremedhin and Swinton 2000, Haddad and Adato 2001, Jalan and Ravallion 2001). Much less research has been focused on the longer-term effects of FFW. Yet the large share of hunger worldwide arises due to chronic deprivation and vulnerability, not short-term shocks (Speth 1993, Barrett 2002). Also most of the FFW programs in Ethiopia have long-term development goals and are formally distinguished from the disaster relief FFW programs (Aas and Mellemstrand 2002). It is therefore appropriate to evaluate these programs based on their long-term goals and not only on the basis of short-term targeting. In a case study in Tigray Aas and Mellemstrand (2002) found that the FFW recipients considered the long-term benefits of FFW as more important than the short-term benefits of food provision.

FFW programs may produce valuable public goods. For example, Von Braun et al. (1999) report multiplier effects of a FFW-built road in the Ethiopian lowlands. Public provision of public goods may be socially desirable because private investment in soil and water conservation and tree planting may be well below socially optimal levels due to poverty and market imperfections (Holden, Shiferaw and Wik 1998, Holden and Shiferaw 2002, Holden and Yohannes 2002, Pender and Kerr 1998), tenure insecurity (Gebremedhin and Swinton 2000, Holden, Benin, Shiferaw and Pender 2003), lack of technical knowledge and coordination problems across farms (Hagos and Holden 2002). There is, however, also a danger that FFW programs crowd out private investments (Gebremedhin and Swinton 2000).

We analyze these issues using multiple methods. First, section II introduces a simple theoretical framework for understanding the analytically ambiguous effects of FFW programs on sustainable land use patterns. We first present the basic intuition in a static framework to illustrate the selection, crowding out and targeting issues, before generalizing it to a dynamic model to illustrate the possible insurance and crowding in effects of FFW. Section III then uses an applied, dynamic bio-economic farm household model applied to a less-favoured area in Ethiopia to investigate via numerical simulation how household welfare and land use patterns vary with changes in environmental and FFW program design parameters. Section IV presents econometric evidence based on survey panel data from northern Ethiopia to assess the relationship between FFW and private investment in conservation. Section V discusses our findings and fleshes them out a bit with further empirical evidence. Section VI concludes.

II. Theoretical Framework

We begin by developing a simple, static model of household labor allocation. This lets us focus tightly on households' choice of whether or not to participate in a FFW program and on the effects of FFW participation on labor allocation to farming activities. In the second subsection, we then generalize the framework to explore the dynamics of household welfare, land use patterns and investment in soil conservation.

a. A simple, static model

We begin with a simple, static model of household choice in an environment of missing markets for labor and land. While we are ultimately concerned with the long-term effects of FFW on land use patterns, this parsimonious introduction underscores the importance of initial resource endowments when factor markets work imperfectly or not at all. Assume that the household maximizes utility, where utility is a function of consumption (c) and leisure (Le).

$$U = U(c, Le) = U(p_q q(L_a, \overline{A}) + w_{FFW} L_{FFW}, T - L_a - L_{FFW}) \qquad (1)$$

where p_q is the price of output produced (the consumption good is taken as the numéraire), $q(\bullet)$ is a production function that is concave in each argument, with the marginal returns to each input increasing in the other inputs, L_a is labor input in farm production, $\overline{A}$ is the land endowment,[2] w_{FFW} is the FFW wage rate, L_{FFW} is the amount of FFW labor, and T is the total time endowment. Because the model is static and the utility function satisfies the usual local nonsatiation assumption, the household consumes all its cash income (y). This model has no factor markets for land and oxen, only a market for FFW labor and a market for farm output. The two decision variables in the model are labor in agricultural production and labor in FFW. The first order conditions imply

$$w_{FFW} \leq w^* = \frac{\partial U / \partial Le}{\partial U / \partial c} = p_q \frac{\partial q}{\partial L_a} \qquad (2)$$

where w* is the household's shadow wage rate, the marginal revenue product of labor in agriculture on the household's farm. The first order condition provides the selection mechanism that underpins household choice over whether or not it

[2] One can equally think of $\overline{A}$ as the stock of quasi-fixed inputs, including not only land but also livestock and other productive farm assets.

participates in the FFW program. It participates only if the returns to farm work are as low as the FFW wage, in which case it will allocate labor so as to equalize the marginal returns to labor in agriculture and FFW. This is illustrated graphically in Figure 1.

As depicted in Figure 1, the marginal returns to agricultural labor are higher for the relatively land-rich household than for the land-poor household, holding all other endowments constant. The household with more land will allocate D amount of its labor to agriculture and not participate in the FFW program. Its shadow wage is $w^* > w_{FFW}$. The land-poor household, by contrast, faces a more rapid reduction in the marginal returns to its agricultural labor. Without access to FFW it would have a shadow wage of $\underline{w^*} < w_{FFW}$. It will therefore choose to participate in FFW up to the point where the marginal returns to agricultural labor just equal w_{FFW}. This illustrates the idea of self-selection into FFW by land-poor households.

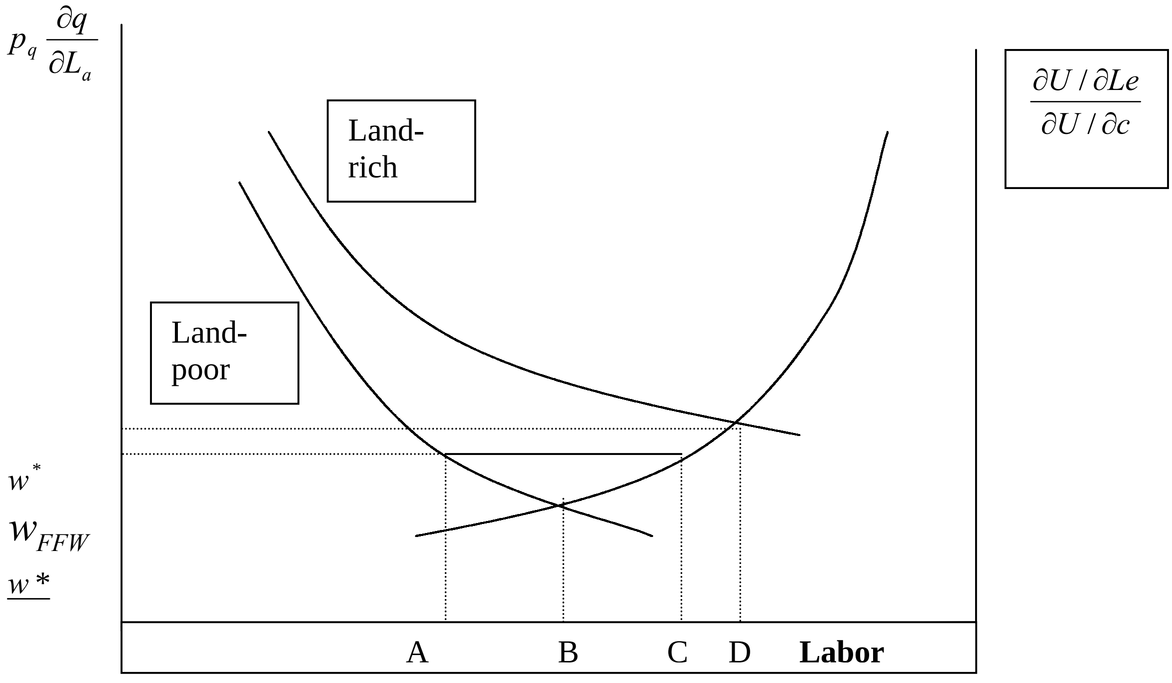

Figure 1. Time allocation of land-poor vs. land-rich households

The land-poor household will allocate C-A amount of labor to FFW. Without access to FFW it would allocate B amount of labor to agriculture. The availability of FFW employment crowds out B-A amount of labor from agriculture and C-B amount of labor from leisure. This illustrates the first potential complication of FFW – and the key one for the purposes of this paper – it may crowd out other productive activities that require household labor. Similarly, households with relatively greater endowments of other productive resources that increase the marginal productivity of agricultural labor, such as livestock and education, also achieve higher marginal returns to their labour and therefore are less likely to choose to participate in FFW programs if the w_{FFW} is sufficiently low.

