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Impacts of FFW on nutrition in rural Kenya

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Abstract

Assessing the impacts of Food-for-Work (FFW) on human capital formation depends on understanding the specific nutritional contributions of FFW to the overall diet of FFW participant households. However, empirical studies in this area are very scant. This paper is an attempt to fill such gap. The primary objectives are to measure the magnitude of the FFW contribution to participants' nutritional status. Primary data collected from a random sample of 300 farm-households in the Rift Valley Province of Kenya are used. A linear programming model is used to estimate the shadow prices of nutrients. These prices are then entered into an econometric model of consumer demand for nutrients in order to estimate own and cross-price elasticities for each nutrient component.

The results indicate that FFW significantly improves the nutritional status of FFW participant households. More specifically, participants experienced an implicit income gain, which resulted in a significant nutritional improvement. The poorest FFW participant households exhibited even higher nutritional gains (32.46%) than those participants from relatively higher income groups. FFW participant households showed a 90% higher propensity to spend on nutrients than the non-FFW participants. The findings of this study are expected to assist in the design of future 'targeted' food aid projects.

1. Introduction

Food aid can be an essential mechanism to accelerate development in food aid recipient countries when it is distributed through food-for-work (FFW) programs (Bezuneh, Deaton and Norton, 1988). FFW strategies are conceived as more effective means of reaching the poor, because the lowest-income workers receive all or part of their wage payments in the form of food items. Although this form of distributing food aid might require considerable administrative/logistical capacities, it is expected to be nutritionally cost-effective.

In cooperation with the World Food Program (WFP) of the United Nations, Kenya is formulating a desirable national food strategy by determining the appropriate levels of food aid (and food for work) needed in order to meet

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national/regional nutritional and development needs. The specific FFW program analyzed in this paper started in the early 1980s and is being carried out in the rural development project referred to as the Baringo Semi-Arid Area Project (BSAAP), Baringo District, Rift Valley Province of rural Kenya.

Participants in the BSAAP rural projects are being paid in food commodities in exchange for their labor input into soil and water conservation projects. Consequently, FFW expands the range of consumption, and the amount of nutrients available to participant households, while improving the productive capacity of the agricultural system. This paper addresses only the consumption aspects of FFW. Accordingly, two effects of FFW on participants are identified. First, FFW increases the consumption opportunity set. Hence, it is expected that FFW differentiates the consumption behavior of the participants, compared to non-participants, and that this effect can be measured by the respective income elasticities of demand for nutrients. Second, the indirect income contribution of FFW to participant households is also expected to affect the magnitude of the differentiated consumption response of the participants, which can be measured by comparing the income elasticities of demand between participants and non-participants.

Evidence of increased household consumption due to participation in FFW projects has been established (Bezuneh, 1985). The major hypothesis of this study is that the nutritional gains obtained from food-payment under FFW are higher than the net market food value equivalent (income gains). This hypothesis stems from an intuitive notion that food commodities in hand lead to higher food consumption, partly due to the transaction costs associated with converting food aid commodities into cash. If equivalent-valued cash wages were received by the worker, consumption alternatives would be expanded at least by the amount of the transaction costs. It is also possible that intra-household food distribution is very different for commodities in hand as compared to cash wages. There has been no known research to document such different patterns in this context.

The purpose of this paper is to assess the consumption and nutritional impacts of FFW on the participant households. Comparisons between participants and non-participants will highlight the importance of the income elasticities and income level difference on consumption patterns. Given the argument of the nutritional effectiveness of food aid programs (Deaton, 1980; Mellor, 1980), this paper will directly address the impact of food aid on nutritional intake of participant households.

The methodology followed in this research is a two-step procedure. First, a set of Mathematical Linear Programming Models (Lancaster-type) were used to estimate the marginal (shadow) nutrient prices of four consumed nutrients, calories, protein, fat and carbohydrates following the Ladd and Suvannunt (1976) approach. It is expected that changes in food commodity prices will affect the nutrient demand by affecting the nutrient shadow prices. The flexibility of LP also helps to determine the effect of specific food price policy changes on the nutritional levels of different types of households for each nutrient category. Second, following the standard neoclassical consumption theory, a set of Linear Econometric Models was used to estimate the own and cross-price elasticities, and income elasticities of demand for the four nutrients.

