http://dx.doi.org/10.18350/ipaid.2016.25s.185

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일반논문「지역발전연구」제25권 특별호 : 185~207 JRSD

Factors affecting the household food security in Dodoma Municipal, Tanzania*

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Ninety six households were randomly selected for a cross sectional survey from September to October in 2014 in Dodoma municipal, Tanzania. The survey collected information on socioeconomic and farming characteristics of the sample households to find out the main determinants of household food security (HFS). We adopted the Household Food Insecurity Access Scale (HFIAS) developed by the Food and Nutrition Technical Assistance (FANTA). We investigated whether households have experienced problems in accessing food for the last 30 days. Given the Likert scale, the households were asked to evaluate the role of municipal council's activities related to food security such as land use policies and activities related to extension, farm input, clean water, sanitation, and marketing services. Our findings show that household incomes, educational level, land ownership, and landholding size are significantly related to the household food security. About 40% of the households often worry about food supply, 5% sleeps feeling hungry and 3% goes a whole day and night without eating food. Most households had positive views on water and sanitation services; however

* This study was financially supported by the National Research Foundation of Korea (NRF-2013S1A5B8A01055336).

the services have been made possible because of assistance from international organizations. The households appeared to consider agricultural input services the most important factor affecting their food security, but had the least satisfaction on the role of Dodoma municipal in providing agricultural input services. It suggests that increasing the agricultural input services might enhance the HFS in Dodoma municipal.

[Keywords: Tanzania, Dodoma, food security, household perceptions, government interventions]

Ⅰ. INTRODUCTION

About 45% to 55% of households in the Dodoma region of central Tanzania are food insecure.[1] Cereals and legumes are major staple food in Dodoma, but the region produce less cereals and legumes when compared with other regions. It is mainly because Dodoma is a drought prone area. The irrigated area is only 6% of the total area planted. According to the agriculture and food production survey conducted by the National Bureau of Statistics in 2012, over 53% of households in Dodoma Municipal were smallholders who are vulnerable to drought (Kalinjuma, Mafuru, Nyoni, and Modah, 2013). However, low rainfall is not the only cause of food insecurity. There are various factors affecting the HFS in Dodoma municipal. Earlier studies have identified several factors affecting the HFS in Sub-Saharan Africa. Firstly, socioeconomic and farm characteristics of households can significantly affect food production. The characteristics include household size and

1) Food security is defined as a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Food security and insecurity are terms used to describe whether or not households have access to sufficient quality and quantity of food. From the definition of food security, four dimension of food security can be identified: food availability, food accessibility, food utilization and stability of food (FAO, 2001, 2008).

income, landholding size, land tenure, education level, age and gender of a household head and availability of agricultural inputs (Babatunde, Omotesho, and Sholotan 2007). An increase in household size tends to deteriorate the HFS because of limited food for consumption (Ugbomeh, 2011; Bashir et al., 2012; Aidoo, James, and Thomas 2013). High income households are more likely to modernize their production system and cope with unexpected crop failure, and thus enhance the HFS (Babatunde, et al., 2007; Oluwatayo, 2008; Aidoo, et al. 2013). Unequal access to land tenure has a profound effect on the livelihood of smallholder farmers (United Nations Economic Commission for Africa, 2004). Equitable access to land and natural resource is essential for food production for smallholders and marginalized groups in rural areas (Cotula, Djiere, and Tenga, 2008). Education raises the human capacity to diversify assets and income generating strategies including food production (Anderson & Saidi, 2011). Education is also a major determinant for adoption of new agricultural technology (Muro & Burchi, 2007).

Secondly, local governments in Sub-Saharan Africa can play critical roles in enhancing the HFS. In general, governments build basic infrastructure such as roads, wells, dams, power stations, markets and distribution centers. Governments can also monitor and mitigate adverse effects of climate changes, crop and livestock diseases, water scarcity and price volatility on food production (Slade, 2009; Mallya & Kessy, 2013; UNCDF, 2010). More directly, governments can help improve farmers' access to farm inputs such as high yielding varieties, fertilizers and pesticides, all of which can increase food production and thus enhance food security (Akramov, 2009; Minot & Benson, 2009; Mwaijande & Maro, 2012). Most subsistence farmers in the Dodoma region have low productivity because of a lack of access to essential farm inputs and technology. Additionally, governments can improve the HFS by providing clean water and primary health care as well as education on hygiene, sanitation and women empowerment (Wiggins and Keats, 2013; Kidane, Mduma & Naho, 2015). Particularly, clean water is essential for maintaining good health because it reduces vulnerability to diseases (Tolossa and