The household's labor endowment figures prominently in the calculus of FFW participation and in the consequences of FFW participation for private labor allocation patterns. We illustrate this in Figure 2. T1 is the time endowment of a relatively labor-poor household (holding all other endowments constant) and T2 is the labor endowment for a labor-rich household. Since, by assumption, the two households have the same amount of land and the same preferences, they face the same marginal return to agricultural labor and marginal rate of substitution schedules. The difference in labor endowments thus induces the labor-rich household to allocate more labor to both farming and leisure because the marginal return to its agricultural labor is lower than that of the labor-poor household. If FFW employment is offered at w_{FFW}, only the labor-rich household will self-select into FFW. This illustrates a second prospective shortcoming of FFW: it is not a good policy instrument for assisting labor-poor households, such as those affected by disease or injury.

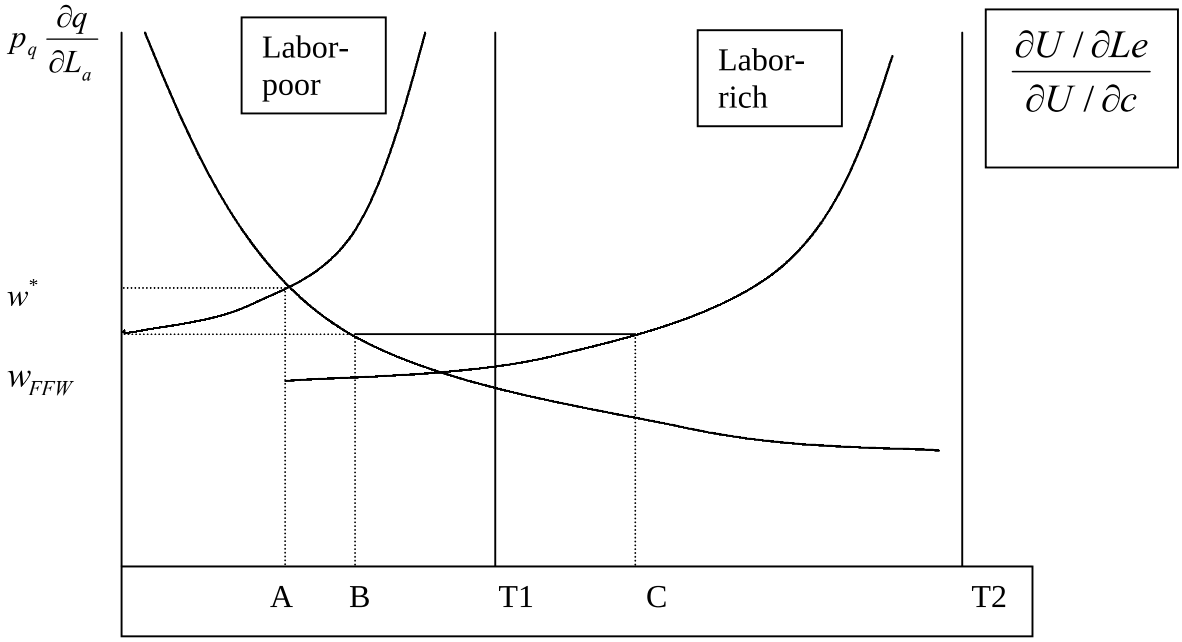

Figure 2. Time allocation for labor-rich vs. labor-poor households

The preceding analyses varied only one asset endowment at a time. In reality, all vary simultaneously. But the intuition laid out simply above underscores how FFW participation and prospective crowding out of on-farm labor vary across the household wealth distribution according to land/labor ratios. As Barrett and Clay (2003) emphasize and illustrate using nationally representative data from Ethiopia, a poor household with relatively little land but proportionately less labor may have a higher shadow wage than a richer household with a greater land endowment but proportionately more labor available. In the presence of incomplete factor markets, shadow wages therefore need not increase with land or livestock endowments, or with wealth or income more broadly, and the efficacy of FFW self-targeting breaks down. The wealthy may become as likely as the poor to participate in FFW programs. This may also be due to the fact that the “FFW wage” has been set too high in Ethiopia and is higher than the opportunity cost of time of most households.

Household willingness to participate in FFW programs varies according to climatic conditions because of climate's impact on agricultural labor productivity. If we generalize the production function to condition output on rainfall, *r*, $q(L_a, \bar{A} \mid r)$, with both output and the marginal productivity of labor and land increasing in rainfall, then we can easily see how drought affects household demand for FFW. We assume the FFW real wage (w_{FFW}) remains the same, a food ration that is constant across rainfall regimes. But due to covariate production risk and imperfect integration of rural output markets into broader national and international food markets, the food price, p_q, moves inversely with rainfall. Food prices are typically higher in drought years than in normal years. As a consequence of constant physical rations but higher nominal food prices, the nominal FFW wage increases in drought years. At the margin, this induces increased FFW program participation, as illustrated in Figure 3.

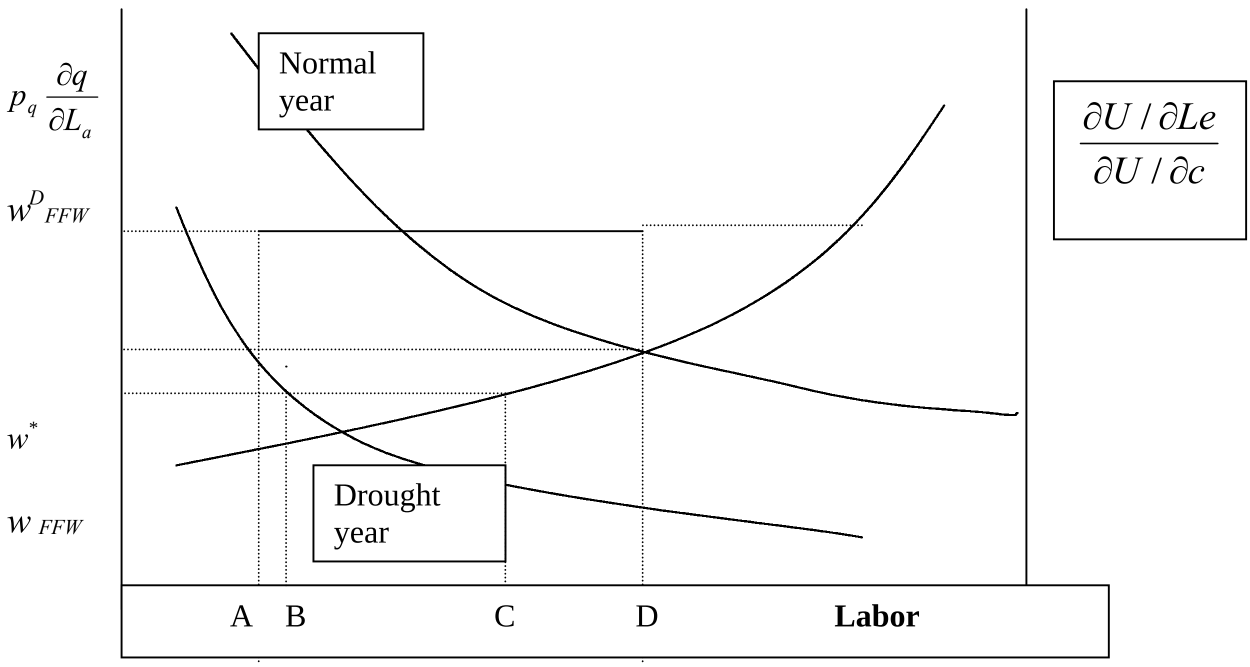

Figure 3. The impact of drought on labor productivity and FFW participation.

