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Bethelhem Legesse Debela
Gerald E. Shively
Stein T. Holden

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Food for Work and Diet Diversity in Ethiopia[1]

Bethelhem Legesse Debela[a] (corresponding author)
bdebela@uni-goettingen.de
Tel: +49 551 39 20204
Fax: +49 551 39 20203

Gerald E. Shively[b]
shivelyg@purdue.edu

Stein T. Holden[c]
stein.holden@nmbu.no

[a]Department of Agricultural Economics and Rural Development, University of Goettingen, Heinrich-Dueker-Weg 12, 37073 Goettingen, Germany

[b]Department of Agricultural Economics and Purdue Policy Research Institute, Purdue University, 403 West State Street, West Lafayette, IN 47907-2056, USA

[c]School of Economics and Business, Norwegian University of Life Sciences, P.O. Box 5003,1432 Ås, Norway

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Abstract

We use four waves of panel data from Northern Ethiopia to investigate the link between Food for Work (FFW) participation and the diversity of food consumption and production. Food-based transfer programs have become a standard tool for addressing the problem of chronic food insecurity in developing countries. Such programs have the potential to expand diet diversity if food items provided under FFW are not part of the beneficiaries' staple diet. By raising effective incomes, cash payments also have the potential to "crowd in" purchases of nutritionally important foods. On the other hand, FFW programs have the potential to undermine dietary diversity by altering the basic crop mix if participation requires households to divert labor away from on-farm production. The net effect is unclear, which we empirically investigate in this study. By employing random effects, fixed effects and difference-in-difference estimations, we find that FFW participants had greater dietary diversity compared to non-participants, with an average effect magnitude equivalent to one-fifth of a standard deviation in the food variety score. When items directly provided by the FFW program are excluded from the variety score, the overall effect is statistically weaker, but similar in sign and magnitude, suggesting modest "crowding in" of diet diversity from FFW participation. Findings also reveal that higher intensity of participation in FFW is linked with diversified food consumption. We find no evidence that FFW participation led to changes in production diversity, suggesting that FFW programs may not be competing for labor with on farm production. Findings have relevance for interventions that aim to improve food security and promote dietary quality in low-income populations.

Keywords: diet diversity; Ethiopia; food for work; food security; nutrition
JEL Codes: I38, Q12.

1. Introduction

Do Food for Work (FFW) programs affect diet and production diversity in participating households? The question is important because food-based transfer programs have become a standard tool for addressing the problem of chronic food insecurity in low-income settings (Alderman and Mustafa, 2013). By engaging beneficiaries in building up community infrastructure in exchange for food or cash, Food for Work programs have become especially attractive to donors and recipients (Rogers and Coates, 2002). In theory, such programs have the potential to expand dietary diversity, especially if the food items provided by the program are not otherwise part of the staple diet. Further, consumption of additional varieties of food items also is possible if FFW frees up spending that would have been used to purchase food items provided under the program. By raising effective incomes, cash payments also have the potential to "crowd in" purchases of nutritionally important foods (Bailey, 2013; Burchi et al., 2016; de Groot et al., 2017). For these reasons, ongoing participation in a FFW program has the potential to improve the nutritional status of household members, especially women and children (Nair et al., 2016). At the same time, however, if FFW participation requires a household to divert labor away from on-farm production, such programs have the potential to undermine dietary diversity by altering the basic crop mix, especially if labor is withdrawn from non-staple food production.[2] The extent to which opposing effects are at play is unclear. In this paper, we examine the empirical evidence regarding both.

We focus on Ethiopia, where recurrent droughts and chronic food insecurity have resulted in more than two decades of food assistance and FFW interventions (Jayne et al.,

[2] Nutrition effects aside, Barrett et al. (2005) argue that these programs have reduced labor supply to agriculture and off-farm activities in Ethiopia, as well as reduced incentives to invest in agriculture. Gelan (2007) also finds a decline in local food production in conjunction with FFW. In contrast, Abdulai et al. (2005) and Bezu and Holden (2008) uncover no strong evidence of FFW disincentives for agricultural production, and Tadesse and Shively (2009) find modest downward pressure on local food prices.

2001; Caeyers and Dercon, 2012). Since 2005, FFW programs in Ethiopia have been administered mainly as part of the country's Productive Safety Net Program (PSNP) (after 2005), a larger and more comprehensive social protection program designed to reach more than five million chronically food insecure individuals. A large proportion of beneficiaries receive cash transfers in exchange for work on public work projects. A smaller proportion (10-15 percent, mostly elderly or disabled individuals or pregnant women) receives unconditional transfers.

A number of previous studies have attempted to measure the dietary effects of the PSNP, but findings have been mixed. Berlie (2014) found PSNP beneficiaries in Amhara to have lower dietary diversity than non-beneficiaries. Using four regions in Ethiopia, Berhane et al. (2011) carried out an impact evaluation of the public work payments from PSNP and finds that longer payment periods do not have an impact on the diet diversity of beneficiaries. In both cases, however, researchers were unable to completely control for underlying and pre-existing differences between participants and non-participants due to shortcomings in data and study design. Uraguchi (2011) found that income transfer programs (both FFW and the PSNP more generally) had limited effects on food security in Tigray and Amhara. However, the author did not look at the direct effect on dietary diversity but rather used a dietary diversity score and a coping strategy index to classify households as food secure and insecure. Elsewhere in Africa, a social cash transfer pilot scheme in Malawi (Miller et al., 2011) and the Child Grant Program in Zambia (American Institutes for Research, 2013) were found to improve household dietary diversity. Merttens et al. (2013) find that Hunger safety net program in Kenya only improved the diet diversity of the poorer households and no impact was observed for the overall beneficiaries of the program. Research on transfers from Latin American countries suggests the potential for positive impacts. For example, Hoddinott and

Wiesmann, (2008) found diet quality to be higher among transfer beneficiaries in Honduras, Mexico and Nicaragua than among non-beneficiaries, with the largest nutritional gains accruing to the poorest households. Similarly, Ahmed et al. (1995) found higher calorie acquisition among FFW beneficiaries in Bangladesh, and Hoddinot and Skoufias (2004) found caloric gains among PROGRESA beneficiaries in Mexico.

Here, we make two contributions. First, we provide new evidence for Ethiopia, making use of four waves of panel data including periods prior to the start of the PSNP. While rigorous studies of dietary diversity effects of conditional transfer programs have been conducted in Latin America, the record for Africa is incomplete, and evidence for Ethiopia is based mainly on cross sectional data. Our use of panel data allows us to control for household fixed effects and thereby get closer to an accurate estimate of project impact than previous attempts. Second, we study the implications of a Food for Work program on production diversity. We are not aware of any study to date that measures the connection between FFW programs and production diversity, which is somewhat surprising given that a major requirement of all such programs is that beneficiary households provide labor to local projects, in some cases diverting individuals from other productive activities.

2. Study Context and Data

2.1. Food for Work programs in Ethiopia

Ethiopia is one of the largest recipients of food aid, taking 20-30 percent of all food aid delivered to Sub-Saharan Africa (Bezu and Holden, 2008; Asfaw et al., 2011; Caeyers and Dercon, 2012). Food aid programs in Ethiopia started in the early 1970s (Uraguchi, 2011), and have traditionally been delivered as free food, with the major portion (80%) delivered via Food for Work programs (Jayne et al., 2001; Caeyers and Dercon, 2012). Able-bodied

household members in FFW participant households are eligible to take part in community development activities. These include construction of dams, roads and conservation structures. In return, participants receive either food (typically wheat and oil) or cash, generally at levels that equate to a sub-market wage rate (Bezu and Holden, 2008).

Persistent food shortages and an increase in the number of chronically food insecure households (Nega et al., 2010; Rahmato et al., 2013) led donors and the government of Ethiopia to launch the Productive Safety Net Program (PSNP) in 2005. The main goal of the PSNP is to provide a long-term support for chronically food insecure households by providing assistance for a predictable period. Similar to earlier food aid programs, the PSNP includes Food for Work, Cash for Work and unconditional free food.

2.2. Data

Our data come from surveys conducted in 2001, 2003, 2006 and 2010 for a panel of households in the highlands of Tigray region, Northern Ethiopia. The initial sample consisted of 400 households from 16 villages, 25 from each village, surveyed in 1998. Households were selected using stratified random sampling. Sample villages are representative of population density, market access, agro-climatic conditions and agricultural potential (Hagos and Holden, 2002). Follow up surveys were carried out in 2001, 2003, 2006 and 2010. These four waves provide the data used for this analysis. The surveys in each round used household and village questionnaires to gather information. Topics covered in the household questionnaire included household characteristics; food consumption; crop and livestock production; land and non-land asset ownership; livestock and crop sales; off-farm income; Food for Work participation and PSNP membership. PSNP membership status was collected in the 2010 survey round. For purposes of this paper, Food for Work participation refers to participation in any public work

project that resulted in a household receiving food, cash, or some combination of the two. In one subset of analysis however we classify households that receive food only, cash only or the combination of food and cash. Our dataset consists of an unbalanced sample of 1,436 observations – consisting of 344 households for 2001 and 2003, 317 households for 2006 and 431 households for 2010.