2. Theoretical model

Given the unit of analysis, the subsistence farm household in the study area, it is assumed that each household minimizes its total expenditures on food commodities necessary to obtain the levels of food nutrients actually consumed. Households are also assumed to maximize their utility by allocating their monetary budgets (total food expenditures) subject to nutrient constraints. FFW is viewed as a means to expand the opportunity set of the participant household's consumption preferences. Thus, it is argued that the FFW activities (food products exchanged for labor services) affect the consumption behavior of the participants and, consequently, affect the nutritional status of the participants. Therefore, each participant household's consumption decisions and nutritional condition are based on the specific budget constraints that they face and their food preferences. Assuming that the participants are indifferent between being paid in food and being paid in cash, they will minimize their total food expenditures while consuming the preferred amount of food. Obviously, the particular food amount that each household consumes corresponds to a specific amount of nutrients.

According to Lancaster's theory, each household's demand for several food products is a function of the implicit demand for each product's characteristics (here, nutrient values). The characteristics theory approach is based upon the idea of obtaining a set of characteristic variables that explains the differences in the products' prices. This fundamental idea leads to the specification of a set of equations which can be estimated via standard econometric techniques, where the actual product characteristics (nutrients) are regressed on characteristic's prices. Each coefficient estimated through the regression procedure can be interpreted as an estimate of the marginal implicit (shadow) price that consumers are willing to pay for an additional unit of the respective good's characteristic while minimizing total food expenditure.

Given a price vector and the characteristics vector, the consumer will choose the most efficient combination of goods in order to achieve the desired collection of characteristics (nutrients, in this case). The criterion of the efficiency condition will be minimum cost or minimum food expenditure (Lancaster, 1966).

The commodities included in the food aid package are corn, beans and vegetable oil. While corn and beans are common elements of the local diet, vegetable oil is being introduced into the local diet through the FFW program.

2.1. Utility framework

Each household will maximize its utility, subject to the total food expenditures which were minimized by the linear programming model. Thus, we get:

$$\max_{b} \mathrm{U}(b_1, b_2, b_3, \ldots, b_k; D)$$

subject to

$$\sum_{k=1}^{k} Y_k b_k = Y_E$$

where b_j are specific nutrients ($j = 1, 2, \ldots, k$), Y_E represents total food expenditures, and D demographic characteristics.

This utility function is defined in terms of the good's characteristics, or nutrient values. Such specification of a utility function is consistent with Lancanster's (1966) formulation, and the empirical work of Ladd and Suvannunt (1976). Note also, that the primal and dual problems of the LP model provide the same value for the objective functions, i.e.

$$\sum_{k=1}^{k} Y_k b_k = \sum_{i=1}^{N} P_i X_i = Y_E$$

In this model, a nutrient demand analysis is to be used. By imposing a commodity by commodity analytical basis, we accept restrictive assumptions about the separability of the impact of price changes for one commodity class on changes in demand for other commodity groups.

3. Empirical model

3.1. Linear programming specification

As the first step, a linear programming model (LPM) was specified and run for each household (80 for the FFW participants and 172 for the non-participants). Every household had a different set of food items consumed, and a different set of food prices paid. Hence, each household required separate LP-model specification, and faced its own objective function. It is assumed that each participant household in the FFW project minimizes its total food expenditures in order to obtain the levels of nutrients actually consumed. Thus, households are assumed to:

$$\min_{X} \sum_{i=1}^{N} P_i X_i = Y_E$$

subject to

$$a_{11}X_1 + a_{21}X_2 + \ldots + a_{1N}X_N \geq b_1$$
$$a_{21}X_1 + a_{22}X_2 + \ldots + a_{2N}X_N \geq b_2$$
$$\vdots$$
$$a_{k1}X_1 + a_{k2}X_2 + \ldots + a_{kN}X_N \geq b_k$$
$$X_1, X_2, \ldots, X_k \geq 0$$

where X_i is amount of food commodity i purchased by households, P_i market price of the food commodity i purchased, Y_E total food expenditures of each household, b_j level of the j nutrient actually consumed by participant household, and a_{ji} technical coefficient representing the amount of nutrient j per unit of food commodity i.