We assume that Figure 3 represents a land-rich household that does not demand FFW in normal years because its shadow wage, w^*, is higher than the FFW wage, w^{FFW}, in normal years. However, the marginal return to agricultural labor falls in a drought year. This effect alone is sufficient for the household to demand C-B amount of FFW employment were the nominal FFW wage held constant. But because the price of food also increases in the drought year, the increase in the FFW wage to $w^{D}{}_{FFW}$ further increases household demand for FFW employment.

FFW programs do not have unlimited budgets, however, so increased demand for program participation commonly overwhelms programs in drought years, forcing rationing of FFW employment. In some cases, rationing is effected through unemployment, in others through underemployment relative to an unbounded equilibrium. In Figure 3 we have assumed that the FFW program rations employment equitably across all prospective participants, capping access to FFW at D-A amount of labor. This necessarily causes households to increase their on-farm labor allocation relative to what would occur if the FFW program budget did not constrain FFW employment. In Figure 3, we show the special case in which employment rationing causes the household’s (nominal) shadow wage to be the same in the drought year as in the normal year. The all-too-common problem of employment rationing illustrates a third prospective weakness of FFW. It may not be an effective instrument for self-targeting of the poor in drought years – or in the face of other covariate shocks to labor productivity in the region – because the self-selection mechanism breaks down in the face of excess demand for program participation unless the food wage rate is adjusted down, which is ethically problematic and contravenes the principles of most of the humanitarian agencies that commonly administer FFW programs.

b. A dynamic extension

We now generalize the simple model above to account for the dynamics of investment in soil conservation structures. This requires three key modifications to the static model of the previous subsection. First, in the dynamic model the household no longer consumes all its income today so long as there is some prospect of being alive tomorrow. Instead, the household has to allocate current income between consumption and investment so as to equalize its marginal utility of consumption across periods. Second, while in the static model, households will only devote labor to activities that generate current income, in a dynamic model, they might invest labor in activities that generate income only with a lag. We therefore now break household agricultural labor into two distinct activities: field labor that generates income in the current period and conservation labor spent improving the land so as to increase future productivity and income.[3] We model soil conservation investments this way because natural resources investments in African agriculture tend to be very labor-intensive (Barrett , Place and Aboud 2002). This leads directly to the third basic difference from the static model: effective land quantity is now a state variable. The initial stock of land evolves in response to soil and water conservation investments and natural degradation due to erosion and nutrient depletion. Farmers understand this and make labor allocation decisions accordingly.

Assume the household's utility is intertemporally separable. Then the household's infinite period dynamic optimization problem can be represented by the following

[3] One could equally understand land dynamics as depending on labor allocation through labor-intensive land clearing at the extensive margin (Reardon and Barrett 2001). In the Ethiopian context on which we focus in the empirical sections of this paper, however, soil and water conservation is the more germane link, so we focus on that interpretation for the remainder of the paper.

Bellman's equation, in which β represents the household's discount rate, Lc is the amount of labor allocated to constructing or maintaining soil conservation structures, δ^A and δ^T are endogenous depreciation rates for land and labor stocks, respectively, z is the stock of productive public goods, and I is net investment in conservation units:

$$\underset{c_t, Le_t, La_t, Lc_t, L_{FFWt}}{Max} V(A_t, T_t) \equiv U(c_t, Le_t) + \beta V(A_{t+1}, T_{t+1})$$

$$= U(p_{qt} q(L_{at}, A_t, z_t) + w_{FFW} L_{FFWt}, T_t - L_{at} - L_{ct} - L_{FFWt}) + \beta V(A_{t+1}, T_{t+1})$$

(3)

$$s.t. A_{t+1} = \delta^A(q_t, Lc_t, z_t) A_t + I(Lc_t, z_t)$$
$$T_{t+1} = \delta^T(c_t, Le_t) T_t$$

We include the public good, z, because the typical justification for FFW programs is that they couple a short-term safety net for vulnerable subpopulations with investment in valuable public goods – roads, reforestation, irrigation, soil and water conservation structures – that increase future productivity. The short-term safety net provides an income floor to insure against insufficient current consumption, thereby guarding against loss of household labor due to illness or injury associated with under-nutrition, through the δ^T human capital depreciation function.[4] As modeled here, the public good may affect the rate of depreciation of land (e.g., through reforestation projects

[4] In a more general specification, one might allow for the sale of quasi-fixed assets. FFW could then reduce disinvestment in valuable productive assets, as commonly occurs in distress sales of land or livestock. Since we treat land and livestock as nontradable, we omit the distress sale mitigation effect from the present model. Similarly, FFW could permit continued investment in other key assets, such as children's education. Given low school enrollment rates in rural Ethiopia, we likewise omit the possibility of educational investments and thus of FFW stemming the withdrawal of children from school during times of stress. Finally, one could allow the discount rate, β, to be an endogenous function of current consumption (reflecting how survival probabilities vary with consumption levels), with the effect that FFW wage receipts limit households' discounting of future consumption, thereby encouraging greater investment in conservation structures. Although we omit them from the formal model in this section for reasons of parsimony, these phenomena nonetheless merit attention in empirical work.

that reduce erosion or feeder road construction projects that accelerate erosion[5]), the productivity of conservation labor in improving land quality (e.g., due to terracing or reforestation of public lands on hilltops that increases the productivity of private terracing down-slope), or direct agricultural productivity (e.g., through small-scale irrigation projects).[6]

The laws of motion for the state variables A and T each depend on endogenous depreciation rates. Land quality depreciates with increased harvests that extract more soil nutrients and with higher rates of erosion (part of the z vector), while land quality increases with time spent working on conservation structures and with public goods that stem erosion (e.g., reforestation or terracing). The stock of labor available to the household is increasing in energy consumption (c) and decreasing in energy expenditure (equivalently, increasing in leisure, Le). Given initial values A_0 and T_0 and exogenous public goods stock z_0, the household then solves the current value Hamiltonian associated with the above problem.

This specification reveals the inherent ambiguity of FFW programs' effect on land quality. If the household chooses to participate, FFW program participation will reduce time allocated to both on-farm labor and leisure, as illustrated in the static framework of the previous subsection. Because households rationally equalize the returns to field and conservation labor – the two forms of on-farm labor we consider – so as to equalize the marginal utility of current and future consumption, FFW participation will induce a reduction in labor allocated to soil and water conservation,

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[5] Giambelluca et al.(2002) find in hilly, smallholder regions of northern Thailand that unpaved roads are, by far, the primary source of water runoff and erosion, having far greater adverse effects on soil loss and siltation of downstream irrigation than forest clearing due to shifting cultivation.

