

## The Heckman Model of Dietary Diversity Score: The Case of Akaki Small-Scale Irrigation Scheme

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### Abstract

The study aims to develop Heckman model of dietary diversity score: the case of Akaki Small-Scale Irrigation Scheme. Out of 700 farming households with systematically stratified random sampling technique, this causal type of study analyzed 246 household surveys based primary data (personal interview questionnaire) with inferential statistics (Heckman two stage). It shows that farming households are still insufficient of dietary diversity. At 0.05 probability level; sex, land size (ls), educational level (ed), off farm income (offarmi), irrigation experience (exep) and distance from home to water source (dhome) are significant determinant factors of dietary diversity. At 0.05 probability level; sex, off farm income (offarmi), irrigation experience (exep) and distance from home to water source (dhome) are statistically significant determinants and they reliably predict participation in small scale irrigation scheme, *ceteris paribus*. Collective action among governments, NGOs and farming households on flood control and market linkage (perfect information on price of their product) should be taken to let farming households harvest two times per year and prosper.

**Keywords:** Dietary diversity; Small-scale irrigation

### Introduction

Different economists highlighted that urban agriculture does appear to be associated with greater dietary diversity score (Dietary diversity indicator: number of food groups that a household consumes over a reference period [1]) and calorie availability. Akaki small scale irrigation scheme households have availed/produced vegetables (lettuce, swiss charade, carrot, kale, cabbage, potato, cucumber, cauliflower, beans, tomato, pepper and onion) along river bank of Akaki with surface irrigation for both their family and community. It is therefore paramount for government, NGOs, interest groups and individuals to give small scale irrigated agriculture the needed attention to ensure adequate food supply all year round as food stability [2].

It can play a crucial role in ensuring food security and improvement of the nutritional status of vulnerable populations such as children and the sick [2].

### Statement of the Problem

The major research gaps in this study area are enough information accessibility and methodology deficiency (indicators, conceptualization, construction of terms and research design problem) on farm households' dietary diversity score. Accordingly, there has no study farm households' dietary diversity score. Accordingly, there has no study farm households' dietary diversity score. None whatsoever has evaluated dietary diversity score of Akaki small scale irrigation on its goal achievement; even the government. Urban agriculture in Addis-Ababa was benefitting urban farmers and had enabled them to bridge the food gap by supplying fresh vegetables [3]. Thirty percent of vegetables found in the city are grown in the city (60-70% of leafy vegetables) [3]. It is only food availability, but no indication of dietary diversity score. It is a necessary condition of dietary diversity score. More importantly there has no a quantitative type of research on dietary diversity score of small scale irrigation at this study area. On the other hand urban farmers in Addis Ababa produced about 16,220 tons of different vegetables within an area of 433 ha. But this is something which has location issue, conceptualization and problem.

### Objectives

(a) General objective:

In line with the research topic the general objective of this research

project is to evaluate impact of Akaki small scale irrigation scheme on farm households' dietary diversity score.

(b) Specific objectives:

- To evaluate impact of Akaki small scale irrigation scheme on farm households' dietary diversity score;
- To identify determinant factors of farm households' dietary diversity score and
- To forward actionable suggestion.

### Research Hypothesis

Questions related to objectives of the study require clear and unambiguous declarative sentence. Based on that a realistic set of hypothesis would be:

- Coefficient of irrigation access estimator ( $\lambda$ ) in the farm households' dietary diversity score function ( $y_i$ ) is expected to be significant, *ceteris paribus*;
- Participation to irrigation, family size, sex of the household head, land size, school year of the household head, irrigation experience, off-farm income, on-farm income, non-farm income and distance from home to water source are individually statistically significant determinant factors of farm households' dietary diversity score, *ceteris paribus*.

### Theoretical and Empirical Framework

#### Econometric theory

A model commonly employed in evaluating program impacts

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Received July 12, 2015; Accepted July 27, 2015; Published August 06, 2015

Citation: Negash MD (2015) The Heckman Model of Dietary Diversity Score: The Case of Akaki Small-Scale Irrigation Scheme. Int J Econ Manag Sci 4: 280. doi:10.4172/21626359.1000280

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is the following:  $S = X\beta + \lambda p + \epsilon$ , where P is the participation dummy variable. The estimate of  $\lambda$  is interpreted as the program net impact. In this study  $y_i = \beta X_i + \lambda w_i + \epsilon_i$ , where the estimate of  $\lambda$  is interpreted as the small scale irrigation scheme net impact on farm households' dietary diversity score.

### Empirical framework

As Arega Bazezew [4] has described HDDS showed that sample households were severely constrained in dietary diversity and were highly dependent on only two food groups (cereals and pulses).