2.3. Construction of Dietary Diversity

We measure a household's dietary diversity using recall data on food consumption observed at the household level. We use a set of 29 food items that were consistently defined and reported across all survey rounds. Respondents (mainly the household head or spouse) reported the amount of food items consumed in the previous year based on a list of prompted food items. For each household, we compute a food variety score (FVS) as a simple unweighted count of the number of different food items reported as being consumed by the household in the previous year.[3] We use the FVS to compare dietary diversity in participant and non-participant households. Using this count of food items, rather than a count of food groups, allows us to test whether results are sensitive to the inclusion of items (primarily wheat and oil) provided directly by the Food for Work program. To examine the diversity of food items, we follow FAO (2011) and aggregate the 29 food items into nine food groups (cereals; legumes, nuts and seeds; vegetables; meat; eggs; milk; oil and fats; sweets; spices and condiments). We then generate food group shares for each food group. For example, to calculate share of cereals consumed, we divide the number of cereal items consumed by the total number of all food items consumed. Table 1 summarizes dietary diversity in the sample,

[3] Although annual recall data may lead to underreporting of some food items (Ruel, 2002), using annual reported consumption to generate the FVS allows us to control for seasonality in food consumption. For Ethiopia, this is useful because fasting is widely observed during some periods of the calendar, during which households avoid animal products (meat, eggs, milk).

including the average number of food items in each food group (mean=14.4; stddev=3.9; min=1; max=25) and average shares for each food group for each survey year. Average diet diversity is similar across survey years, except for a slightly lower value observed in 2003, probably because 2003 was a drought year. As one would expect, the largest diet share corresponds to cereals (mean=0.24 ; stddev=0.09; min=0; max=1).

2.4. Construction of Production Diversity

We measure production diversity by counting the number of crops cultivated annually. We classify each crop into one of five food groups (cereals; legumes, nuts and seeds; vegetables; fruits; and spices). We then compute the production share for each food groups, using as our denominator the total number of crops cultivated. In Table 2, we present production diversity, the number of crops in each food group, and the share of food groups observed in each survey round. In the latter case, for example, the share of cultivated vegetables would be equivalent to the number of distinct vegetables produced divided by the total number of crops cultivated. On average, a household produced three different crops, with cereals constituting the largest share (0.88). The maximum number of crops cultivated was seven. As with consumption diversity, production diversity in 2003 was lower than in other years, reflecting the influence of the drought.

Table 1 Dietary diversity in each survey round

	All	Min	Max	2001	2003	2006	2010
Food variety score (FVS)	14.35	1	25	14.51	12.89	14.62	15.20
	(3.93)			(4.05)	(4.10)	(3.59)	(3.60)
Number of items in food groups							
Cereals [a]	3.25	0	6	3.33	2.99	3.60	3.15
	(1.13)			(1.11)	(1.09)	(1.22)	(1.04)
Legumes, nuts and seeds [b]	1.47	0	6	1.86	1.19	1.36	1.46
	(1.00)			(1.08)	(0.89)	(1.05)	(0.87)
Vegetables [c]	2.10	0	4	1.72	1.46	2.50	2.61
	(1.20)			(1.16)	(1.13)	(0.96)	(1.09)
Meat [d]	1.91	0	4	1.85	1.82	1.88	2.04
	(0.81)			(0.79)	(0.84)	(0.83)	(0.75)
Eggs	0.40	0	1	0.40	0.28	0.41	0.48
	(0.50)			(0.49)	(0.45)	(0.49)	(0.50)
Milk	0.15	0	1	0.14	0.06	0.16	0.21
	(0.35)			(0.35)	(0.25)	(0.37)	(0.41)
Oil and fats [e]	1.26	0	2	1.38	1.09	1.32	1.26
	(0.65)			(0.71)	(0.75)	(0.60)	(0.51)
Sweets [f]	0.57	0	1	0.72	0.79	0.03	0.68
	(0.49)			(0.45)	(0.41)	(0.17)	(0.47)
Spices and condiments [g]	3.24	0	4	3.11	3.20	3.34	3.32
	(0.81)			(0.78)	(0.81)	(0.82)	(0.80)
Proteins (0/1 for consumption of eggs, meat or milk)	0.94	0	1	0.93	0.92	0.95	0.97
	(0.23)			(0.25)	(0.26)	(0.23)	(0.18)
Share of Food Groups							
Share of Cereals	0.24	0	1	0.24	0.25	0.25	0.21
	(0.09)			(0.09)	(0.12)	(0.09)	(0.07)
Share of legumes, nuts and seeds	0.10	0	0.50	0.13	0.09	0.09	0.09
	(0.06)			(0.07)	(0.01)	(0.06)	(0.05)
Share of vegetables	0.14	0	0.38	0.11	0.10	0.17	0.17
	(0.07)			(0.07)	(0.07)	(0.06)	(0.06)
Share of meat	0.13	0	0.44	0.13	0.14	0.13	0.13
	(0.05)			(0.05)	(0.06)	(0.05)	(0.05)
Share of eggs	0.02	0	0.14	0.02	0.02	0.02	0.03
	(0.03)			(0.03)	(0.03)	(0.03)	(0.03)
Share of milk	0.01	0	0.14	0.01	0.004	0.01	0.01
	(0.02)			(0.02)	(0.01)	(0.02)	(0.02)
Share of oil and fats	0.09	0	0.33	0.09	0.08	0.09	0.08
	(0.04)			(0.05)	(0.05)	(0.04)	(0.04)
Share of sweets	0.04	0	0.20	0.05	0.06	0.002	0.04
	(0.04)			(0.03)	(0.04)	(0.01)	(0.03)
Share of spices and condiments	0.23	0	0.50	0.22	0.26	0.24	0.22
	(0.07)			(0.06)	(0.07)	(0.07)	(0.06)
Number of observations	**1436**			**344**	**344**	**317**	**431**

Note: Standard deviations in parentheses [a]Teff, wheat, barely, maize, sorghum, millet [b]Favabean, chickpea, pea, lentil, latyrus [c] Cabbage, onion, tomato, garlic [d] Beef, sheep, goat, chicken [e] oil and butter [f] Sugar [g] Pepper, coffee, spice, salt.

Table 2. Production diversity in each survey round

	Mean	Min	Max	2001	2003	2006	2010
Production diversity	2.63	0	7	2.71	2.41	2.73	2.67
(number of crops)	(1.17)			(1.13)	(1.12)	(1.30)	(1.11)
Number of crops in food groups							
Cereals [a]	2.22	0	5	2.31	2.03	2.37	2.18
	(0.92)			(0.90)	(0.86)	(1.00)	(0.88)
Legumes, nuts and seeds [b]	0.33	0	3	0.30	0.33	0.30	0.37
	(0.55)			(0.53)	(0.57)	(0.54)	(0.57)
Vegetables [c]	0.06	0	1	0.03	0.04	0.04	0.10
	(0.23)			(0.16)	(0.19)	(0.20)	(0.31)
Fruits [d]	0.003	0	1	0.003	0.01	0.003	0.002
	(0.06)			(0.05)	(0.08)	(0.06)	(0.05)
Spices [e]	0.03	0	1	0.07	0.01	0.01	0.01
	(0.16)			(0.26)	(0.11)	(0.11)	(0.11)
Share of Food Groups							
Share of cereals	0.88	0	1	0.88	0.88	0.91	0.85
	(0.20)			(0.19)	0.20	(0.17)	(0.21)
Share of legumes, nuts and seeds	0.10	0	1	0.09	0.10	0.08	0.12
	(0.17)			(0.16)	(0.19)	(0.14)	(0.19)
Share of vegetables	0.02	0	1	0.01	0.01	0.01	0.03
	(0.08)			(0.05)	(0.08)	(0.07)	(0.09)
Share of fruits	0.001	0	0.25	0.001	0.001	0.001	0.0004
	(0.01)			(0.01)	(0.01)	(0.01)	(0.01)
Share of spices	0.01	0	1	0.02	0.003	0.003	0.003
	(0.05)			0.09	(0.03)	(0.03)	(0.02)
Number of observations	1436			344	344	317	431