[6] One might also want to permit prices to be a function of z so as to capture the effect of road building or maintenance projects on marketing transactions costs. We leave this extension for future work.

ceteris paribus. This can reduce land quality and hurt future productivity. Similarly, if the reduction in leisure due to FFW participation outweighs the increase in current consumption – as has been shown to happen in some FFW programs, where women especially have been known to increase energy expenditure by more than the marginal increase in energy intake they enjoy (Barrett, Holden and Clay forthcoming) – then there may be some degradation of household labor capacity, and thus of future earnings potential.[7]

These possible adverse effects may be dampened or even dwarfed by the potentially salutary effects of FFW on land quality through avoidance of lost labor time due to under-nutrition, through reduced pressure on the land due to reduced current cultivation (i.e., the crowding out of current field labor can reduce rates of soil nutrient harvest), and via investment in public goods, z. Whether the negative or positive land quality effects of FFW dominate will depend on local biophysical and economic environmental conditions and on the design of the FFW program, as Section IV illustrates through simulation modeling techniques.

III. Simulations with a dynamic bio-economic model

The bio-economic model presented here is a dynamic, nonseparable household model that simultaneously integrates economic optimization in production and consumption with inter-temporal environmental feedbacks, allowing for nonlinearities in constraints as well as in the objective function. The model also incorporates risk averse behavior through a constant partial relative risk aversion utility function,

[7] One sometimes hears claims that FFW programs also create dependency or retard innovative behaviour. We know of no strong empirical evidence of such effects, however, and they fall outside the scope of the present modelling effort.

production risk due to drought, and downside risk aversion to taking credit for fertilizer. Drought also affects prices for crops and livestock and price expectations and these have follow-on effects on household production and welfare. The model has been calibrated and aggregated to resemble observed patterns of northern Ethiopian household interactions through their participation in imperfect factor and output markets. We refer interested readers to Holden and Shiferaw (in press), Holden, Benin, Shiferaw and Pender (2003), Holden, Shiferaw and Pender (forthcoming) for more details and applications of the bioeconomic model employed in this section.

The models endogenize land degradation due to soil erosion and nutrient depletion. The availability of biophysical data from conservation experiments in the study area allows us to estimate erosion rates as well as crop productivity responses on different soils. The model also integrates crop and livestock interactions. Crop choice, building or removal of conservation structures on different types of land, fertilizer use, and manure use are endogenous decisions that affect the rate of land degradation. These decisions affect soil erosion and nutrient depletion rates that, once again, determine crop productivity in later years.

We want to assess the impact of new FFW programs in Andit Tid that aim to enhance food security through provision of seasonal employment at a low wage rate paid in kind, in the form of food. In what follows, we study the impact of FFW under three distinct scenarios: (a) when employment is provided outside agriculture and (b) when employment is provided for conservation investment within agriculture. In the first two scenarios, we assume that access to off-farm employment is constrained (i.e., households do not face infinitely elastic labor demand) and that conservation investment does not reduce initial yields. Scenario (c) is like scenario (b), but with unconstrained access to off-farm employment and with conservation investment reducing initial yields (both these changes reduce incentives for farm production and conservation investment). In cases (b) and (c) we assume that the investment is taking place on the FFW participant households' farms. In all cases the "wage rate" in FFW is 3 kg wheat per day of work, the standard rate used in FFW programs in Ethiopia.

One oft-heard criticism is that FFW will undermine participants' incentives to produce their own food and to take care of their own farms, partly because FFW activities compete for scarce time with households' private farming activities. FFW advocates counter that FFW provided outside the main agricultural season stems such competition, enabling FFW investments and income to be largely additional to the household's private earnings and investment patterns. However, FFW may still compete with households' own conservation activities, as these activities are typically carried out in the slack agricultural season. In the site for which we developed this model, Andit Tid in northern Ethiopia, there are two growing seasons. It is most relevant to provide FFW after the short rains, that is in the period March to May, during which time households indeed undertake most of their soil and water conservation investments through labor intensive work on structures on-farm.

In our first simulation (scenario (a)), we study the impact of FFW not used for conservation, when households have constrained access to the labor market, and conservation technologies do not reduce initial yields. We see from the 10 graphs that comprise Figure 4 that over the whole ten year horizon we simulate, FFW increases

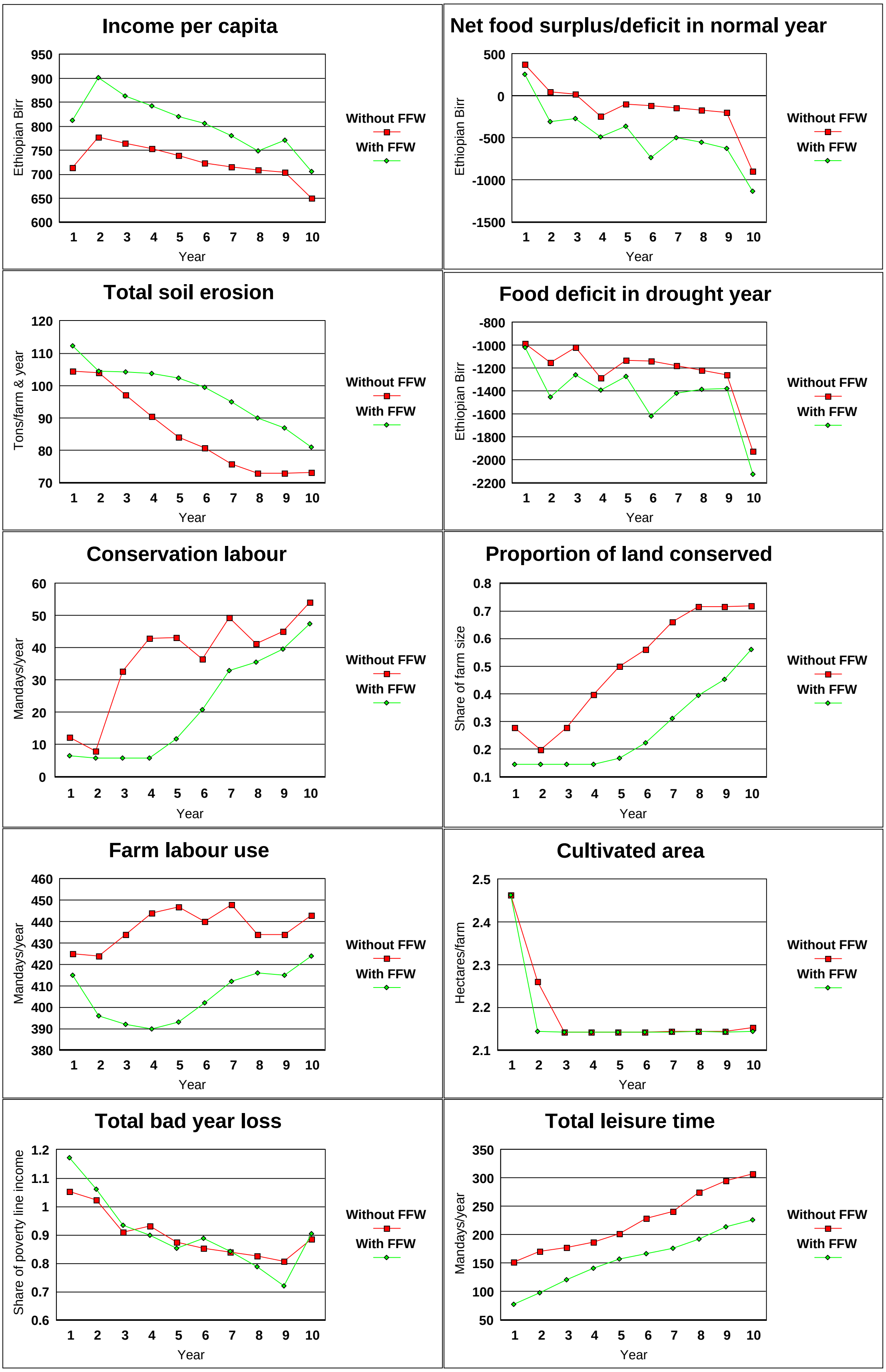

Figure 4. The impact of introducing FFW when FFW is not used for conservation, labor market access is constrained and land conservation does not reduce initial yields