Tafesse, 2008; Wenhold et al., 2007). A lack of safe water can aggravate poverty and food insecurity because water borne diseases result in increased medical costs and a loss of labor days on farm. Women also need to travel a long distance to find and fetch clean water and then are unable to perform other activities like child care (FAO, WFP &IFAD 2013). In short, food security can be enhanced if local governance and political structures are firmly established to provide needs for smallholders in rural areas (Sikwela, 2008). In light of the discussion put forward, we measure whether households in Dodoma municipal in Tanzania have experienced problems with the HFS. We then identify the main determinants of HFS in the context of Dodoma municipal. Finally, we measure the perception of smallholders over activities carried out by the municipal council to improve the HFS and food availability in particular.

Ⅱ. METHODOLOGY

1. Description of the Study Area

Dodoma is the national capital of Tanzania as well as the capital of Dodoma region with a population of 410,956 according to the national census in 2012. The city covers an area of 2,576 km2, of which 625 km2 is urbanized and 2,144 km2 is rural (National Bureau of Statistics, 2013). The city has a semi-arid climate. It has a long dry season from late April to November and a short wet season from December to April. The average rainfall is about 550-600 mm per year (Tanzania Meteorological Agency Central Zone, 2006). The annual income per capita in Dodoma in 2012 was USD 240, which is much lower than USD 385 the national average. Dodoma municipal has crop diversity, including maize, beans, sorghum, sunflower, groundnuts, millets, and vegetables. However, it has insufficient food supply because of seasonal shortages of food and inadequate marketing or distribution system.

2. Sample and Data Collection

We conducted a cross sectional survey with 96 households, collecting both primary and secondary data in September and October, 2014, in Dodoma municipal. The survey collected information on socioeconomic and farm characteristics of the sample households, and also on activities or interventions carried out by the municipal council to increase food production. The council activities include land use policies, agriculture input service, extension service, marketing support service, and water and sanitation service. These are selected as explanatory variables that are believed to affect the HFS. A description of each variable is provided in Appendix A and B, which show how each variable was measured from the survey. Also, we adopted the Household Food Insecurity Access Scale (HFIAS) as a dependent variable. It was developed by the Food and Nutrition Technical Assistance (FANTA) to make an assessment of the household food security and its ability to obtain sufficient quality and quantity of food (Coates, Swindale, and Bilinsky, 2007). One can measure the HFIAS with nine questions as shown in Table 2. A household head or a person responsible for food preparation was asked if a situation described in each question has occurred at least once during the last 30 days. We applied the regression analysis using the SPSS software.

Ⅲ. RESULTS AND DISCUSSION

1. Descriptive statistics of socioeconomic and farm characteristics of the sample households

Table 1 summarizes the descriptive statistics of socioeconomic and farm characteristics of the sample households. The majority of respondents were a male aged between 25 and 55. Nearly all households had more than 4 family members.

About two third of the respondents received formal education and the rest never went to school. The average monthly household income ranges from $5 to $52. Most households earn incomes from selling a portion of their agricultural produce and running small businesses. Farming is their major source of income and 67% of the households have small businesses. The average landholding size was 4 acres. About 82% of the households owned land and the rest rented. Older headed households over 45 years had a greater landholding size than did younger headed households under 25-35 years. A relatively few households used chemical fertilizers because the government stopped providing fertilizer subsidies: only about 20% of the households applied chemical fertilizers, 69% applied organic fertilizers like manure and 11% applied neither organic nor chemical fertilizers. The household labor was the main source of power on farm, accounting for about 62% of the total. The draft animal and machines accounted for about 27% and 11%, respectively. About 89% of the households had livestock including cattle, sheep, goats and poultry. Out of them, 56.3% of the households had cattle, 21.1% poultry, 8.3% goat, and 2% sheep.