[a] Teff, wheat, barely, maize, sorghum, millet [b] Legumes, nuts and seeds: fieldpea, bean, linseed, lentil [c] Onion [d] Papaya [e] Pepper

3. Empirical Strategy

Our goal is to estimate the influence of Food for Work participation on diversity in food consumption and production. We use panel data methods to run two sets of regressions, one each for dietary diversity (Model 1) and production diversity (Model 2). The regressions take the form:

$$DD_{it} = \beta_0 + \beta_1' \mathbf{X}_{it} + \beta_2' \mathbf{A}_{it} + \beta_3 FFW_{it} + \beta_4' \mathbf{T} + a_i + \varepsilon_{it} \quad (1)$$

$$PD_{it} = \beta_0 + \beta_1' \boldsymbol{X}_{it} + \beta_2' \mathbf{A}_{it} + \beta_3 FFW_{it} + \beta_4' \mathbf{T} + a_i + \varepsilon_{it} \quad (2)$$

where in equations (1) and (2), DD_{it} and PD_{it} represent dietary diversity and production diversity for household *i* at time *t*, respectively. $\mathbf{X}_{it}$ represents a vector of household characteristics (age, sex and education of the household head; the number of children, the number of adult females and males; and an indicator for participation in off farm activities), $\mathbf{A}_{it}$ denotes asset indicators (land area owned and livestock ownership), FFW_{it} is a binary indicator for participation in Food for Work or Cash for Work programs, $\mathbf{T}$ is a vector of survey year indicators, and ε_{it} represents an idiosyncratic error with expected value of zero.

We check whether a random effects or fixed effects estimator provides a better approach to our data using the Hausman test. The test indicates that differences in the coefficients between the two specifications are systematic. We therefore use household fixed effects to control for time invariant unobserved heterogeneity. In equations (1) and (2) a_i is a time invariant unobserved effect, which is differenced out when performing fixed effects estimation.

Over the survey years, it is possible that households switch in and out of the FFW program. To account for this, we additionally estimate a model using a Difference-in-Difference (DID) method, taking the first differences of the dependent and independent variables. This allows us to eliminate the unobserved effect, a_i, by differencing adjacent periods (Wooldridge, 2009). The model takes the following form:

$$\Delta DD_{it} = \beta_0 + \beta_1'\Delta\mathbf{X}_{it} + \beta_2'\Delta\mathbf{A}_{it} + \beta_3\Delta FFW_{it} + \beta_4'\mathbf{T} + \Delta\varepsilon_{it} \quad (3)$$

$$\Delta PD_{it} = \beta_0 + \beta_1'\Delta\boldsymbol{X}_{it} + \beta_2'\Delta\mathbf{A}_{it} + \beta_3\Delta FFW_{it} + \beta_4'\mathbf{T} + \Delta\varepsilon_{it} \quad (4)$$

where t=2003, 2006 and 2010. Values in 2001 are missing since first set of difference is taken between 2003 and 2001.$\mathbf{T}$ in equations (3) and (4) control for years 2006 and 2010.

To assess whether results change when we exclude food items provided under the FFW program, we estimate a variant of equation (1) that excludes FFW items (wheat and oil)

from the calculation of dietary diversity. The effect of public works programs on consumption depends on the form of transfer, i.e., food or cash (Bailey, 2013). With the aim to examine if difference exists in the estimated impacts among food (FFW) and cash (CFW) beneficiaries, we replicate the estimations by controlling for these groups (FFW only, CFW only and combination of FFW and CFW).

In order to investigate whether the intensity of participation determines the effect on diet diversity, we use the monetary equivalent of the public work benefits in fixed and random effects estimations. Further, we employ control function approach which involves first stage random effects Tobit model and second stage random effects model. Since we include generated residual term in the second stage, we use bootstrapped standard error with 400 replications. As a robustness check, we fit a dose-response model (Cerulli, 2015) that estimates a control function regression using ordinary least squares and examine the relation between FFW income and dietary diversity.

The issue of endogeneity is a major stumbling block in such a program evaluation due to the potential existence of unobserved heterogeneity. We attempt to control for this by using fixed effects estimation in both the binary and continuous treatments. Further, we use DID approach for the binary treatment of FFW participation. In the case of continuous treatment, we employ control function approach rather than DID, since FFW income is censored from below.

4. Results

4.1. Descriptive Results

Table 3 presents descriptive statistics for all variables used in the analysis, separately by Food for Work participation status. Of the 1436 household-observations, 760 (roughly 50 percent) participated in Food for Work programs. Characteristics of households in the two groups differ significantly. Participants own larger parcels of land and more livestock, and have higher labor endowments (of both female and male labor). This is in line with the requirements for participating in the work force programs. Our empirical analysis controls for these potentially confounding factors when estimating the effect of FFW participation on consumption and production diversity.

In Table 4, we report tests for differences in average food variety and production diversity scores by FFW participation. FFW participants consume a significantly higher variety of foods compared to the non-participants. When disaggregating FFW participation by survey year, it seems that the difference in the food variety score is driven mostly by changes in 2006 and 2010. On the other hand, we find no overall significant difference in production diversity between FFW participants and non-participants, except for a slight difference in the year 2001. Figures 1 and 2 illustrate these patterns. The distribution of the food variety score is shifted to the right for participants compared to non-participants (Figure 1) while participants and non-participants exhibit similar production diversity (Figure 2).

Table 3. Descriptive statistics

	All years			2001		2003		2006		2010	
	Mean	FFW=1	FFW=0	FFW=1	FFW=0	FFW=1	FFW=0	FFW=1	FFW=0	FFW=1	FFW=0
Age of household head (years)	54.05	53.0	55.27***	50.9	55.5***	55.3	51.6**	53.79	56.60*	52.3	56.7***
	(14.58)										
Female headed household	0.28	0.25	0.32***	0.22	0.35***	0.34	0.22**	0.21	0.39***	0.23	0.31*
(0/1)	(0.45)										
Education of head (0/1)	0.31	0.32	0.30	0.38	0.29*	0.31	0.37	0.36	0.28	0.25	0.26
	(0.46)										
Adult female labor (#)	1.36	1.48	1.24***	1.49	1.13***	1.33	1.31	1.59	1.20***	1.52	1.28***
	(0.85)										
Adult male labor (#)	1.39	1.51	1.24***	1.52	1.23**	1.33	1.37	1.72	1.08***	1.52	1.27**
	(1.13)										
Children (#)	2.10	2.31	1.86***	2.75	1.93***	2.19	2.52*	1.88	1.26***	2.33	1.79***
	(1.61)										
Land area owned (Tsimdi) [a]	4.61	4.39	4.85**	4.45	4.65	4.63	4.99	4.35	4.58	4.15	5.07***
	(3.40)										
Livestock (TLUs) [b]	3.17	2.98	3.38**	4.13	4.35	2.19	3.21***	2.74	2.57	2.78	3.46**
	(3.31)										
Off-farm income (0/1)	0.49	0.52	0.47**	0.77	0.76	0.53	0.18***	0.41	0.48	0.36	0.46**
	(0.50)										
Number of observations	1436	760	676	202	142	190	154	156	161	212	219

[a] 1 Tsimdi=0.25 hectare; [b] Tropical Livestock Units (calculated based on Ayalew et al., 2003)

Table 4. Dietary diversity and production diversity by Food for Work participation

	Food variety score (FVS)	Production diversity score (PDS)	Number of observations
All years	14.35 (0.10)	2.63 (0.03)	1436
FFW=1	14.63 (0.13)	2.64 (0.04)	760
FFW=0	14.05 (0.16)	2.61 (0.05)	676
Diff	0.58***	0.04	
2001	14.51 (0.22)	2.71 (0.06)	344
FFW=1	14.74 (0.26)	2.80 (0.08)	202
FFW=0	14.18 (0.37)	2.59 (0.09)	142
Diff	0.56	0.21*	
2003	12.89 (0.22)	2.41 (0.06)	344
FFW=1	13.02 (0.28)	2.36 (0.08)	190
FFW=0	12.73 (0.34)	2.48 (0.09)	154
Diff	0.29	0.12	
2006	14.62 (0.20)	2.73 (0.07)	317
FFW=1	15.09 (0.23)	2.77 (0.10)	156
FFW=0	14.16 (0.33)	2.68 (0.11)	161
Diff	0.94**	0.09	
2010	15.20 (0.17)	2.67 (0.05)	431
FFW=1	15.61 (0.24)	2.66 (0.07)	212
FFW=0	14.81 (0.25)	2.66 (0.08)	219
Diff	0.80**	0.01	