The vector (X_i's) consists of the food commodities' levels purchased by the participant household. The vector of (b_j's) is the amount of nutrients actually consumed by the household unit. The dual problem of the primal can be specified as:

$$\underset{Y}{\text{MAX}} \sum_{k=1}^{K} Y_k b_k = Y_E$$

subject to

$$a_{11}Y_1 + a_{21}Y_2 + \ldots + a_{k1}Y_k \leq P_1$$
$$a_{12}Y_1 + a_{22}Y_2 + \ldots + a_{k2}Y_k \leq P_2$$
$$\vdots$$
$$a_{1N}Y_1 + a_{2N}Y_2 + \ldots + a_{kN}Y_k \leq P_N$$
$$Y_1, Y_2, \ldots, Y_k \geq 0$$

The variables Y_k represent the shadow prices of the constraint vector (b_j's). Thus, Y_i for example, can be interpreted as the shadow price of nutrient b_j. In other words, Y_j is the marginal cost of the b_i nutrient. Therefore, the purpose of solving the dual problem is to obtain the vector of nutrient shadow prices for each household participating in the FFW projects. Hence, the fundamental assumption behind the LP-model specification is that participant households adjust their market basket of the preferred foods consumed according to their real income and the cost of food available to them. It is accepted that participant households are indeed efficient in the sense that they buy the cheapest bundle of food products which will give them the specific combination of food nutrients which they actually consume.

The shadow price (marginal cost) of each nutrient type consumed by each household unit can be determined by the following data sets:

1. observed food prices, including opportunity costs of own produced and consumed food, along with FFW foods;
2. food quantities consumed; and
3. technical coefficients which show the amount of each nutrient per unit in each food type actually consumed by the participant household.

By using these household data sets, one can estimate the various demand elasticities for the corresponding nutrients. Estimating the demand elasticities for each nutrient directly rather than observing the estimates on a commodity by commodity basis has a set of advantages:

1. We avoid the intermediate step of first estimating the commodity consumption responses, and then converting the commodity consumption responses into nutritional equivalence. Thus, we can estimate the desired values directly. In doing so, we can solve the problem directly and sufficiently.
2. Price differentials associated with different types (qualities, etc.) of food items consumed, and blanks in the available data can be avoided. The estimation will be targeted on the nutrient analysis and not on the commodity comparisons.

3.2. Econometric model specification

The second step, i.e., after estimating the optimal nutrient shadow prices through the LP-Model, is to specify an econometric model for nutrient demand. The proposition for the empirical analysis through the use of an econometric specification is elaborately discussed in Lancaster (1971) and Ladd and Suvannunt (1976). Briefly, household's total demand for the jth nutrient b_j actual consumed can be expressed as:

$$b_j = f_j(Y_1, Y_2, \ldots, Y_k, Y_E, D)$$

where Y_i's, Y_E, and D are as specified before. This argument states that the participant household's total demand for a nutrient is affected by the implicit prices of the other nutrients, income, and household's demographic characteristics. Consequently, this equation can be transformed into an empirically estimable econometric relationship, and can be specified as:

$$b_j = \beta_0 + \beta_1 Y_1 + \beta_2 Y_2 + \beta_3 Y_3 + \dots + \beta_k Y_k + \beta_{k+1} Y_{E+1} + \beta_{k+2} + D$$

where the β's represent the parameters to be estimated econometrically. Preference structures of the participant households are included by incorporating the household size (D), assumed to be the main demographic variable.