Table 1. Descriptive statistics of socioeconomic and farm characteristics of the households

Variable	Category	Frequency	Percentage
Gender	Male	76	79.2
	Female	20	20.8
Age	25-35	26	27
	36-45	36	37.5
	46-55	21	21.9
	56-65	4	4.2
	66+	9	9.4
Household Size	1-3	3	3.1
	4-7	50	52.1
	8-10	43	44.8

Variable	Category	Frequency	Percentage
Educational Level	No education	36	37.5
	Primary	25	26
	Secondary and above	35	36.5
Average Monthly Household Income (USD)	< 25	35	36.4
	26-50	39	40.7
	51-75	11	11.5
	76-100	3	3.1
	> 100	8	8.3
Landholding Size (Acres)	< 5	67	69.8
	5-10	9	9.4
	>10	3	3.2
Land Ownership	Yes	79	82.3
	No	17	17.7
Fertilizer Type	None	11	11.5
	Organic fertilizers	66	68.8
	Chemical fertilizers	19	19.8
Farm power	Machines	11	11.5
	Draft animal	26	27.0
	Household labor	59	61.5
Livestock Ownership	None	11	11.5
	Cattle	54	56.3
	Poultry	21	21.9
	Others	10	10.3

2. Measurement of the Household Food Insecurity Access Scale (HFIS)

Table 2 shows the results from measuring the Household Food Insecurity Access Scale (HFIAS) of the sample households. Only about 28% of the households never worried about food supply (level 1), whereas the remaining 72% had uncertainty about food supply at least once during the last 30 days. On the other hand, about 85% of the households never went a whole day and night without eating (level 9), whereas the remaining 15% experienced starvation at least once during the last 30 days. If we examine from one extreme to the other, it suggests that a relatively few households experience severe food shortages in Dodoma municipal.

Table 2. Measurement of the level of household food insecurity

Level of Household Food Insecurity	No	Rarely	Sometimes	Often
1. Worry about food supply	28.1	11.5	20.8	39.6
2. Unable to eat preferred foods	32.3	9.4	32.1	26
3. Eat just a few kinds of foods	36.5	19.5	24	19.8
4. Eat foods they really do not want	40.6	18.8	29.2	12.5
5. Eat a smaller meal	47	13.5	31.3	6.3
6. Eat fewer meals per day	53.1	19.8	25	2.1
7. No food of any kind	48.3	30.2	8.3	4.2
8. Go to sleep hungry	68.8	24	5.2	2.1
9. Go a whole day and night without eating	85.4	10.4	3.1	1.1

Additionally, we categorized the HFIAS into four different groups (food secure, mild food insecure, moderately food secure and severely food insecure groups), which were developed by Coates, Swindale, and Bilinsky (2007). For instance, the respondents were asked to enter 0 for No, 1 for rarely, 2 for Sometimes, and 3 for Often, from each question shown in Table 2. Households that scored 0~1 in total were classified as a food secure group, 2~7 a mild food insecure group, 8~14 a moderate food insecure group and 15~27 a severely food insecure group. Hence, the minimum and maximum score would be 0 and 27, respectively. The mean food insecurity score was 8.5, which suggests that most households are moderately food insecure. The highest and lowest were respectively 21 and 0. Table 3 shows that 29.2% of the households belong to a food secure group, 13.5% a mild food insecure group, 33.3 % a moderate food insecure group, and 24 % a severely food insecure group.

Table 3. Food security groups categorized by the HFIAS score

HFIAS Score	Food security group	# of HH	Percentages
0-1	Food secure	28	29.2
2-7	Mild food insecure	13	13.5
8-14	Moderately food insecure	32	33.3
15-27	Severely food insecure	23	24.0

3. Estimation of factors affecting the HFIAS

The HFIAS score discussed above is now used as a dependent variable in the OLS regression model. The explanatory variables include activities carried out by the municipal council and also the socioeconomic and farm characteristics of sample households shown in Table 1. The municipal activities include implementation of

land use policies and provision of agricultural input, clean water and sanitation, extension and marketing services. A correlation analysis was conducted among the explanatory variables before estimating the multiple regression models. The cutoff point of 0.7 was used for correlation tests because collinearity significantly distorts the model estimation and prediction at values greater than 0.7. (Appendix C). Three explanatory variables showed high multicollinearity: they were size of land owned, size of land grown and the amount of food crop produced. Hence, the land size owned and the amount of food crop produced were excluded. Normal P-P plot was used to check the assumption of normality for the residuals. The model results were selected based on adjusted R square. The models with higher adjusted R square was chosen.