Note: Standard errors in parentheses

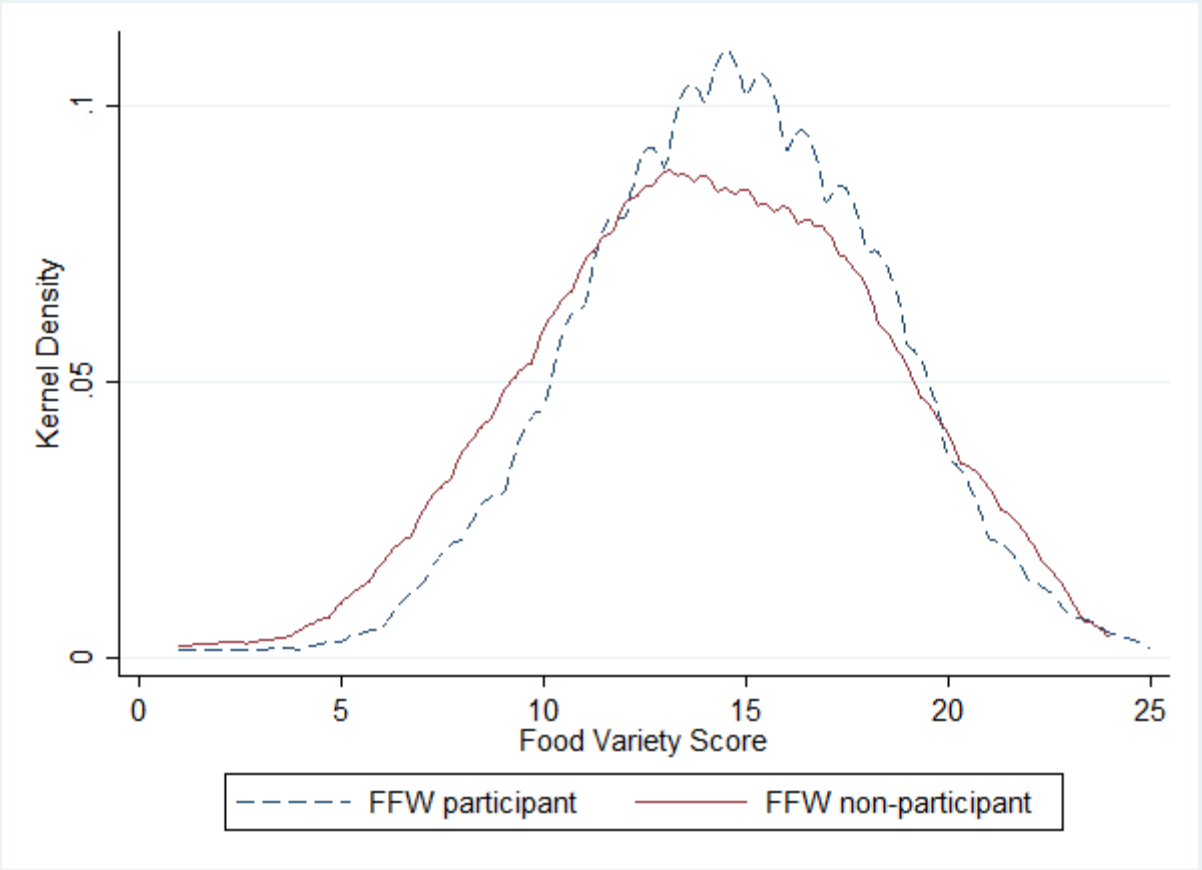

Figure 1. FFW participation and dietary diversity

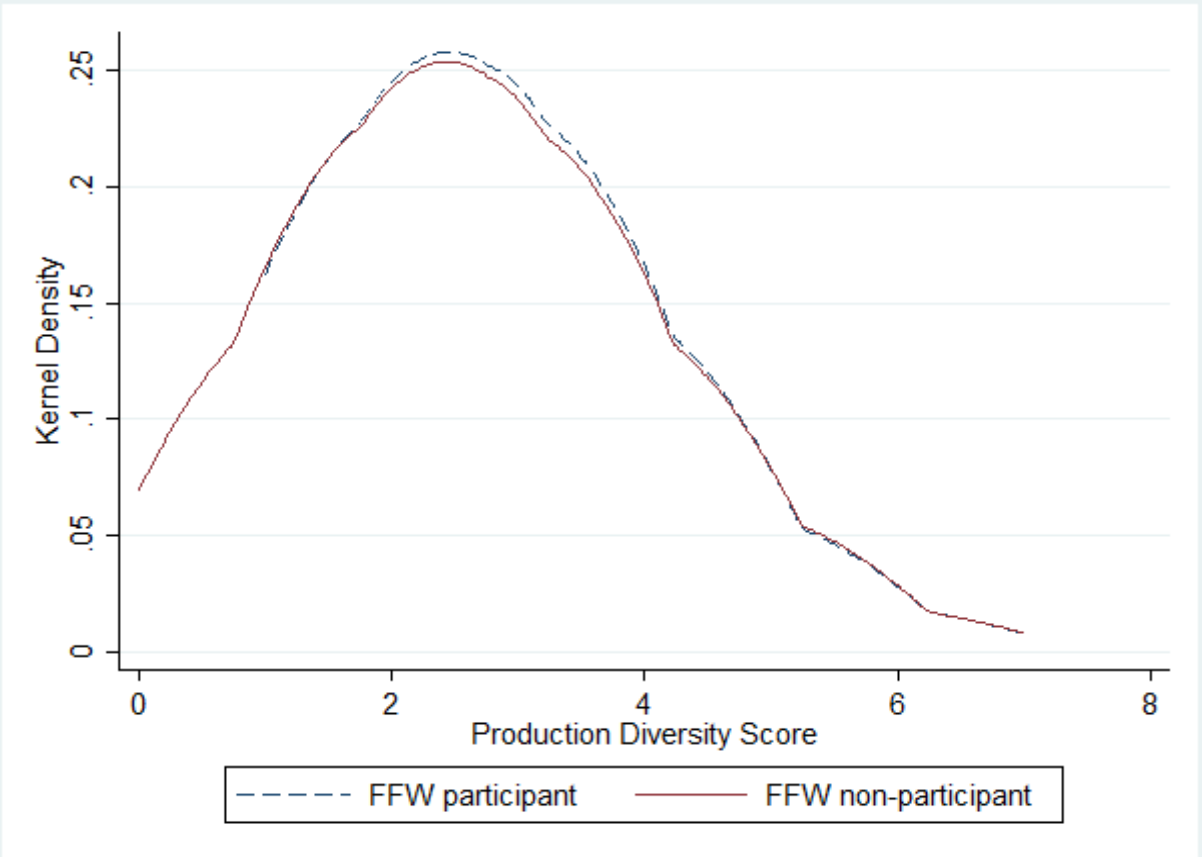

Figure 2. FFW participation and production diversity score

Table 5 further examines differences in dietary and production diversity among participant and non-participant households by asset wealth quintile. The wealth quintile was generated based on wealth index for land and livestock ownership which was constructed using principal component analysis. The largest difference in food variety score between FFW participant and non-participants is observed in the lowest wealth quintile. As one moves from the lowest to the middle wealth quintile, the difference declines and then disappears in the fourth and highest wealth quintile. On the other hand, significant differences in production diversity do not exist in all wealth quintiles.

Table 5. Difference in dietary and production diversity by asset wealth quintile

Asset wealth quintiles	Food variety score (FVS)	Production diversity score (PDS)	Number of observations
Lowest	12.55 (0.23)	2.16 (0.06)	288
FFW=1	13.21 (0.30)	2.16 (0.08)	160
FFW=0	11.73 (0.35)	2.16 (0.10)	128
Diff	1.48***	0.01	
Second	13.39 (0.22)	2.54 (0.07)	288
FFW=1	13.91 (0.27)	2.62 (0.09)	156
FFW=0	12.78 (0.36)	2.45 (0.11)	132
Diff	1.13**	0.16	
Middle	14.60 (0.22)	2.65 (0.07)	286
FFW=1	14.99 (0.27)	2.72 (0.09)	154
FFW=0	14.14 (0.35)	2.58 (0.10)	132
Diff	0.86**	0.15	

Table 5 continued			
Fourth	15.18 (0.21)	2.82 (0.07)	287
FFW=1	15.31 (0.27)	2.81 (0.09)	162
FFW=0	15.02 (0.33)	2.82 (0.11)	125
Diff	0.29	- 0.02	
Highest	16.06 (0.22)	2.98 (0.07)	287
FFW=1	15.97 (0.34)	2.99 (0.07)	128
FFW=0	16.13 (0.28)	2.97 (0.09)	159
Diff	-0.16	0.02	

Note: Standard errors in parentheses. The asset wealth quintile was generated based on wealth index for land and livestock ownership which was constructed using principal component analysis.