income per capita compared to the base case model in which households lack access to FFW employment. We also see that own food production is reduced in normal as well as in drought years for households with access to FFW. This occurs because households with access to FFW reduce farm labor use, including soil conservation labor. Reduced labor allocation to construction and maintenance of soil conservation structures means that a smaller proportion of the farm is conserved and total soil erosion increases among households with access to FFW. Total leisure time is reduced for households with access to FFW, indicating that FFW has substituted not only for farm labour but also for leisure time. This presumably increases food energy intake requirements, offsetting at least part of the increased income and consumption. Scenario (a) thus demonstrates the clear costs of providing FFW in an environment and in a fashion in which it may reduce incentives for own food production and conservation, thereby undercutting future productivity and increasing the likelihood that participant households will need future assistance as well.

In scenario (b), we only change the allocation of FFW labor, now assuming it to be applied to conservation on participating households’ farms, again under the twin assumptions of constrained labor market access and no initial yield reduction due to conservation investments. The results are presented in Figure 5. Household income per capita once again increases for FFW participant households. But because FFW labor no longer crowds out on-farm conservation labor, FFW stimulates land conservation and thus leads to less soil erosion, although the long-term impact on household food production is relatively modest.

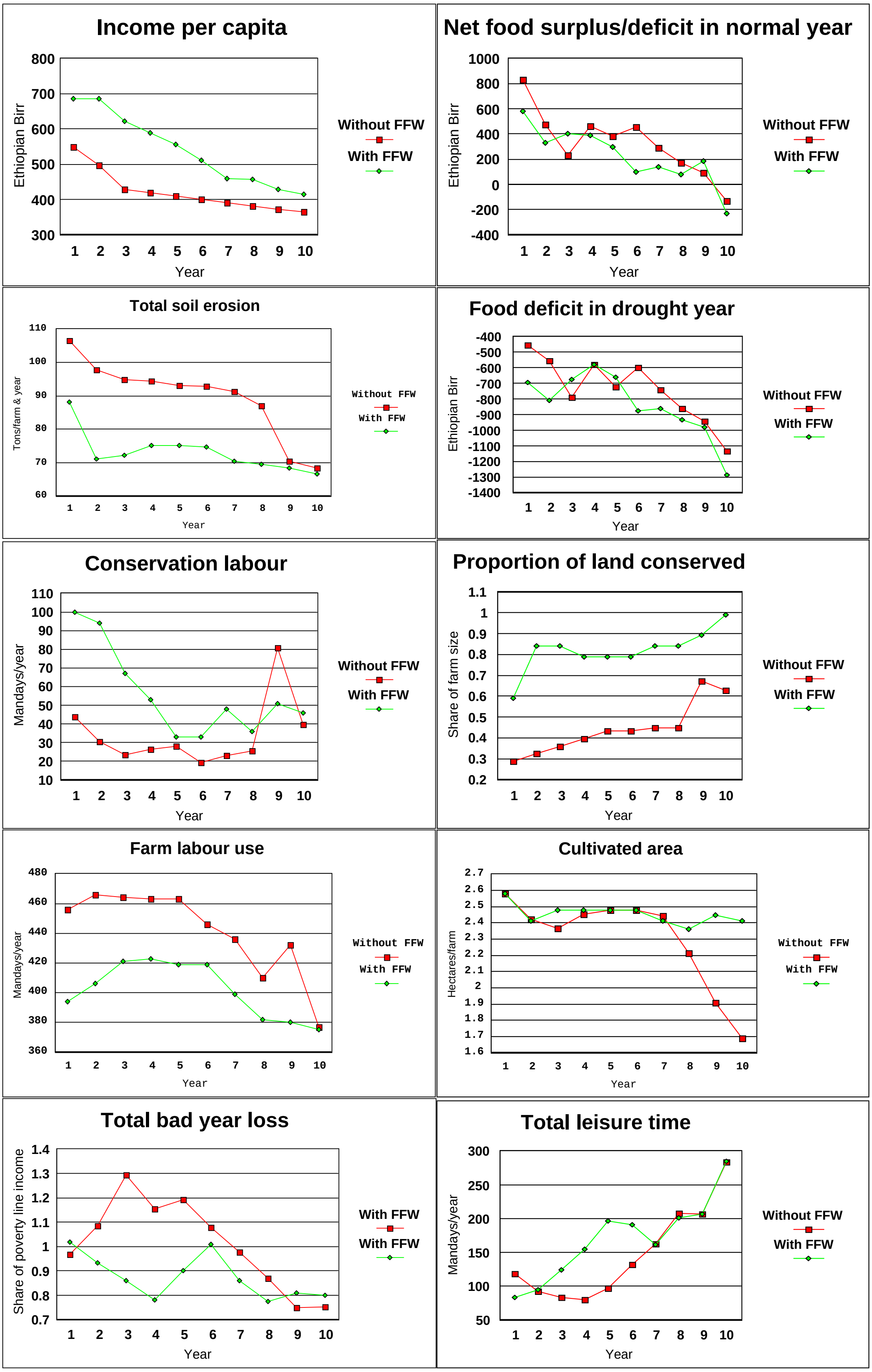

Figure 5. The impact of FFW when FFW is used for land conservation, labor market access is constrained and conservation does not reduce initial yields

In scenario (c), we alter two of the initial assumptions in order to study the impact of FFW used for on-farm conservation when households have unconstrained access to the labor market (i.e., they enjoy better non-farm employment opportunities than previously assumed) and conservation technologies reduce initial yields, thereby dampening incentives to conserve land. Figure 6 reports the results of the scenario (c) model simulations.

As always, household income per capita increases for households that choose to participate in the FFW program, although the gains are less than when access to the labour market was constrained because FFW no longer resolves a structural deficit in labor demand. FFW participation in an environment in which cash wage employment is available implies that the FFW payment (3 kg wheat per day) is higher than the cash wage prevailing on the local labor market. As a consequence, FFW substitutes for other off-farm work, causing a reallocation of labor within the economy.