4. Data

The data used in this study were collected from Baringo District (Ewalel and Marigat locations), Rift Valley Province of Kenya, during seven months of field work by the authors (August 1983 through February 1984). A random sample of 300 households were randomly selected from the 1030 households identified within the two locations, of which 100 were found to be participants in FFW projects during the study period (February 1983 through January 1984). The data cover all the production and consumption activities for one calendar year. Data on FFW include beans, corn and vegetable oil. Details on the type and procedures of data collected are discussed in Bezuneh (1985) and Bezuneh, Deaton and Norton (1988). In this paper, the data on 252 households (80 FFW participants and 172 non-participants) were utilized, and compared. Table 1 shows the mean income of the sample households and other relevant demographic characteristics. Deaton and Bezuneh (1987) have shown that these two groups of households are comparable, at least, with respect to mean and relative mean income, and other relevant household compositions.

The nutritional content of the several food products consumed was estimated by using the primary data from previous research in rural Kenya (Bezuneh, 1985). The technical coefficients used in the LP-Model specification (nutrient values per food unit) were calculated from the *Food Composition Tables for Use in Africa* (FAO, 1968).

Table 1
Relevant variable statistics for sample households

Variable	FFW participant	Non-participant
Sample size	80	172
Income		
Mean	3685.24 [a]	3591.81
Standard deviation	2551.55	3266.42
Minimum value	721.50	495.00
Maximum value	15369.90	21807.30
Standard mean error	285.27	249.06
Household size		
Mean	4.78	4.47
Standard deviation	1.70	1.85
Minimum value	1.00	1.00
Maximum value	9.00	10.00
Standard mean error	0.19	0.14
Education of home-maker		
Mean	0.87	1.01
Standard deviation	2.14	2.37
Minimum value	0.00	0.00
Maximum value	7.00	11.00
Standard mean error	0.23	0.18
Age of home-maker		
Mean	38.12	42.45
Standard deviation	10.80	13.90
Minimum value	22.00	20.00
Maximum value	80.00	87.00
Standard mean error	1.20	1.06

[a] Includes the implicit income derived from FFW (mean income without FFW = 3109).

5. Results

Table 2 compares the amount of nutrient consumption by participant households with that of non-participants. Differences in mean values were tested (t-test) to determine whether they were statistically significant. More important figures for the nutritional evaluation of the consumption behavior of the two household groups (FFW participants and non-participants) are the nutrient values per person and per day. Hence, Table 3

Table 2
Statistics of the consumed nutrient quantities [a]

Variable	FFW participant	Non-participant
Calories		
Sample size	80	172
Mean [b]	461593	343187
Standard deviation	22994	198356
Minimum value	35050	6148
Maximum value	1342174	1033485
Standard mean error	25708	15125
Protein		
Mean [b]	15215	12288.6
Standard deviation	6886	6457.6
Minimum value	6694	2531.0
Maximum value	41519	31810.5
Standard mean error	770	492.4
Fat		
Mean [b]	6996.4712	4617.5
Standard deviation	2906.8124	2464.4
Minimum value	2625.0000	1016.3
Maximum value	17255.2000	11456.5
Standard mean error	324.9915	187.9
Carbohydrates		
Mean [b]	90116.5301	67461.9
Standard deviation	47009.0251	40596.5
Minimum value	28353.4000	10538.0
Maximum value	280033.0000	213615.0
Standard mean error	5255.7688	3095.4

[a] Nutrient values are estimated on a monthly per-household basis.
[b] Statistically significant at the 5% level.

shows the calculated dietary allowances on a per-person, per-day basis. Household members of FFW participants are found to consume an average of 3213.8 calories per person, per day; while the corresponding values for the non-participants is 2555.3 calories per person, per day.

Table 3
Nutrient consumption per person per day for all income groups

Nutrient	FFW-participant	Non-participant
Calories	3213.8	2555.3
Protein	105.9	91.5
Fat	48.7	34.4
Carbohydrates	627.4	502.3

Protein, fat and carbohydrates' values are in grams per capita and day.

Table 4
Ratios of non-FFW/FFW-participants nutrients consumption for all income groups

Nutrient	Ratio per household per month	Ratio per person per day
Calories	0.74	0.80
Protein	0.81	0.86
Fat	0.66	0.71
CARB/TES	0.75	0.80

Ratios represent percentage points.