4.2. Regression Results

Table 6 presents fixed effects, random effects and DID regression results for dietary diversity. We present both models for comparison but interpret results based on the fixed effects specification. Findings reveal that households participating in Food for Work programs have significantly higher dietary diversity compared to non-participants. Participation in FFW program is associated with a 0.86 point higher food variety score, on average, or roughly one additional item in a basket that averages 14 items (see Model 1B). This is equivalent to 22 percent of a standard deviation in the food variety score. Table 6 also reveals that dietary diversity is higher for households with an educated household head and in households with a larger number of children. Survey round indicators reveal that consumption diversity declined significantly in 2003 compared to 2001. Dietary diversity in subsequent years increased.

Table 6. Regression results for dietary diversity-Binary treatment

	Fixed effects		Random effects		DID[c]
	Model 1A	Model 1B	Model 1C	Model 1D	Model 1E
FFW participant (0/1)		0.86***		0.58***	0.67***
		(0.22)		(0.19)	(0.25)
Age of household head (years)	-0.02	-0.02	-0.02***	-0.02***	-0.05**
	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)
Female headed household (0/1)	-0.13	-0.18	-0.46*	-0.45	-0.28
	(0.47)	(0.47)	(0.28)	(0.28)	(0.49)
Education of head (0/1)	0.92**	0.92**	0.68***	0.69***	0.68
	(0.37)	(0.37)	(0.24)	(0.24)	(0.45)
Adult female labor (#)	0.33**	0.27	0.36***	0.32***	0.40*
	(0.17)	(0.16)	(0.12)	(0.12)	(0.20)
Adult male labor (#)	0.16	0.09	0.23**	0.20**	0.19
	(0.14)	(0.14)	(0.10)	(0.10)	(0.17)
Children (#)	0.22*	0.20*	0.17**	0.15**	0.27**
	(0.11)	(0.11)	(0.08)	(0.08)	(0.12)
Land area owned (Tsimdi) [b]	0.04	0.04	0.16***	0.16***	0.04
	(0.05)	(0.05)	(0.03)	(0.03)	(0.06)
Livestock owned (TLUs)	-0.01	0.00	0.13***	0.13***	-0.01
	(0.05)	(0.05)	(0.04)	(0.04)	(0.07)
Off-farm income (0/1)	0.25	0.19	0.38*	0.36*	0.22
	(0.24)	(0.23)	(0.20)	(0.19)	(0.26)
2003	-1.51***	-1.50***	-1.24***	-1.23***	
	(0.28)	(0.28)	(0.26)	(0.26)	
2006	0.49*	0.58**	0.67**	0.73***	3.61***
	(0.30)	(0.30)	(0.27)	(0.27)	(0.45)
2010	0.98***	1.09***	1.16***	1.22***	2.38***
	(0.29)	(0.29)	(0.26)	(0.26)	(0.44)
Region 2			-0.87***	-0.87***	
			(0.33)	(0.33)	
Region 3			-0.29	-0.29	
			(0.34)	(0.34)	
Region 4			-0.58*	-0.46	
			(0.34)	(0.34)	
Region 5			-1.51***	-1.42**	
			(0.58)	(0.58)	
Constant	14.02***	13.64***	13.34***	12.98***	-1.59***
	(1.09)	(1.08)	(0.68)	(0.69)	(0.31)
Number of households	1,436	1,436	1,436	1,436	915
Number of groups	521	521	521	521	372
R-squared (overall)	0.14	0.14	0.20	0.20	0.14

[a] Standard errors in parentheses [b] 1 Tsimdi=0.25 hectare; Hausman test (χ^2=31.8, p-value=0.003) [c] In DID model, standard errors are clustered by household ID

If households would not otherwise consume these items, improvements in dietary diversity may arise directly as a result of foods provided by the FFW program, namely wheat and oil. In Table 7, we report the fixed effects regression for FVS excluding the FFW food items in the calculation of FVS. Results indicate that participation in the public works still has a positive and significant effect on dietary diversity, although the magnitude of the effect declines by 0.17 points, or approximately 20 percent.

Table 8 summarizes results for tests of differences in the average number of food groups consumed with and without FFW food items. The significant difference in cereal consumption between FFW participants and non-participants disappears once wheat is excluded from the calculation. This implies that the difference in cereal consumption among FFW participants and non-participants is attributed to the wheat received under the FFW. Table 8 also shows that FFW participants had significantly higher consumption of other food items such as meat, butter, spices and condiments. One can infer from this that FFW participants were able to add other food items, possibly by reallocating expenditures that would have otherwise been used for food items provided under FFW. In an evaluation of pilot program of cash transfer in Tigray region, Berhane et al. (2015) find that the diversity of food consumed by beneficiaries improved as the program allowed them to purchase greater diversity of food items.

Table 7. Fixed effects regression for dietary diversity-with and without FFW food items (wheat and oil)

	With FFW food items	Without FFW food items
	Model 1A	Model 1F
FFW participant (0/1)	0.86***	0.69***
	(0.22)	(0.21)
Age of household head (years)	-0.02	-0.02
	(0.02)	(0.01)
Female headed household (0/1)	-0.18	-0.11
	(0.47)	(0.45)
Education of head (1/0)	0.92**	0.92***
	(0.37)	(0.35)
Adult female labor (#)	0.27	0.21
	(0.16)	(0.16)
Adult male labor (#)	0.09	0.08
	(0.14)	(0.14)
Children (#)	0.20*	0.17
	(0.11)	(0.11)
Land area owned (Tsimdi) [b]	0.04	0.03
	(0.05)	(0.05)
Livestock owned (TLUs)	0.00	0.01
	(0.05)	(0.05)
Off-farm income (1/0)	0.19	0.17
	(0.23)	(0.22)
2003	-1.50***	-1.83***
	(0.28)	(0.27)
2006	0.58**	0.15
	(0.30)	(0.28)
2010	1.09***	0.62**
	(0.29)	(0.28)
Constant	13.64***	12.52***
	(1.08)	(1.03)
Number of households	1,436	1,436
Number of groups	521	521
R-squared (overall)	0.14	0.13

[a] Standard errors in parentheses [b] 1 Tsimdi=0.25 hectare

Table 8. Food variety scores and shares of food types by FFW/CFW participation-With and without wheat and oil

	With wheat and oil				Without wheat and oil			
	All	FFW=1	FFW=0	Diff	All	FFW=1	FFW=0	Diff
Food variety score (FVS)	14.35	14.63	14.05	***	12.78	12.94	12.58	**
Number of items in each food groups or dummy for any								
Cereals[a]	3.25	3.33	3.17	***	2.48	2.48	2.47	
Legumes, nuts and seeds[b]	1.47	1.47	1.47		1.47	1.47	1.47	
Vegetables[c]	2.10	2.14	2.05		2.10	2.14	2.05	
Meat[d]	1.91	1.94	1.87	*	1.91	1.94	1.87	*
Eggs	0.40	0.41	0.38		0.40	0.41	0.38	
Milk	0.15	0.14	0.16		0.15	0.14	0.16	
Oil and fats[e]	1.26	1.32	1.19	***	0.47	0.51	0.43	***
Sweets[f]	0.57	0.59	0.56		0.57	0.59	0.56	
Spices and condiments[g]	3.24	3.29	3.20	**	3.24	3.29	3.20	**
Proteins (=1 for consumption of eggs, meat or milk)	0.94	0.96	0.93	**	0.94	0.95	0.93	*
Share of Food Groups								
Share of Cereals	0.24	0.23	0.24		0.20	0.19	0.20	**
Share of legumes, nuts & seeds	0.10	0.10	0.10		0.11	0.11	0.11	
Share of vegetables	0.14	0.14	0.14		0.16	0.16	0.16	
Share of meat	0.13	0.13	0.13		0.15	0.15	0.15	
Share of eggs	0.02	0.03	0.02		0.03	0.03	0.03	
Share of milk	0.01	0.01	0.01		0.01	0.01	0.01	
Share of oil and fats	0.09	0.09	0.08	***	0.03	0.04	0.03	***
Share of sweets	0.04	0.04	0.04		0.04	0.05	0.04	
Share of spices and condiments		0.23	0.24		0.27	0.26	0.27	
Number of observations	1436	760	676		1436	760	676	

Note: Standard deviations in parentheses [a]Teff, wheat, barely, maize, sorghum, millet [b]Favabean, chickpea, pea, lentil, latyrus [c] Cabbage, onion, tomato, garlic [d] Beef, sheep, goat, chicken [e] oil and butter [f] Sugar [g] Pepper, coffee, spice, salt

To further investigate the mechanism through which higher dietary diversity is observed among public work participants, we summarize the regression results in Table 9 that classify household based on whether they receive benefits under food-for-work, cash-for-work or both. Findings show that the benefit from food-for-work mainly contributes to the improved dietary diversity in FFW households. This however is not conclusive since cash-for-

work component of the public works program did not fully operate throughout the survey years but rather was increasing during the later survey years.