On the other hand, FFW stimulates own food production and reduces food deficits in normal as well as drought years, and particularly so towards the end of the ten year period for which the models have been run. This arises largely because FFW is used for land conservation, which makes farm production more sustainable. Without FFW households, do not invest in conservation at all because conservation reduces initial yields and because they have alternative off-farm employment opportunities. This scenario illustrates how FFW can help poor households overcome borrowing constraints that restrict costly investment. The food provided by FFW enables households to reallocate labor from current on-farm production without forcing them to make an excessive sacrifice in terms of current consumption. Indeed, the core

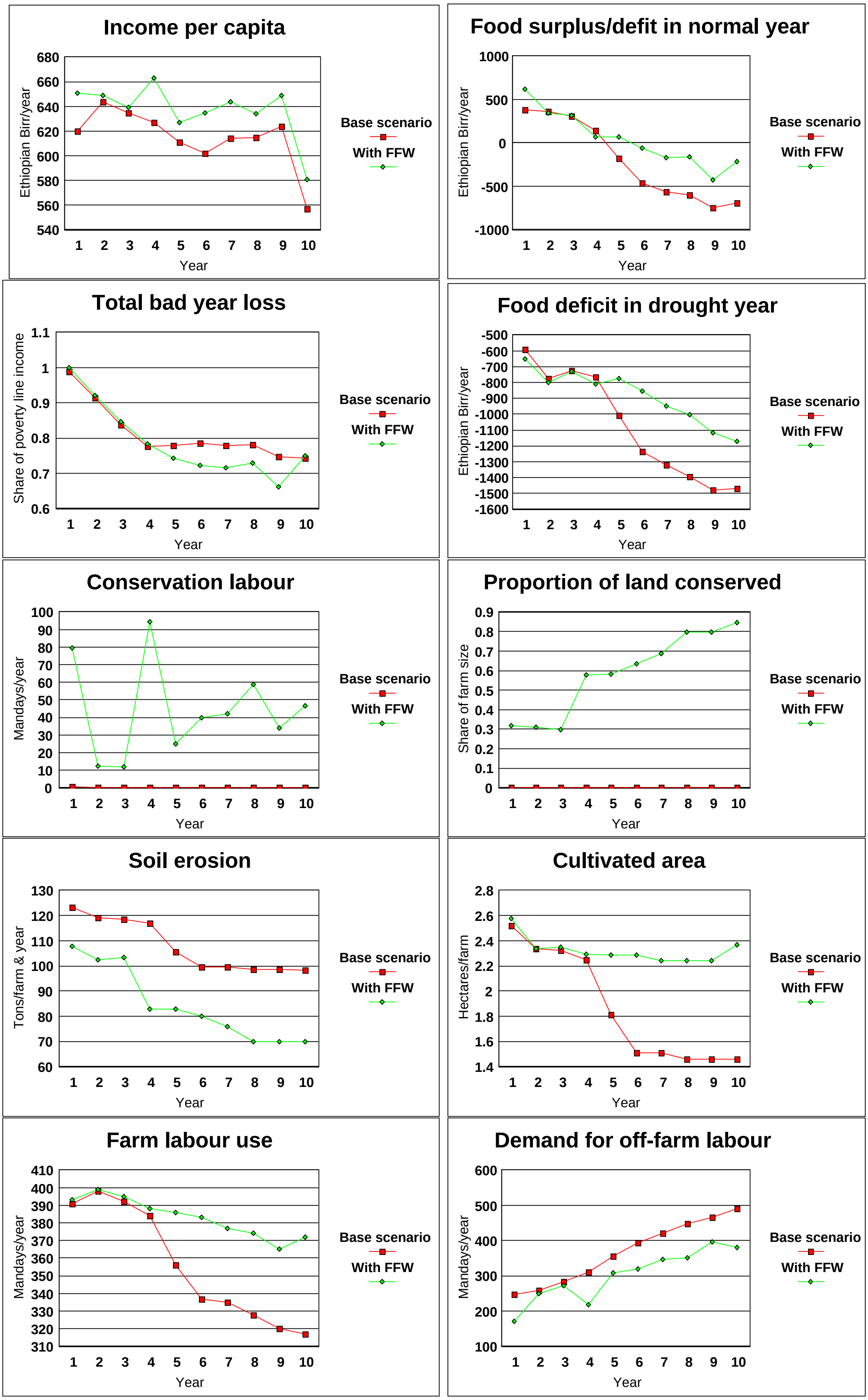

Figure 6. Effects of FFW when conservation reduces initial yields and access to off-farm employment is unconstrained

point of this paper is that these sorts of desirable crowding-in effects only emerge under particular combinations of FFW program design and the underlying biophysical and economic environment.

We see that the effects of FFW on food production and conservation of land can differ greatly depending on how and for what activities FFW is used, on the characteristics of the labor market, and on the impact of conservation technologies on short-term yields. We also see that even a daily FFW wage of 3 kg wheat may be too high in some places of northern Ethiopia. Better poverty targeting and greater coverage may be achieved with less displacement of pre-existing employment patterns by lowering the rate to 2 or 2.5 kg wheat per day of work, although this depends on the wheat price as well.

We also run simulations with a reduced FFW wage rate. We found that households choose to participate in FFW programs at wages as low as 1.1 kg wheat per day (down from the 3 kg/day baseline commonly used in Ethiopian FFW programs). The level of soil conservation investment was not reduced significantly when the wage was reduced from 3 kg to 2 kg wheat. If the main objective of long-term oriented FFW programs is to promote land conservation and the budget for this is limited it would be possible to expand total land conservation by reducing the FFW wage. This may also improve the self-selection of the poorer households, thereby allowing limited funds to reach more households.

The land use effects of FFW projects have not been well studied. The simulation results reported in this section underscore that when FFW competes with labor used for conservation, FFW may reduce incentives to conserve land, at least where such incentives exist without intervention. On the other hand, FFW may be used to stimulate conservation when there are insufficient incentives to conserve land, as in the case when initial yields fall with the construction of soil conservation structures. This illustrates that great care has to be taken when such programs are designed if they are to overcome private investment disincentive effects and not to crowd out private investment in soil conservation. Good knowledge about local farming systems, local market characteristics and prices, and the distribution of resources and welfare, are needed to avoid design failures. Lack of such knowledge by many past FFW program managers likely helps explain mixed past experience with such programs (Barrett, Holden and Clay, forthcoming).

IV. Econometric evidence from northern Ethiopia

This section reports econometric findings based on data from a survey covering 400 households in 16 communities in the highlands of Tigray. This is a sub-sample of the stratified random sample of communities in the IFPRI-ILRI community survey (ref.). The sub-sample of 16 communities was strategically chosen to include four communities from each of the four zones in Tigray, to have eight communities with low population density and eight with low population density, to have eight with good market access and eight with poor market access, and to include three communities with irrigation projects. The households were surveyed in 1998 and 2001. We obtained complete data for both years for 323 households that are included in this analysis.

FFW is an important policy instrument used in northern Ethiopia in an effort to improve food security and promote sustainable development. Fifty-seven percent of our sample households participated in FFW projects, supplying an average of 45 labor man-days in 2000, with greater participation in remote areas with poor market access.

a) FFW participation

Analysis of FFW participation focuses on the discrete decision to participate in the FFW program. Recall from section IIa that a household's probability of self-selection into FFW programs is expected to increase in household labor supply. Indeed, the regression estimates of the probit equation show that male and female labor availability within the household are the best predictors of FFW participation, both in the sense of having the strongest marginal effect and the most statistically significant effect on program participation. Households with secondary school education – who are thus more likely to hold remunerative off-farm employment at a wage rate in excess of the FFW wage – are less likely to participate. These findings confirm basic intuition about household labor allocation patterns. Old age also tends to be correlated with lower probability of participation. We also find economically and statistically significant differences between the 16 different communities.

b) Crowding out or crowding in effects of FFW?