### Methodology

#### Study area description

Akaki kalit district is the place where both irrigators and non-irrigators of vegetables producers found. Therefore describing Akaki small scale irrigation scheme with its tremendous attribute is important. Its location, population size and density, land use, irrigable land sizes are the main essence of this area. Akaki small scale irrigation scheme is located at Akaki-Kality sub-city in the South of the city of Addis Ababa, Ethiopia through which river Akaki crossed.

#### Sample size and sampling procedure

In the study area there are 700 farm households who are more vulnerable with food insecurity prevalence. These are both irrigator

and no irrigator farmers. If this is so, it is better to stratify them as "households who use small-scale irrigation" and "households who are not using small-scale irrigation". Out of 355 sampling frame of households who use small-scale irrigation with random sampling technique, 123 sample sizes were drawn. Out of 345 sampling frame of households who are not using small-scale irrigation with systematic random sampling technique, 123 sample sizes were drawn. As Scott Smith has conducted the correct sample size was determined by the following formula.

$$\text{Necessary Sample Size} = \frac{[(Z\text{-score})^2 * \text{Std Dev} * (1 - \text{Std Dev})]}{[(\text{margin of error})^2]}$$

Where Z-Score=Z-score of Confidence level at 95% (standard value of 1.96), Std Dev=Standard of Deviation or estimated prevalence of food insecurity (0.2). In this study area, even if some studies have conducted, there is no margin of error. If this is so, Scott Smith has decided to use 5% margin of error which is the safe, forgiving number and ensures large enough sample in this case about.

$$\text{Necessary Sample Size} = \frac{[(1.96)^2 * 0.2 * (1 - 0.2)]}{(0.05)^2} = 246$$

Based on a report gotten from Federal Democratic Republic of Ethiopia population census survey commission [5], there is a total of 181,202 populations in Akaki kality sub city. Out of these populations 700 are urban farmers (vegetable producers). Because of a complete list of the population exist in the sub city, with stratified random sampling technique 246 sample sizes were drawn from farm households by grouping the farming households in to two. Three hundred fifty five of these households are irrigators and the rest are none irrigators. Therefore, 123 samples from participant and non-participant with systematic random sampling were drawn out of 700 households. Sample interval was determined by dividing total population with sample size; i.e., 355/123=3 for irrigators and 345/123=3 for non-irrigators. Then, the first respondent was determined by randomization table. That is number 2 from the list of 355 and 345 households between one and the sampling interval, every other respondent was selected every 3 interval up to the end (123) starting from number 2 to collect the necessary data from its source.

### Data sources and data collection

Stating data sources, variables and the way the data was collected from its source are certainly a crucial task. The basic variable in this study survey is dietary diversity score. Due to poor quality data and unwillingly to analyze estimators of food security below the national level, high data collection and analysis cost, skill level required, undernourishment, household survey food consumption data and caloric intake indicators at an average was not selected in this study. In lieu this to clear these ambiguities, undernourishment, household survey food consumption data and caloric intake indicators in favor of dietary diversity for data collection were omitted out.

In this study quantitative data type was collected from both primary data sources. With highly structural questionnaire and personal contact interview; primary data was collected as per the due date. Dietary diversity was collected by recording the number of food groups that a household consumes over a reference period.

### Data analysis method

The collected data were analyzed in such a way that employing inferential statistics (Heckman's two-step procedures). However, significance of estimators' identification and interpretation was based on post estimation of marginal effect.

Variables	Heckman analysis				Marginal effect
	Coef.	Std. err.	z	p> z	
w	0.0040166	0.01152	0.35	0.727	
fs	-0.0012122	0.0058062	-0.21	0.835	
sex	0.2694272	0.0383332	7.03	0.000	
ls	0.0531168	0.0300659	1.77	0.077	
ed	0.3915751	0.046395	8.44	0.000	
offarmi	0.000366	0.0000816	4.48	0.000	
dhomeland	-0.0817047	0.038696	-2.11	0.035	
onfarmi	7.95e-06	6.14e-06	1.29	0.195	
exp	0.0256571	0.0059585	4.31	0.000	
nonfarmi	0.0000151	8.86e-06	1.70	0.089	
cons	-0.021203	0.00466486	-0.45	0.649	
Dependent variable	<b>Households food security</b>				
sex	1.49e-06	2630.316	0.00	1.000	0.2694272*
offarmi	6.28e-09	6.491465	0.00	1.000	0.000366*
dhomeland	3.64e-06	3331.409	0.00	1.000	-0.0817047*
onfarmi	3.85e-10	0.5292129	0.00	1.000	7.95e-06
exp	2.12e-07	451.9884	0.00	1.000	0.0000151
generator used	1.51e-05	1016.016	0.00	1.000	N/A
nonfarmi	6.56e-10	0.7577287	0.00	1.000	0.0256571
lambda	-0.0003356	94.20654	0.00	1.000	N/A
cons	6.109908	1689.125	0.00	0.997	N/A
Dependent variable	<b>Household Irrigation participation</b>				
Number of observations	246				
Log likelihood	263.5313				
Wald chi2(10)	5020.43				
Prob>chi2	0.0000				

Notice: Indicates significant at 0.05 probability level.