Table 9. Dietary diversity among participants of food-for-work versus cash-for-work programs

	FE	RE	DID[c]
	Model 1G	Model 1H	Model 1J
Food-for-work only (0/1)	0.99***	0.78***	0.80***
	(0.25)	(0.21)	(0.25)
Cash-for-work only (0/1)	0.43	-0.02	0.21
	(0.50)	(0.45)	(0.47)
Both food-and cash-for work (0/1)	0.41	-0.22	-0.89
	(0.52)	(0.42)	(0.74)
Age of household head (years)	-0.02	-0.02**	-0.05**
	(0.02)	(0.01)	(0.02)
Female headed household (0/1)	-0.12	-0.41	-0.23
	(0.47)	(0.28)	(0.50)
Education of head (0/1)	0.98***	0.72***	0.76*
	(0.37)	(0.24)	(0.45)
Adult female labor (#)	0.27*	0.33***	0.40*
	(0.17)	(0.12)	(0.20)
Adult male labor (#)	0.12	0.22**	0.21
	(0.15)	(0.10)	(0.17)
Children (#)	0.18	0.14*	0.23**
	(0.11)	(0.08)	(0.12)
Land area owned (Tsimdi)[b]	0.03	0.15***	0.03
	(0.05)	(0.03)	(0.06)
Livestock owned (TLUs)	0.01	0.14***	-0.01
	(0.05)	(0.04)	(0.07)
Off-farm income (0/1)	0.25	0.41**	0.28
	(0.23)	(0.19)	(0.26)
2003	-1.21***	-0.96***	
	(0.29)	(0.27)	
2006	0.66**	0.85***	3.17***
	(0.30)	(0.28)	(0.47)
2010	1.25***	1.46***	2.21***
	(0.31)	(0.27)	(0.43)
Regional dummies	No	Yes	No
Constant	13.33***	12.77***	-1.34***
	(1.09)	(0.70)	(0.32)
Number of households	1,436	1,436	915
Number of groups	521	521	372
R-squared (overall)	0.14	0.21	0.14

[a] Standard errors in parentheses [b] 1 Tsimdi=0.25 hectare [c] In DID model, standard errors are clustered by household ID ; [d] Classification of groups: 534, 65 and 89 participate in FFW only, CFW only and combination of FFW and CFW, respectively.

Table 10. Regression results for dietary diversity-continuous treatment

	FE	RE	RE Tobit-FFW income	CF-RE[c]
FFW income per adult equivalent (log)	0.14***	0.09**		0.66***
	(0.05)	(0.04)		(0.24)
Age of household head (years)	-0.02	-0.02***	-0.07***	0.02
	(0.02)	(0.01)	(0.01)	(0.02)
Female headed household (0/1)	-0.13	-0.43	-1.16***	0.23
	(0.47)	(0.28)	(0.37)	(0.41)
Education of head (1/0)	0.94**	0.72***	-0.77**	1.16***
	(0.37)	(0.24)	(0.32)	(0.29)
Adult female labor (#)	0.28*	0.35***	0.69***	-0.05
	(0.17)	(0.12)	(0.16)	(0.20)
Adult male labor (#)	0.12	0.22**	0.54***	-0.09
	(0.15)	(0.10)	(0.13)	(0.17)
Children (#)	0.20*	0.16**	0.23**	0.03
	(0.11)	(0.08)	(0.10)	(0.09)
Land area owned (Tsimdi)[b]	0.03	0.16***	-0.08	0.20***
	(0.05)	(0.03)	(0.05)	(0.04)
Livestock owned (TLUs)	0.00	0.13***	-0.10**	0.18***
	(0.05)	(0.04)	(0.05)	(0.05)
Off-farm income (0/1)	0.29	0.44**	-0.71**	0.85***
	(0.24)	(0.20)	(0.28)	(0.27)
2003	-1.33***	-1.12***	-2.89***	0.54
	(0.29)	(0.27)	(0.40)	(0.77)
2006	0.58*	0.73***	-0.96**	1.29***
	(0.30)	(0.27)	(0.39)	(0.39)
2010	1.02***	1.16***	-0.49	1.44***
	(0.29)	(0.26)	(0.37)	(0.32)
Region 2		-0.81**	-0.44	-0.55
		(0.33)	(0.40)	(0.34)
Region 3		-0.23	-0.36	-0.02
		(0.34)	(0.40)	(0.29)
Region 4		-0.42	-2.75***	1.16*
		(0.34)	(0.43)	(0.67)
Region 5		-1.47**	-2.55***	
		(0.58)	(0.81)	
CF with Tobit				-0.57**
				(0.23)
Constant	13.72***	12.90***	5.34***	9.84***
	(1.10)	(0.72)	(0.89)	(1.42)
Number of households	1,426	1,426	1,426	1,426
Number of groups	514	514	514	514
R-squared (overall)	0.14	0.20		0.20
Chi2 (P-value)			214.9(0.00)	

[a] Standard errors in parentheses [b] 1 Tsimdi=0.25 hectare [c] Standard errors bootstrapped with 400 replications

In Table 10, we present results for continuous treatment of FFW income on diet diversity. Results reveal that diet diversity increases with higher income from FFW. The magnitude of influence for the variants of the regressions is however small. The dose response model (Cerulli, 2015), which is summarized in Table 11 also shows a positive and significant average treatment effect equivalent to 0.42. This implies that FFW has on average a positive effect on food variety score when considering all values of FFW income. Dose response function plot in Figure 3 illustrates that FVS is weakly increasing as FFW income increases, especially at higher values of FFW income. The precision of estimation however declines at higher values of the treatment.

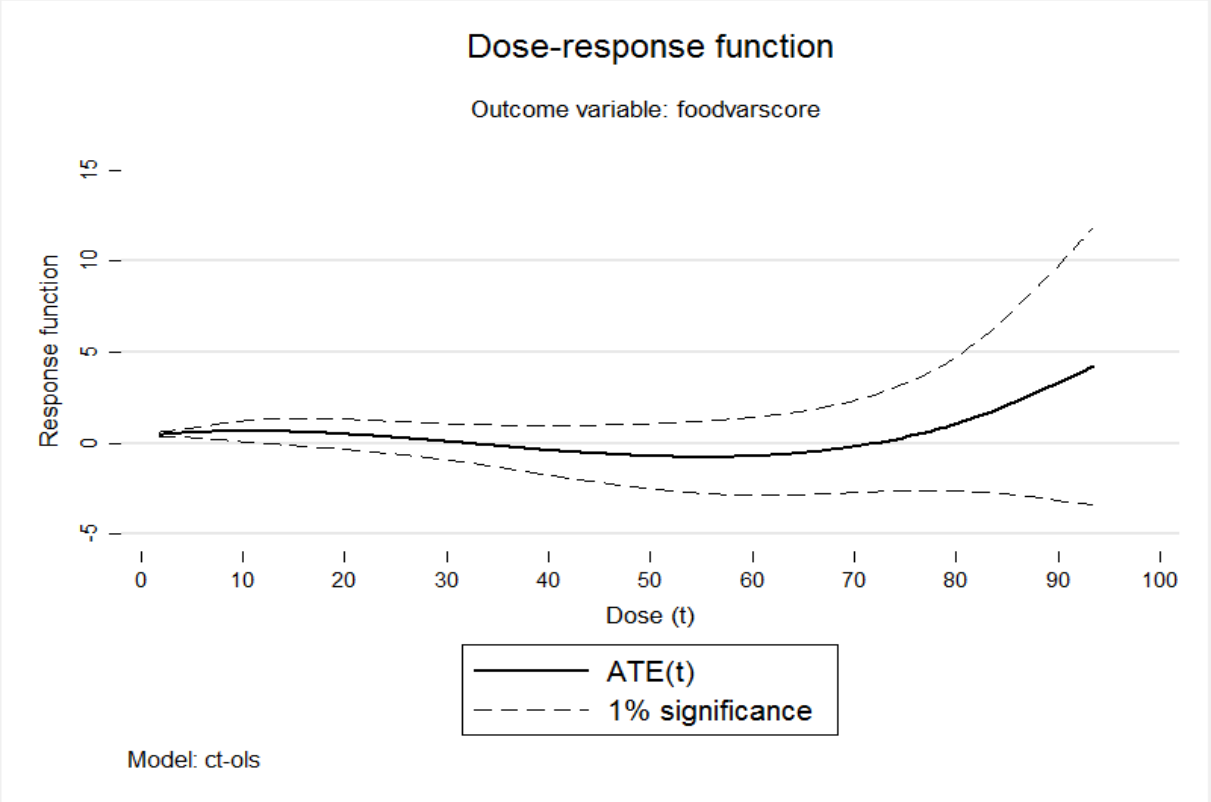

Figure 3. Dose response function of FFW income on food variety score-Continuous treatment effect (ctreatreg). Dose (t) represents FFW income per adult equivalent divided by 25, i.e., one unit represents 25 Ethiopian Birr per adult equivalent household size.