In the first round survey in 1998, 21% of the households stated that FFW participation gave them less time to look after their farm and animals, while only one percent stated that it gave them more time to look after their farm and animals (Hagos and Holden 1998). Furthermore, 43% stated that FFW reduced their need to produce own food, while only four percent stated that it made them able to invest more on their own farms. This suggests that FFW may indeed have some of the crowding-out effects on farm labor and production posited in the preceding sections. On the other hand, the insurance function played by FFW may reduce the subjective discount rates and increase the planning horizon of poor people (Holden et al. 1998; Holden and

Table 1. Probit model for FFW participation

ffwmark	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
hhage	-.0109002	.0063565	-1.71	0.086	-.0233587	.0015584
hhsex	-.1499885	.3506377	-0.43	0.669	-.8372258	.5372489
hhedu	.1666104	.1572888	1.06	0.289	-.14167	.4748909
hhskill	-.0220808	.1955269	-0.11	0.910	-.4053066	.3611449
lncwrati	.3730377	.2648434	1.41	0.159	-.1460458	.8921211
lnfem	1.043379	.3823081	2.73	0.006	.2940692	1.792689
lnmale	.5412297	.2548529	2.12	0.034	.0417272	1.040732
lnprime	-.0673437	.2345154	-0.29	0.774	-.5269855	.3922981
lnsecond	-.6196708	.2040153	-3.04	0.002	-1.019534	-.2198081
lnownhol	.1488218	.2003874	0.74	0.458	-.2439304	.5415739
lnoxen98	.2215104	.2516461	0.88	0.379	-.2717069	.7147276
lntlu98	-.1631953	.1932283	-0.84	0.398	-.5419158	.2155252
_Ivillage_2	-.1671024	.0977553	-1.71	0.087	-.3586993	.0244945
_Ivillage_3	.0536279	.0562779	0.95	0.341	-.0566747	.1639305
_Ivillage_4	-1.410307	.1406173	-10.03	0.000	-1.685912	-1.134702
_Ivillage_5	.1073146	.0933135	1.15	0.250	-.0755766	.2902058
_Ivillage_6	.3406326	.0794419	4.29	0.000	.1849293	.4963358
_Ivillage_7	-.6095858	.067225	-9.07	0.000	-.7413444	-.4778272
_Ivillage_8	.0546807	.1015686	0.54	0.590	-.1443901	.2537515
_Ivillage_9	.2101829	.1883417	1.12	0.264	-.15896	.5793258
_Ivillage_10	.5645241	.1328074	4.25	0.000	.3042264	.8248218
_Ivillage_11	.3200702	.1349391	2.37	0.018	.0555945	.5845459
_Ivillage_12	.4065213	.1078518	3.77	0.000	.1951358	.6179069
_Ivillage_13	-.997943	.1239139	-8.05	0.000	-1.24081	-.7550763
_Ivillage_14	-.4822097	.1110757	-4.34	0.000	-.699914	-.2645053
_Ivillage_15	-.1347221	.0872382	-1.54	0.123	-.3057058	.0362616
_Ivillage_16	-1.376176	.113321	-12.14	0.000	-1.598281	-1.154071
_cons	-.5475462	.7099908	-0.77	0.441	-1.939103	.8440103

Number of obs. =327, Log likelihood = -178.422, Pseudo R2 = 0.1865
(standard errors adjusted for clustering on village)

Shiferaw 2002). Lower discount rates and longer planning horizons increase the attractiveness of investment relative to current consumption and would thereby be expected to have the opposite, crowding-in effect on private soil conservation investment behaviour.

Table 2 enumerates the various FFW activities in which sample households participated. As can be seen, much FFW activity in Tigray has focused on soil and water conservation. Initially, much of these activities were carried out on communal land; but in the second half of the 1990s these activities also expanded into the private land holdings. These investments were also complemented by mass mobilization of labor at community level. Mass mobilization has been an annual activity in Tigray for many years. Each able-bodied adult person has to contribute 20 days of work to the community without any direct payment. This may be seen as a publicly organized collective action or a labor tax that is invested within the local community. The local community also decides on where to allocate the mobilized labor. Table 3 presents the types of activities households participated in through mass mobilization in 1997.

Table 2. Types of food-for-work activities in which households have participated

FFW activities in which households have participated	**Zone**				**All**
	Central	**Eastern**	**Southern**	**Western**	
Stone terrace construction	35	8	20	6	18
Soil bund construction	4	4	15	0	6
Bench terraces construction	1	0	0	7	2
Check dam construction	6	5	0	1	3
Dam construction	14	12	48	15	22
Gully control	6	4	0	0	3
River diversion	0	2	0	0	1
Tree planting	2	5	3	4	4
Soil and water conservation	18	8	3	7	9
Road construction	8	14	7	6	9
School construction	1	4	1	0	2
Other house construction	3	0	0	0	1

Table 3: Types of mass mobilization activities during last year (1997)

Types of Activities (%	Zone				Average
	Central	Eastern	Southern	Western	
Conservation on communal land	62	51	48	27	47
Conservation on private land	28	17	41	14	25
Road construction	0	0	4	1	1
Other work	3	19	14	2	10
All activities	93	87	107	44	83

The survey also asked households what assistance they considered important in order to be able to reduce land degradation in their area. Their responses are summarized in Table 4. Respondents universally considered technical assistance most important, although many – especially in the western zone – also emphasized the importance of labor mobilization and conflict resolution as well. There is clearly a need to coordinate conservation activities across farms and considerable technical skills are required to design and fit the alternative conservation technologies into the landscape. This adds an additional rationale – beyond what we have discussed in the theoretical and applied models so far - for public intervention to promote land conservation on private land. FFW may in this connection also be beneficial as a complementary instrument to mass mobilization to increase investment on privately operated land. It may also reduce the negative effect on the human capital caused by the labor mass mobilization. The result of this may crowding in rather than crowding out of private investment due to the demonstration, coordination, labor mobilization and conflict resolution effects.

Table 4: Types of assistance needed to reduce the land degradation problem

Type of Assistance	Zone				Average (%)
	Central	Eastern	Southern	Western	
Technical assistance and labor mobilization	60	58	45	59	56
Technical assistance	23	28	46	8	26
Technical assistance and conflict resolution	14	10	4	31	15
Technical assistance and other assistance	0	1	1	0	1
Conflict resolution and labor mobilization	1	0	0	1	1
Conflict resolution and other assistance	1	0	0	0	0
Labor mobilization	1	1	2	1	1
Other assistance	0	0	1	0	0
No assistance	0	2	1	0	1

How are public and private investments distributed across farm plots? Table 5 presents the distribution of public and private investment in soil bunds and stone terraces at farm plot level. Roughly half of the plots with privately-built stone terraces also had public conservation investment, while only about one-quarter of the plots on which there had been public conservation investments had privately-built stone terraces. These patterns were roughly similar for soil bunds. These data provide an uncommon opportunity to analyze the determinants of private investment in conservation at plot level, in particular the effect of public conservation investments through FFW and other labor mobilization schemes on private soil conservation investments (Hagos and Holden 2003).

Table 5: Role of public and private conservation investments

Private investment	Public-led conservation investment	
	Yes	No
Number plots with stone terraces		
Yes	173	174
No	527	650
Number plots with soil bunds		
Yes	106	68
No	594	756
Intensity of stone terraces		
Yes	71.540	70.953
No	5.393	0.000
Intensity of soil bunds		
Yes	111.308	93.844
No	17.799	0.000

Intensity of conservation technologies is measured in meters on structure per ha of land. Yes and No in the rows indicate whether there are private investments or not on the plots, and similarly for public investments in the Yes and No columns.