The calculated ratios (Table 4) reveal that non-participants consume only 80% as many calories as the FFW participants, 86% as much protein consumption, 71% as much fat consumption, and 80% as much carbohydrates consumption. Table 5 presents the corresponding estimates of nutrient consumption ratios for the lowest 25% income group comparing participants and non-participants. The most striking figure here is the relatively lower fat consumption by non-participants.

Table 6 shows the results of the FFW contribution to consumption of the four nutrients. The results indicate that the FFW contribution to nutrition consumption for the lowest income group (lowest 25% income quintile) is higher than its contribution to the overall group for each of the nutrients. FFW contributed relatively more to carbohydrates consumption (42.68%).

Table 5
Lowest household's income groups' nutrient ratios

Calories	Protein	Fat	Carbohydrates
1.0	1.0	0.78	0.90

Lowest household's income groups' nutrient consumption per person and day

Nutrient	FFW-participant	Non-participant
Calories	2484.14	2279.10
Protein	85.42	85.17
Fat	39.58	30.80
Carbohydrates	488.31	439.90

All nutrient ratios and consumption levels refer to the lowest income groups. Comparisons are made between participants' lowest income group, and non-participants' lowest income group.

Table 6
Contribution of FFW to nutrient consumption of participant households (%), by income groups

Nutrient	FFW nutrient contribution	
	All income groups	Lowest income group
Calories	26.07	32.43
Protein	20.67	24.63
Fat	32.69	38.76
Carbohydrates	25.45	42.68

For the protein analysis, the following model was estimated for both FFW participants and non-participants:

QPR = F(PPR, PFAT, YINC, HHSIZE, EHR, AGEHR)

where the quantity of protein (QPR), which was consumed by each participant household on a monthly basis, was regressed on the price of protein (PPR), the price of fat (PFAT), household income from all sources (YINC), household size (HHSIZE), the level of education of the homemaker (EHR), and the age of the homemaker (AGEHR). Except for the prices of protein and fat, the other variables represent the demographic characteristics of the sample households. The prices of protein and fat represent the nutrient shadow prices as estimated by the set of linear programming models (LPM). [1] All parameter signs are as expected (Table 7).

Table 8 presents the own and cross-price elasticities of demand for protein with respect to fat and the income elasticities of demand for protein. The income elasticity of demand for protein was found to be 0.239 for the FFW participants, and

Table 8
Pairwise table of elasticities for protein demand

Elasticity [a]	FFW participant	Non-participant
Uncompensated		
Own-price	−0.299	−0.340
Cross-price	−0.189	−0.165
Compensated		
Own-price	−0.284	−0.330
Cross-price	−0.187	−0.163
Income elasticity	0.239	0.13

[a] Estimated at the sample means.

[1] The marginal shadow prices of the other two nutrients (calories and carbohydrates were of zero value).

Table 7
Pairwise table of protein estimates

Variable	DF	Parameter estimate	Standard error	t for H_O: Parameter = 0	Prob
FFW participants' model					
Intercept	1	17 147.683	4 194.3	4.088	0.0001
PPR	1	−304 818.000	136 163.0	−2.239	0.0282
PFAT	1	−640 224.000	248 881.0	−2.572	0.0121
YINC	1	0.987	0.274009	−3.605	0.0006
HHIZE	1	974.725	398.1	2.449	0.0167
EHR	1	568.771	324.8	1.751	0.0842
AGEHR	1	−86.634	64.8	−1.337	0.1889
F-value		Prob $> F$	R-square	ADJ R-SQ	D-W
6.993		0.0001	0.3650	0.3128	1.429
Non-participants'model					
Intercept	1	11 665.312	2 786.76	4.186	0.0001
PPR	1	−253 550.000	86 197.66	−2.941	0.0037
PFAT	1	−177 722.000	38 064.85	−4.669	0.0001
YINC	1	0.47064900	0.135713	3.468	0.0007
HHIZE	1	809.442	236.73	3.419	0.0008
AGEHR	1	36.325	31.54	1.152	0.2512
F-value		Prob $> F$	R-square	ADJ R-SQ	D-W D**
11.652		0.0001	0.2598	0.2375	2.105