Table 12 summarizes the evidence regarding the link between FFW participation and production diversity. As before, the Hausman test points to fixed effects as the preferred specification. Results indicate that FFW participation has no significant association with production diversity. This implies that FFW has no measurable effect on households' cropping decisions, and provides indirect evidence that the FFW program is not likely displacing labor from on-farm agricultural production.

4.3. Robustness Checks

Our data consists of an unbalanced sample of households from four survey rounds. We assessed the robustness of the results by performing the analysis for the balanced sample. Findings show that major results are consistent and our conclusion remain the same (see Table A1).

In order to examine whether our results remain consistent when using alternative definitions of dietary diversity, we redefine the variable in two ways. First, we exclude food items that have low nutritional value (oil and fats; sweets; spices and condiments) from the FVS. Results indicate that FFW continues to affect dietary diversity, although the magnitude of the effect is smaller (see Table A2). Second, we redefine dietary diversity using food groups in the nine categories defined in Table 1. That is, we generate a binary indicator for each food group, with the indicator taking a value of 1 if a household consumed any food item in the food group. We then sum across groups to generate a dietary diversity score that ranges from 1-9. Regression patterns are similar under this alternative definition (see Table A3).

Table 12. FFW participation and production diversity

	Fixed effects		Random effects		DID[c]
	Model 2A	Model 2B	Model 2C	Model 2D	Model 2E
FFW participant (0/1)		0.03		0.01	-0.10*
		(0.08)		(0.06)	(0.05)
Age of household head (years)	-0.003	-0.003	0.003	0.003	-0.004
	(0.01)	(0.01)	(0.002)	(0.002)	(0.004)
Female headed household (0/1)	0.09	0.09	-0.04	-0.04	0.07
	(0.16)	(0.16)	(0.08)	(0.08)	(0.14)
Education of head (0/1)	0.05	0.05	0.15**	0.15**	-0.06
	(0.13)	(0.13)	(0.07)	(0.07)	(0.10)
Adult female labor (#)	-0.04	-0.04	0.03	0.03	-0.05
	(0.06)	(0.06)	(0.04)	(0.04)	(0.05)
Adult male labor (#)	0.03	0.03	0.04	0.04	0.01
	(0.05)	(0.05)	(0.03)	(0.03)	(0.04)
Children (#)	0.02	0.02	0.06***	0.06***	-0.02
	(0.04)	(0.04)	(0.02)	(0.02)	(0.03)
Land area owned (Tsimdi) [b]	0.08***	0.08***	0.04***	0.04***	0.05***
	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
Livestock owned (TLUs)	0.04**	0.04**	0.05***	0.05***	-0.01
	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
Off-farm income (0/1)	0.17**	0.17**	0.10	0.10	0.10*
	(0.08)	(0.08)	(0.06)	(0.06)	(0.06)
2003	-0.20**	-0.20**	-0.19**	-0.19**	
	(0.10)	(0.10)	(0.09)	(0.09)	
2006	0.13	0.13	0.16*	0.16*	0.32***
	(0.10)	(0.10)	(0.09)	(0.09)	(0.10)
2010	0.14	0.14	0.15*	0.15*	0.35***
	(0.10)	(0.10)	(0.09)	(0.09)	(0.09)
Region 2			0.01	0.01	
			(0.09)	(0.09)	
Region 3			0.29***	0.29***	
			(0.09)	(0.09)	
Region 4			0.04	0.04	
			(0.09)	(0.09)	
Region 5			-0.53***	-0.52***	
			(0.18)	(0.18)	
Constant	2.13***	2.12***	1.72***	1.72***	2.39***
	(0.37)	(0.38)	(0.20)	(0.21)	(0.07)
Number of households	1,436	1,436	1,436	1,436	915
Number of groups	521	521	521	521	372
R-squared (overall)	0.05	0.05	0.10	0.10	0.04

[a] Standard errors in parentheses [b] 1 Tsimdi=0.25 hectare; Hausman test (χ^2=27.0, p-value=0.01) [c] In DID model, standard errors are clustered by household ID

5. Conclusion

We study whether Ethiopia's FFW programs contribute to the variety in food consumption and crop production. Based on four waves of survey data (2001, 2003, 2006 and 2010), we find that participating in FFW programs improved dietary diversity. The effect remains positive but smaller in magnitude when we excluded food items provided by the FFW from the food variety score (FVS). Further disentangling the food groups consumed among participants and non-participants, results show that the observed difference in cereal consumption between the two groups disappears when we exclude wheat from the FVS calculation. An implication is that FFW improves dietary diversity when the food item is not part of the staple diet. We find that FFW slightly crowds in consumption of other food items. A policy implication is by providing food items that are not part of the staple diet as part of a safety net program not only assures food availability but also improves dietary diversity. Using a continuous treatment, findings also show that higher intensity of participation in FFW is associated with diversified food consumption. On the production side, findings reveal that FFW participation was uncorrelated with production diversity. This suggests that FFW programs may not be competing for labor with on farm production, at least not to the extent that households are making discernable changes in crop mix.

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Appendix

Table A1. Balanced sample regression results

	Dietary diversity		Production diversity	
	FE	DID[c]	FE	DID[c]
FFW participant (1/0)	0.98***	0.67**	0.04	-0.08
	(0.25)	(0.29)	(0.09)	(0.06)
Age of household head (years)	-0.02	-0.05*	-0.01	-0.01*
	(0.02)	(0.03)	(0.01)	(0.01)
Female headed household (0/1)	-0.17	-0.09	0.15	-0.01
	(0.55)	(0.57)	(0.19)	(0.14)
Education of head (1/0)	0.64	0.39	0.02	-0.06
	(0.42)	(0.52)	(0.15)	(0.10)
Adult female labor (#)	0.31	0.51**	-0.09	-0.02
	(0.19)	(0.26)	(0.07)	(0.05)
Adult male labor (#)	0.02	0.18	0.09	0.03
	(0.17)	(0.22)	(0.06)	(0.05)
Children (#)	0.20	0.34**	-0.02	-0.05
	(0.13)	(0.14)	(0.04)	(0.03)
Land area owned (Tsimdi)[b]	0.02	0.04	0.07***	0.03**
	(0.06)	(0.08)	(0.02)	(0.01)
Livestock owned (TLUs)	0.02	0.01	0.04*	0.00
	(0.06)	(0.08)	(0.02)	(0.02)
Off-farm income (0/1)	0.14	0.06	0.09	0.08
	(0.27)	(0.31)	(0.09)	(0.07)
2003	-1.60***		-0.34***	
	(0.33)		(0.11)	
2006	0.63*	3.93***	-0.04	0.21*
	(0.34)	(0.55)	(0.12)	(0.12)
2010	1.13***	2.09***	0.14	0.42***
	(0.33)	(0.48)	(0.11)	(0.10)
Constant	13.57***	-1.59***	2.64***	2.40***
	(1.23)	(0.35)	(0.42)	(0.08)
Number of households	876	657	876	657
Number of groups	219	219	219	219
R-squared (overall)	0.14	0.16	0.05	0.04

[a] Standard errors in parentheses [b]1 Tsimdi=0.25 hectare [c] In DID model, standard errors are clustered by household ID

Table A2. Fixed effects regression of dietary diversity excluding non-nutritious food

	Model A1-1	Model A1-2
FFW participant (0/1)		0.60***
		(0.17)
Age of household head (years)	-0.01	-0.01
	(0.01)	(0.01)
Female headed household (0/1)	0.02	-0.02
	(0.37)	(0.37)
Education of head (1/0)	0.73**	0.74**
	(0.29)	(0.29)
Adult female labor (#)	0.23*	0.19
	(0.13)	(0.13)
Adult male labor (#)	0.09	0.05
	(0.11)	(0.11)
Children (#)	0.16*	0.15*
	(0.09)	(0.09)
Land area owned (Tsimdi) [b]	0.01	0.01
	(0.04)	(0.04)
Livestock owned (TLUs)	0.02	0.03
	(0.04)	(0.04)
Off-farm income (0/1)	0.04	-0.00
	(0.18)	(0.18)
2003	-1.44***	-1.43***
	(0.22)	(0.22)
2006	0.91***	0.97***
	(0.23)	(0.23)
2010	0.74***	0.82***
	(0.23)	(0.23)
Constant	8.50***	8.23***
	(0.84)	(0.84)
Number of households	1,436	1,436
Number of groups	521	521
R-squared (overall)	0.16	0.15

[a] Standard errors in parentheses [b] 1 Tsimdi=0.25 hectare

[c] Non-nutritious food in this regression include oil and fats; sweets; spices and condiments.