Hagos and Holden (2003) find that public investment at plot level was positively correlated with private investment in conservation through both soil bunds and stone terraces. Such positive correlation was found both for the probability of private plot level conservation and the level of plot level private conservation investment. In that analysis, we controlled for a large number of soil and plot characteristics, household characteristics, village and market characteristics. This seems to be strong evidence of public conservation investments crowding in private investment in conservation. The explanation seems to be the need for technical support (demonstration effect), coordination of such efforts across farms, labor mobilization and conflict resolution. These effects go beyond what we have discussed in our theoretical and applied models earlier in this paper. However, the combination of FFW and mass mobilization may reduce the labor depreciation cost of mass mobilization and thus facilitate further private conservation efforts. This is also in line with the argument that FFW may provide insurance and reduce the severity of cash constraints and thus private discount rates.

V. Discussion

FFW projects have been implemented for short-term relief purposes as well as long-term development purposes in Ethiopia and other low-income countries. There may be tradeoffs between the short-term assistance and long-term investment objectives of FFW (Gebremedhin and Swinton 1999). It may be that one can basically have the safety net effects that operate through the law of motion on labor, by maintaining human nutrition and health, or one can enjoy productive public goods investments, but not both.

The theoretical and empirical findings in this paper reinforce existing evidence that FFW may not be a particularly efficient instrument for short-term targeting of the poorest of the poor, a group that often fails to benefit from FFW because they lack the labor power needed in order to participate. Indeed, we found that labor rich households were more likely to participate in FFW in Tigray. However, FFW is typically implemented in areas where almost all households are poor and in need of support, particularly in drought years, when FFW wages tend to increase in real terms relative to market wages (due to increased food prices). As a consequence, unless FFW implementing agencies are willing to reduce FFW wages in times of drought, self-targeting of the poorest breaks down further as demand for FFW participation increases.

In this paper we have focused more on the potential of FFW to stimulate investment in public goods that may increase future productivity. We use a simple theoretical model to lay out the basic analytics of the ambiguous effects of FFW programs on private investment in soil conservation measures, then illustrate these results using both an applied bioeconomic model and econometric analysis of panel data from northern Ethiopia. Our results underscore that the success of FFW investments in stimulating soil conservation, sustainable agricultural productivity increases, and income growth depends crucially on several key conditioning factors, including careful identification of relevant investment projects (a process that typically requires substantive local participation) and of appropriate technology design, local involvement in implementation and maintenance of investments after the project, clear specification of property rights to the investments, implementation only where private capacity or willingness to invest are limited, and timing of projects to minimize labor crowding out effects.

There are, unfortunately, many cases of past FFW projects that did not meet these requirements. For example, the top-down implementation of FFW conservation investments during the 1980s in Ethiopia did not involve local people in planning or organization. Farm households themselves had no real influence over the choice of conservation technology or how it was fit into the landscape on their farms. This caused many to reject the technologies; many were found to have partly or fully removed these structures from their farms (Shiferaw and Holden 1998). The NGOs that implement FFW projects typically are humanitarian agencies that do not have the technical skills needed to undertake substantive investment projects right (although there are certainly wonderful examples of well-conceived and well-executed projects).

Similarly, Smith and Little (2002, p.6) report on a serious bush encroachment problem in the Il Chamus areas of Baringo District. The problem arises from the introduction of *Prosopis spp*. (mesquite in North America) as part of a mid-1980s

FFW reforestation project intended to create fuelwood. The problem is that *prosopis* proliferates quickly, crowds out grasses, and is somewhat toxic for the small ruminants (goats, sheep) on which the Il Chamus agropastoralists depend. The seed pods of the *prosopis* closely resemble a variety of acacia pod, a common livestock feed, so keeping livestock away from *prosopis* is difficult, but it hurts their teeth and gastrointestinal systems. The tree is deemed a serious nuisance by locals and in their view the reforestation effort has actually reduced available grazing area and livestock productivity in the area over the long-term. Smith and Little conclude that this project was "an unmitigated disaster for the [Ng'ambo] community and consequently they are now largely resistant to forestry interventions."

By contrast, more recent FFW projects in Tigray seem to be better designed, and to involve local people more than many FFW projects in other parts of Ethiopia. For example, Aas and Mellestrand (2002) found that the local people perceived the long-term effects of the FFW projects in Eastern Tigray to be more important than the short-term food benefits they got from these projects. Our analysis of data from 16 communities in Tigray also showed that the crowding in effects of FFW on investment in land conservation were stronger than the crowding out effects. FFW projects may enable farm households to become more forward-looking due to their insurance, liquidity and income effects, leading to longer-lasting benefits than are achieved through poorly targeted transfers.

VI. Conclusions

Market imperfections are necessary but not sufficient condition to defend the use of FFW projects for short-term relief and/or for promotion of long-term development. Market imperfections may also prevent FFW projects from being efficiently targeted to the poor and effective in stimulating investment. This paper offers a combined theoretical, simulation and econometric exploration of the conditions under which FFW can be effective in reaching the poorest target subpopulations and in stimulating investment in soil conservation structures that are essential to sustainable agricultural productivity and income growth in rural Ethiopia.

How good are FFW projects at targeting the poor and how can targeting of the poor with FFW be improved? FFW projects tend to favor labor-rich households and are not designed to reach the poorest of the poor. The opportunity cost of labor and the "FFW wage" jointly determine whether households demand FFW employment. It is possible that the FFW wage has been set too high in Ethiopia to make the self-selection mechanism efficient. A central point of our analysis, however, is that structural failures in rural factor markets account for much of the apparent mistargeting, irrespective of the prevailing FFW wage.

Most of the FFW projects in Ethiopia have had long-term development, rather than short-term relief, as their primary goal. One should therefore guard against evaluating these programs solely on the basis of their short-term poverty-targeting efficacy. It is not likely that the best investment projects are located at the same places as the most needy households are located. There may therefore be tradeoffs between the long-term and short-term objectives.

FFW induced investments may be socially beneficial where private investments are below socially optimal investment levels. This may be due to the public good nature of the investments (e.g. infrastructure), poverty and liquidity constraints, risk (e.g. tenure insecurity) and intertemporal market imperfections, lack of technical skills and the need for collective action to coordinate investments across farms. FFW projects may provide insurance and relax cash constraints and thus lower the discount rates of poor people and make them more forward looking and more able and willing to invest. But careful identification of investment projects is crucial for the success of FFW investment projects. Involvement of the local people in identification, implementation, and maintenance of the FFW public good investments is very important if de novo FFW investment is to prove durable and if it is not to crowd out private investment.

Most of this paper has focused on how best to minimize crowding out effects and how best to maximize crowding in effects on private investment in soil conservation. There seem to be several key, basic rules of thumb one can follow. First, FFW investments need to timed so as to minimize competition with other constructive activities and when the opportunity cost of labor is low for poor households who are the primary intended beneficiaries of the long-term investments. Second, if FFW projects can protect human capital in the face of idiosyncratic (e.g., farm-specific yield) shocks, then its short and long-term productivity may be enhanced. Likewise, if FFW projects can enhance land productivity through investment in conservation and more productive activities, like planting of perennials, this will also increase the future returns to labor and other inputs and therefore also stimulate their use. As we illustrated with simulations from a farm-level bioeconomic model and with econometric results from Tigray in northern Ethiopia, FFW can crowd in private investments in soil conservation and improve the welfare of people in the longer term. It is, however, a skill and knowledge demanding task to design and implement efficient FFW programs. There is considerable room for improvement of existing programs.

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