Table 1: House hold dietary diversity estimates of Heckman two stage model.

## Results and Discussion

### Dietary diversity impact of small scale irrigation scheme

As can be seen from the Table 1 the  $\lambda$  value in the dietary diversity indicator (HHDDS=0.0003356) result was statistically insignificant and does not reliably predict the probability of farming households' dietary diversity status and indicates the absence of selectivity bias in the sample. Dietary diversity was not as such observed. This is to mean that small scale irrigation scheme did not give a role on farm household dietary diversity. No matter how these farming households produce more; since they score, ate less diversify food groups, they are food insecure. Therefore null hypothesis is accepted. This confirms the result of Bazezew A [4] and contrary with the results of Bogale and Shimelis, Abonesh et al., Alberto and Luca [1] and Kinfe Asayehegn [6]. This is because of a onetime agricultural crop harvesting season, low and fixed price of their product, and diseconomies of scale, low market share and low sales volume problem they faced on. Farmers produce one time per year, because of over flooding risk fear.

### Determinates of households dietary diversity score

At 0.05 probability level; sex, educational level (ed), off farm income (offarmi), distance from home to water source (dhomeland) and irrigation experience (exep) are significant determinat factors of Households dietary diversity score in the regression result. Based on that as the model results showed  $\text{Prob} > \chi^2 = 0.0000$  which is less than 0.05, then null hypothesis is rejected. Therefore the model is good fit, accepted, reasonably good approximation of reality and good estimator of the true population.  $\text{Log likelihood} = 263.5313$  is greater than 6.63, the probability of being rich in dietary diversity- happening by chance is less than 1%. So this model is 99% certain.

As far as sex estimator of household diary diversity considered; keeping other correlates (ed, offarmi, dhomeland and exep) constant, the probability of being rich in Households dietary diversity (saying accepted-eating diversity diet) is higher by 26.94% for male household heads than female at 5% of probability level. The other significant determinant factor of Households dietary diversity score who eat diversify diet is educational level (ed) of the household. Educated household heads have a probability being rich in Households dietary diversity score by 39% than non-educated, citrus paribus (sex, offarmi, dhomeland and exep). Literate households have a probability of being rich in dietary diversity score by 39% than illiterate. As far as off farm income is considered; keeping other factors (sex, ed, dhomel and and exep) constant, as off farm income changes marginally (1 ETB), then the probability of being rich in dietary diversity is higher by 0.037%. The other significant factor of Households dietary diversity score is distance from home to water source. Households live near the water source score more dietary diversity than households that live far from the water source. As distance changes marginally (from 1 km), then the probability of being score more dietary diversity can be changed by 8.17%, keeping other variables (sex, offi and ex) constant. As distance decreased by 1 km, then the probability of scoring more dietary diversity can be increased by 8.17. Irrigators are living near the water source (they are early settler) and have the potential to use the resource than non-irrigators. The other significant factor of Households dietary diversity score is irrigation experience of the household. Experienced

household heads are more food secured. As irrigation experience changes marginally, then the probability of being rich in dietary diversity (saying accepted) changes by 2.56%, citrus paribus (sex, ed, offi and dhomeland). Flood in the rainy season is always out break on the field that damages their crop (disease, flood/canals damage).

## Conclusion and Recommendations

In general dietary diversity score impact of Akaki small scale irrigation scheme study was investigated. Households are less dietary diversity of food groups. As researcher what I need to give some suggestions here is that the woreda administration and farming households should work hand in hand to curve problems faced on.

Government should open schools (farmers' field school) to increase production or skill around the study area. Magnitude of gender (sex) estimate on food security is absolutely high. Therefore head of farming households should be male for irrigation activities. Not only that even the concerning bodies particularly Institute of Sustainable Development (ISD) and others let the farming households to share experience from outsiders.

### Acknowledgement

There are people that I should have to acknowledge. But it is not simple to mention all names and their backstop. I know that you have spent much time to read my research document with worms eye view, give comments and advices thoroughly without saving your precious time and energy so that I would like to take this opportunity to thank you.

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