Table A3. Fixed effects regression result using alternative definition-Dietary diversity score

	Model A2
FFW participant (0/1)	0.14*
	(0.08)
Age of household head (years)	-0.02***
	(0.01)
Female headed household (0/1)	0.02
	(0.16)
Education of head (1/0)	0.11
	(0.13)
Adult female labor (#)	0.11*
	(0.06)
Adult male labor (#)	0.03
	(0.05)
Children (#)	0.12***
	(0.04)
Land area owned (Tsimdi) [b]	0.02
	(0.02)
Livestock owned (TLUs)	0.01
	(0.02)
Off-farm income (0/1)	0.15*
	(0.08)
2003	-0.34***
	(0.10)
2006	-0.41***
	(0.10)
2010	0.54***
	(0.10)
Constant	6.93***
	(0.38)
Number of households	1,436
Number of groups	521
R-squared (overall)	0.14

[a] Standard errors in parentheses [b] 1 Tsimdi=0.25 hectare

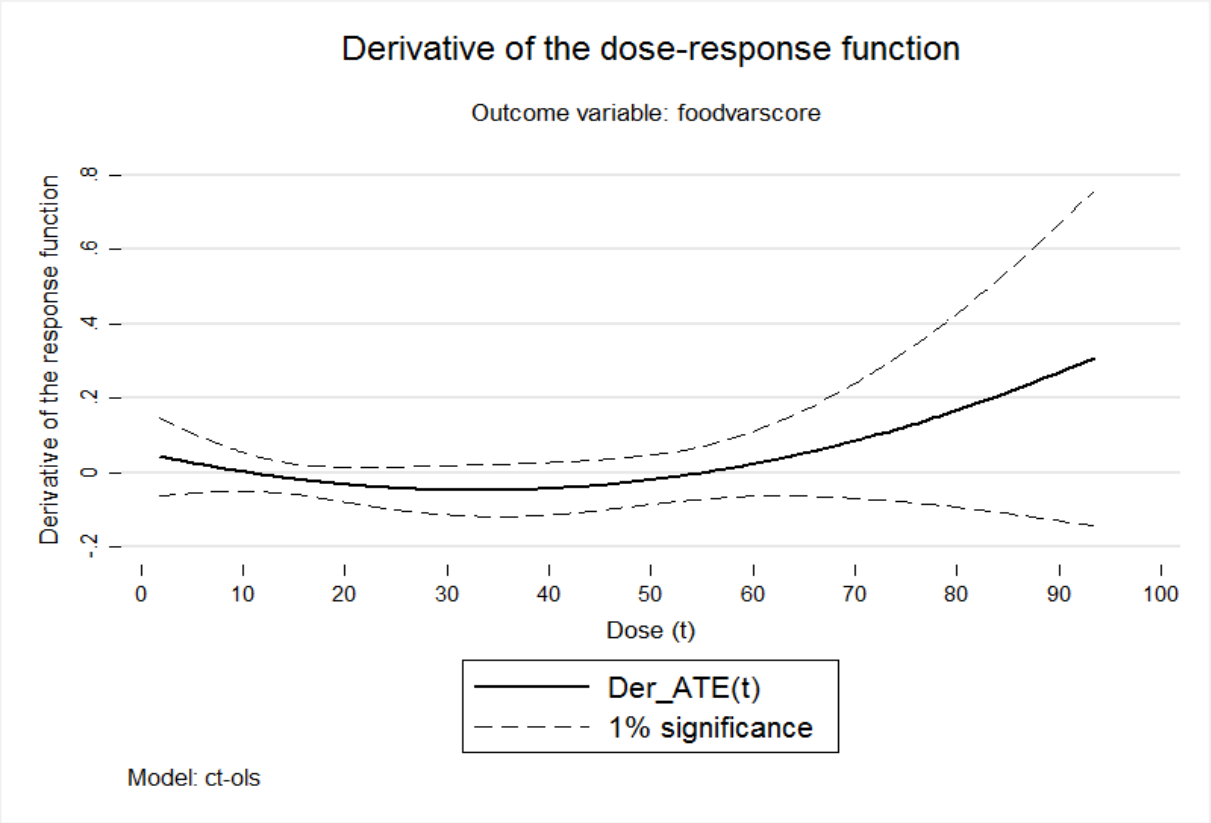

Figure A1. Derivative of dose response function of FFW income on food variety score

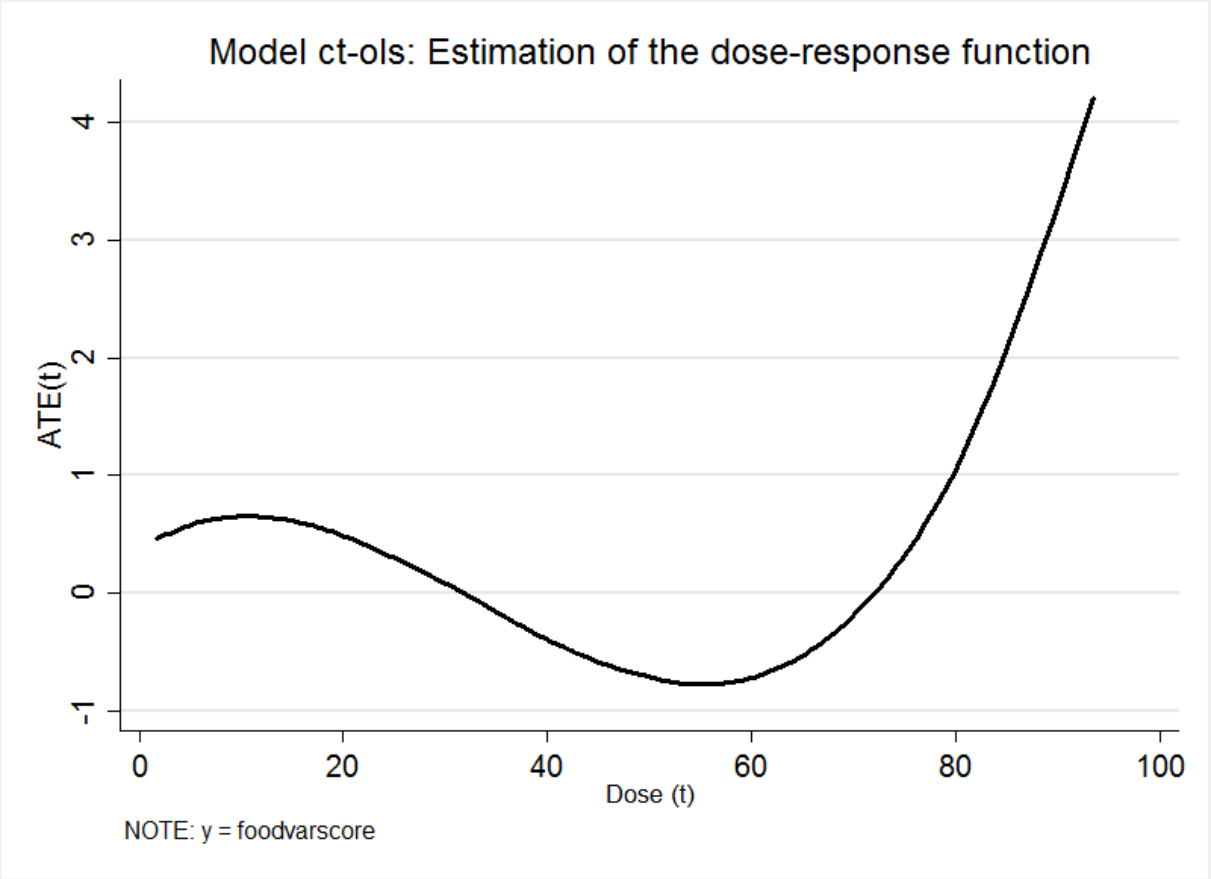

Figure A2. Estimation of dose response function