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Factors Influencing Smallholder Crop Diversification: A Case Study of Manicaland and Masvingo Provinces in Zimbabwe

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Abstract

This study analyzes the degree of crop diversification and factors associated with crop diversification among 479 smallholder farmers in Manicaland and Masvingo provinces of Zimbabwe. The Herfindahl index used to estimate diversification, while the Tobit model evaluated factors associated with crop diversification. The mean crop diversity index is 0.54. On average households in Nyanga and Bikita are the most diversified with indices of 0.48 and 0.49 respectively. The most specialized households are in Mutasa and Chiredzi with indices of 0.62. An analysis by gender shows that male headed households are slightly more diversified than female headed households. The Tobit model indicates that gender of head of

household, education, number of livestock units, access to irrigation, membership to a farmers group, access to markets, farming experience, farms on flat terrain, farmer to farm extension, routine extension, agro-ecological zone and household income are significant contributors to increasing crop diversification. In turn, crop specialization is significantly associated with off-farm employment, soil fertility, farmers who are happy with extension contacts per year, farmers trained using the farmer field school approach and farmers who receive NGO extension support.

Keywords: Crop diversification, Herfindahl index, Tobit regression, Smallholder farmers, agricultural extension

1. Introduction

The agricultural sector plays an important role in the development of the Zimbabwean economy, through its impact on the overall economic growth, households' income generation and food security (Mlambo & Zitsanza, 2001). Eight percent of the Zimbabwean population depends on agriculture for a livelihood. A total of 70% of the country's population resides in rural areas and the majority of the farmers are women. Agriculture is the major employer of the country's labor force, accounting for 65% of the rural population. The major commodities contributing to Zimbabwe's agricultural Gross Domestic Product (GDP) include tobacco (25%), maize (14%), cotton (12.5%), beef and fish (10%), sugar and horticulture (7%) and livestock (24%).

Zimbabwe total land area is 39.6 million hectares, and agriculture is practiced on 39.9% of total land area (15.8 million hectares) of which 10, 9% (4.31 million hectares) is arable. The country is divided into five agro-ecological regions mainly on the basis of the rainfall regime, soil quality and vegetation among other factors (Table 1). The quality of the land resource declines from Natural Region (NR) I to NR V (Moyo, 2000; Vincent and Thomas, 1961). *Agricultural* production patterns depend on these natural regions.

The Zimbabwean agricultural sector is dualistic, comprising large and smallholder farmers. The large scale sector is primarily located in the areas of high agricultural and economic potential while the smallholder farmers occupy areas of lower natural potential in agriculture in terms of rainfall, soils and water for irrigation (Sithole, 1996, Tekere and Hurungo, 2003).About 80% of the rural population who constitutes a majority of the smallholder farmers live in Natural Regions III, IV and V where rainfall is erratic and unreliable, making dryland cultivation a risky venture. Smallholder agriculture is also mainly rainfall dependent with a majority typically growing subsistence crops mainly cereals.

Table 1. Description of Agro-ecological zones of Zimbabwe and farming systems

Natural Region	Area (Km^2)	% of total land area (%)	Annual rainfall (mm)	Farming Systems
I	7 000	2	> 1050. Rain in all months of the year, relatively low temperatures	Suitable for dairy farming forestry, tea, coffee, fruit, beef and maize production
II	58 600	15	700-1050. Rainfall confined to summer	Suitable for intensive farming, based on maize, tobacco, cotton and livestock
III	72 900	18	500-700. Relatively high temperatures and infrequent, heavy falls of rain, and subject to seasonal droughts and severe mid-season dry spells	Semi-intensive farming region. Suitable for livestock production, together with production of fodder crops and cash crops under good farm management
IV	147 800	38	450-600. Rainfall subject to frequent seasonal droughts and severe dry spells during the rainy season	Semi-extensive region. Suitable for farm systems based on livestock and resistant fodder crops. Forestry, wildlife/tourism
V	104 400	27	< 500. Very erratic rainfall. Northern low veldt may have more rain but the topography and soils are poor	Extensive farming region. Suitable for extensive cattle ranching. Zambezi Valley is infested with tsetse fly. Forestry, wildlife/tourism
Total	390 700	100		

Source: Adapted from Vincent and Thomas, 1961 and Ministry of Agriculture, 2016.