The regression results in Table 4 show that agricultural input service, clean water and sanitation services, household income, education level, land ownership and landholding size are negatively related to the HFIAS: a household that has access to these variables is more likely to be food secured. The household size is significantly related to the HFIAS and has a positive sign: greater family sizes are likely to aggravate the household food security. Our findings are consistent with those from earlier studies conducted in Tanzania and sub-Saharan Africa, even though different indicators are used for measuring food security given the complexity of food security issues. For example, Knueppel et al. (2010) used the HFIAS in northern Tanzania and showed that lower levels of education of household head, land access and household incomes are associated with food insecurity. Sikwela (2008) found that the fertilizer use and livestock ownership affect household food security in South Africa, whereas the farm and household size negatively affect household food security. However, we have found that fertilize use, livestock ownership, and age of household head do not significantly influence household food security.

Additionally, Akramov (2009) found that the Nigerian government's intervention in agricultural extension services positively influence the farmers' input use and household food security. Pyakurya etal(2010)andBabu(1999)foundthatland tenure

policies, extension and marketing services have been found to have positive impacts on reducing food insecurity. However, we showed that these factors were not significantly factors of household food security. Other studies conducted in sub-Saharan Africa show that different areas have different factors that affect food security (Babatunde etal.2007;Oluwatayo2008;Aidooetal.2013). Therefore, socioeconomic factors and farm characteristics influence household food security differently in different agro-ecological regions in sub Saharan Africa (Babu, 1999).

Table 4. Factors that affect the HFIAS score.

Independent variables	Model 1	Model 2	Model 3
Constants	41.190 (4.214)	42.953 (4.903)	42.418 (4.843)
Extension services	.573 (.478)		
Land policy	.874 (.737)		
Agricultural inputs	-3.802 (-3.492***)	-3.928 (-4.504***)	-3.870 (-4.439***)
Marketing services	-1.116 (-758)		
Water and sanitation	-2.965 (-2.418)	-2.955 (-2.798**)	-3.080 (-2.929**)
Household size	.953 (3.344***)	.898 (3.506***)	.963 (3.857***)
Age	.001 (.017)		
Gender	.188 (.152)		
Education level	-1.043 (-.1.773)	-1.100 (-2.217*)	-1.143 (-2.308*)
Log of Income	-1.384 (-2.042*)	-1.298 (-2.028*)	-1.311 (-2.045*)
Land ownership	-5.136 (-3.311***)	-5.010 (-3.461***)	-4.431 (-3.277**)
Size of land grown	-1.187 (-3.754***)	-1.223 (-4.284***)	-1.274 (-4.514***)
Farm power	1.900 (1.603)	2.005 (1.861)	

Independent variables	Model 1	Model 2	Model 3
Fertilizer use	.876 (.596)		
Own livestock	-1.844 (-.970)		
R2	.538	.562	.561
F	8.372***	14.559***	16.181***

Note 1 : Numbers are ß coefficients and t-values in parentheses
Note 2 : Asterisks *, **, and *** denote P<0.05, P<0.01, P<0.001, respectively.

Although the subjects for the estimation above are an individual household, we assumed that a group of households might have different perceptions over the role of municipal activities. Hence, we classified the households into food secure, mild insecure, moderately insecure and severely insecure groups as discussed in 3.2. We used the analysis of variance (ANOVA) to determine whether there would be significant differences between the perceptions of the four groups over the municipal activities, i.e. extension services, land use policies, marketing services, agricultural input services and water and sanitation. The ANOVA test result in Table 5 shows that there are different opinions about the extension activities, marketing, clean water and sanitation services. The food secure and mild food insecure groups appear to perceive the role of municipal council positively in extension, marketing, clean water and sanitation services. However, there are no significant differences in land use policies and agricultural input services. Table 5 also shows that all four groups perceive water and sanitation services positively (>3). This is mainly because the water and sanitation services have been managed by other international organizations or NGOs. Lastly, the four groups have relatively poor perceptions over agricultural input services (<3): this can be a major issue in Dodoma municipal because agricultural input services have a significant effect on the HFS as shown in Table 4. With regards to multiple regression results above, the intervention activities such as water and sanitation and agricultural input

services have significant influences on the household food security. However, both the food secure and insecure groups perceive the municipal's agriculture input service negatively, suggesting that the municipal council has not yet intervened effectively in this important aspect of food production. Concerning the water and sanitation, marketing support and extension services, the food secured household have slightly more positive opinions on municipal activities than non-food secured households do. Their different perceptions may indicate that there is inequality in accessing local services from the municipal council. Poor households that are severely food insecure have more negative perceptions on municipal activities than food secure households do.