Table 9
Pairwise elasticities of non-participants groups

Elasticity	Highest income quintile	All quintile
Protein demand elasticities		
Uncompensated		
Own-price	−0.640	−0.340
Cross-price	−0.210	−0.165
Compensated		
Own-price	−0.630	−0.330
Cross-price	−0.207	−0.163
Income elasticity 0.134 0.137		
Fat demand elasticities		
Uncompensated		
Own-price	−0.147	−0.104
Cross-price	−0.610	−0.330
Compensated		
Own-price	−0.145	−0.101
Cross-price	−0.600	−0.320
Income elasticity	0.129	0.176

0.137 for the non-participants. FFW participant's income response was much higher (74.45%) than non-participant's thereby indicating a more elastic protein demand for FFW participants.

Disaggregating the sample of the 172 non-participants' group into four quintiles, and subtracting the higher income group (fourth quintile), the effect of the higher income consumers on the overall consumption behavior can be identified. Hence, Table 9 was constructed in order to evaluate the significance of the higher income group on the protein and fat consumption behavior of the 172 non-participants households. On protein consumption, the highest income group was found to affect the own price elasticity of demand (protein demand with respect to fat price) by 26.99%, and the income elasticity of demand by 2.248%. The own and cross-price elasticities above refer to the net (compensated) elasticity estimates.

Similarly, on fat consumption, own, cross and income elasticities of the highest income group were estimated to be 30.34%, 46.67% and 36.43%, respectively. Therefore, the highest income non-participants' group reveals the following consumption characteristics: (a) significantly more consumption of protein with respect to its own price than fat; (b) significantly less consumption of protein with respect to fat price changes than the opposite; and (c) significantly more sensitivity of fat consumption with respect to income changes than the corresponding protein consumption with respect to income changes.

6. Summary and conclusions

FFW was found to make a significant nutritional contribution to participants. Properly designed FFW projects can have an essential nutritional impact by gradually introducing important nutritional food items (such as vegetable oil).

Both research hypotheses were supported by the results of the analysis. Participants showed a different demand structure and, hence, different consumption behavior than the non-participants. The marginal propensity to spend (MPS) on protein for FFW participants was 0.0148, almost double the respective MPS for the non-participants of 0.0078. The income elasticity of demand for protein was 0.239 for the FFW participants and 0.137 for the non-participants, reflecting a similar greater magnitude for the participants.

Holding income level constant, the lowest income group of participants showed a particularly higher income elasticity of demand for nutrients. In other words, additional income earned in-kind (FFW food items) resulted in a higher proportion of food being consumed as compared to the amount of food that would have been consumed out of an equivalent amount of net cash earnings (payment-in-cash).

One reasonable explanation for this behavior is the high local transportation and transfer costs, along with lack of sufficient local market structures. Such high transaction costs may reduce significantly the actual cash value of the received commodities (FFW). Thus, participants consumed more food items instead of exchanging them in regional (local) markets since the effective price of the food items is substantially less and may be essentially zero given the transaction costs involved. In addition, the greater amount of food items available at the household unit may have been distributed in a different manner compared to cash income because the decision-making process of the household may be different in the case of food distribution rather than cash income spending. [2]

In summary, significant nutritional gains occurred to the benefit of FFW participants via food transfers as compared to an equivalent net income transfer to the participant households. FFW participants revealed 90% higher propensity to spend on nutrients (protein). Reutlinger (1983) emphasized the necessity of evaluating Project Food Aid (i.e. such as FFW projects) on the grounds of the transferred income per dollar of project cost rather than on nutritional grounds (as, for example, provided calories per dollar of cost). The results of this study bring into serious question such arguments and indicate the value of assessing the nutritional impact of food aid. Even though participants may prefer cash payment to food transfers, their household nutritional intake is much higher when commodities are given in exchange for labor.

Previous research (Bezuneh, 1985) showed that the lower income households experienced a significant income gains due to participants in FFW projects. This study, in addition, reveals that the poorest participant households' nutritional gains were higher by 32.46% than the gain by all participants.

[2] These are possible hypotheses (explanations) that will, perhaps, serve as a basis for future inquiries.

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