Table 5. Perception on the municipal council's activities among the four groups

Food Security Categories	Extension Services	Land Use Policies	Marketing Services	Agricultural Input Services	Water & Sanitation Services
Food secure	3.13	2.65	2.86	2.22	3.67
Mild food insecure	3.05	3	2.83	2.4	3.43
Moderately food insecure	2.77	2.8	2.61	2.13	3.15
Severely food insecure	2.68	2.8	2.57	2.21	3.11
P value	0.002	0.194	0.012	0.629	0.001

Note 1 : Means come from opinion scale rated from 1 to 5 scales(1=strongly disagree, 2= disagree, 3= moderate, 4=agree, 5=strongly agree

4. CONCLUSION

Our findings suggest that the water and sanitation services, agricultural input services, household income and size, education of a household head, landholding

size and ownership are significantly related to the household food security. Unexpectedly, the age and gender, livestock rearing, farm power, fertilizers, extension services, land use policies and market support services are not significantly related to the household food security. The local government should implement effective equality policies to ensure that key components like education, health and water and sanitation are equally accessed by all people. The Dodoma municipal council has intervened in land use policies, extension, agricultural input, marketing, and water and sanitation services in order to improve the household food security. However, the households perceived positively only water and sanitation services supported by international organizations. The majority of households have negative perceptions on agricultural input services provided by the council in particular, although it appears to be the most critical factor affecting the household food security. The Dodoma municipal council should therefore consider providing more agricultural input services in order to improve the household food security in Dodoma municipal.

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Appendix

A Questionnaire containing statements about the council's involvement with activities concerning the household food security in Dodoma municipal

	Strongly disagree	Disagree	Moderate	Agree	Strongly agree
EXTENSION SERVICES					
Extension services play a role in improving food production	1( )	2( )	3( )	4( )	5( )
Extension officers are helpful in solving problems	1( )	2( )	3( )	4( )	5( )
Extension service facilities are adequate	1( )	2( )	3( )	4( )	5( )
NGOS provide better extension services than municipal council	1( )	2( )	3( )	4( )	5( )
Extension workers are readily available	1( )	2( )	3( )	4( )	5( )
Extension workers frequently offer training	1( )	2( )	3( )	4( )	5( )
LAND USE POLICIES[1]					
The council has zoned land for farming and others fairly	1( )	2( )	3( )	4( )	5( )
The council has provided equal access to land for households	1( )	2( )	3( )	4( )	5( )
The council is very active in soil conservation work	1( )	2( )	3( )	4( )	5( )
The council has issued a land title to households	1( )	2( )	3( )	4( )	5( )
Women have customary rights to land	1( )	2( )	3( )	4( )	5( )
MARKETING SERVICES					
The council supports famers with marketing	1( )	2( )	3( )	4( )	5( )
The council organizes farmer cooperatives	1( )	2( )	3( )	4( )	5( )
The council manages a public transport to markets	1( )	2( )	3( )	4( )	5( )

	Strongly disagree	Disagree	Moderate	Agree	Strongly agree
The council monitors sanitation in markets	1( )	2( )	3( )	4( )	5( )
AGRICULTURAL INPUT SERVICES					
Provision of subsidized seeds increase food production	1( )	2( )	3( )	4( )	5( )
Agricultural credits help farmers increase food production	1( )	2( )	3( )	4( )	5( )
The council provides subsidized seeds on a timely manner	1( )	2( )	3( )	4( )	5( )
Farmers can afford to buy the subsidized seeds	1( )	2( )	3( )	4( )	5( )
WATER AND SANITATION SERVICES					
The council provides clean drinking water and tap water	1( )	2( )	3( )	4( )	5( )
The council provides education on a healthy diet	1( )	2( )	3( )	4( )	5( )
The council provides and promotes a clean toilet	1( )	2( )	3( )	4( )	5( )
Women receive education and training on hygiene practices	1( )	2( )	3( )	4( )	5( )

Note : [1]The central government in Tanzania can issue a land tittle to residents. The local government facilitates the process by conducting household surveys. The municipal council plays a role in zoning the land for farming and other purposes. Tanzanian women had no right to a land title before. Although new laws have been passed granting women the land title, some tribes and families still deprive women of the land.

B Questionnaire on socioeconomic and farming characteristics of households

Socioeconomic Characteristics	
Age	Age
Gender	Male = 1, Female = 0
Income	Average household income in USD
Education	Educated =1, Not educated =0
Household size	Number of household members
Farming characteristics	
Landholding size	Acres
Source of power on farm	Human labor = 0, Other sources = 1
Fertilizer use	Yes = 1, No = 0
Land ownership	Yes = 1, No = 0
Livestock ownership	Yes = 1, No = 0
Production VolumeKilogram	
Land harvested	Acres

C: Correlation Matrix

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. HHS	1																
2.Gender	.192	1															
3. Age	.388***	.182	1														
4. Income	-.155	-.064	-.038	1													
5. Land size	.225*	.143	.394***	.226*	1												
6. Power	.097	.068	-.129	-.327***	-.308***	1											
7. Fert.use	-.094	.097	-.099	.244*	.160	-.126	1										
8. Livestock	-.424***	.023	-.235*	.177	.079	-.185	-.049	1									
9. O.Land	.440***	.031	-.214*	-.061	.059	.137	-.024	-.518***	1								
10. Nutrition	-.365***	.047	-.194	.198	.136	-.275**	.128	.338***	-.211*	1							
11. Markets	-.022	-.008	-.171	.100	-.015	-.172	-.082	-.462	.054	.341*	1						
12.Inputs	.004	-.225*	-.123	-.112	-.479***	.090	-.168	-.181	.061	-.296**	-.348***	1					
13.L.grown	.078	.200	-.208*	.339***	.849***	-.420***	.155	.261***	-.160	.279**	.003	-.400***	1				
14.LUP	-.032	-.131	-.049	-.107	-.493***	.163	-.046	-.202*	.126	-.059	.182	.392***	-.443***	1			
15.Extension	-.247	-.051	-.128	.160	.123	-.137	-.066	.156	-.037	.353***	.322***	-.072	.182	-.260***	1		
16.A.produce	.036	.143	-.179	.361***	.786***	-.377***	.123	.238*	-.148	.282**	.051	-.355***	.903***	-.315***	.124	1	
17.HHE	-.625***	-.072	-.256*	.217*	.138	-.081	.118	.424***	-.401***	.219*	-.017	-.062	.117	.006	.068	.133	1

국문초록

탄자니아 도도마시 가구 식량 안보에 미치는 요인

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탄자니아 도도마시에서 2014년 9월에서 10월 사이에 무작위로 96가구를 대상으로 소농가구의 식량안보에 관여하는 사회 · 경제학적 정보와 경작형태에 관한 결정요인을 표본조사를 실시하였다. 설문지에는 조사 전 30일간의 식량확보지표로 FANTA에서 개발한 식량안보취약지수(HFIAS)를 인용하였다. 또한 가구들을 지방정부의 토지이용정책, 농업기술지원, 농자재 투입, 음용수, 위생과 시장정책을 질문하였다. 그 결과, 가구들의 소득, 교육정도, 토지소유, 경작면적 등의 요인은 가구의 식량안보와 유의한 상관관계를 보였다. 조사가구의 약 40%는 식량조달을 우려한 적이 있고, 5%는 취침 시 굶주림을 경험하고 약 3%는 하루 종일 식사를 거른 적이 있다고 답하였다. 대부분 농가는 도도마시 행정당국이 음용수와 위생서비스에 긍정적인 답을 하였으나, 이는 국제기관의 원조에 의해 가능하였다. 농자재 서비스는 식량안보에 가장 중요한 요소라고 답하였으나 당국의 식량안보 역할 중 가장 낮은 만족도를 보여 정책에 의한 농자재 서비스 확대는 도도마시 가구의 식량안보를 증진하는 가장 중요한 요소로 판단되었다.

[주제어: 탄자니아, 도도마, 식량안보, 가구인식, 정부개입]

논문접수일: 2015년 12월 9일 / 심사일: 2015년 12월 29일 / 게재확정일: 2016년 2월 17일

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