Smallholder agriculture plays a major role in Zimbabwe's rural development and is a priority sector for government and the simple tool that could be used to reduce poverty. Despite its critical role in rural development, smallholder agriculture also faces a number of risks. Crop diversification has long been a rational response to avoid the many risks and uncertainties arising from climatic factors, pests and diseases, price uncertainties and polices related to

smallholder agricultural production, marketing and trade. Crop diversification strategies have been incorporated in several development programs worldwide to improve household income in less-developed areas (Papademetriou & Dent, 2001). The rational for diversification strategies is based on the following grounds: i) business risk reduction by lessening price fluctuations; ii) production stabilization, by reducing potential pest and diseases; iii) food security, by offering farmers and their societies access to sufficient, nutritious and safe food; and iv) environmental protection, since some specific crop mix can also be used as soil conservation strategies (Caviglia-Harris & Sills, 2005; Kurosaki, 2003; Papademetriou & Dent, 2001; Yao, 1997).

The government of Zimbabwe with the support of international organizations has undertaken a series of public investments focusing on poverty reduction in rural areas, smallholder agriculture diversification and development. Among these investments, the GIZ supported Agriculture Innovation Support Programme (GIZ AISP) has been developed to support public and private extension service providers with the goal of improving household income through improved productivity, job creation, enhanced sustainability of farm enterprises, the adoption of conservation technologies and crop diversification.

Although the extension programs have promoted crop diversification for years, studies analyzing the adoption of diversified cropping patterns in Zimbabwe are rare. Thus, the objective of this study is to analyze the degree of crop diversification and the factors associated with crop diversification among small holder farmers in Zimbabwe.

2. Methodology

This study is based on survey data collected in March 2015 from the 6 districts that GIZ is implementing the Agricultural Innovation Support Project (GIZ AISP). These are Nyanga, Mutasa and Mutare districts in Manica land province; and Chiredzi, Zaka and Bikita districts in Masvingo province. The sample population in the six districts was 30,000 farming households. Using the Rao soft sample size calculator (www.raosoft.com/samplesize.html), the minimum sample size target for the household survey was set at 350 households. This target sample size was based on achieving a 5% margin of error and a 95% confidence level.

To arrive at the sample households, a multi-stage random sampling approach was employed. First, two wards were randomly selected in each of the district. This was then followed by randomly selecting 2 farmer groups from each of the selected wards. One group selected was for farmers who had benefitted from GIZ AISP support through improved extension services and the other group was for non-beneficiary farmers. Lastly, all available farmers in each selected group were interviewed. A total of 479 farmers were interviewed using a structured questionnaire and the sample distribution by district and agro-ecological region is presented in Tables 2 and3 below.

Table 2. Sample distribution by gender by district

Gender	District						Total
	Nyanga	Mutasa	Mutare	Chiredzi	Zaka	Bikita	
Female	33	26	23	45	26	35	188
	40.7%	40.6%	38.3%	46.4%	34.2%	34.7%	39.2%
Male	48	38	37	52	50	66	291
	59.3%	59.4%	61.7%	53.6%	65.8%	65.3%	60.8%
Total	81	64	60	97	76	101	479

Table 3. Sample distribution by Agro-ecological Region

Agro-Ecological Region	Frequency	Percent Households
AER_I	66	13.8
AER_III	59	12.3
AER_IV	228	47.6
AER_V	126	26.3
Total	479	100

The Herfindahl index was used to study the extent of diversification among the farmers. The Herfindahl index (Swades and Shyamal (2012) is defined as:

$$HI = \Sigma P_i^2$$

Where P_i is the proportion of the i^{th} crop

$$P_i = A_i / \Sigma A_i$$

In which A_i = Area under i^{th} crop and ΣA_i = Total cropped area.

This index, by squaring the shares of a farm's activities, gives particular weight to the farm's principal activities. It means that a farm's secondary activities are given only limited weight in calculating the index. This is desirable since it focuses attention on the major activities of the farm. This index takes the value of one when a farm is completely specialised (i.e. produce only one crop) in its primary activity, and approaches zero as the number of crops produced increase.

To estimate the factors associated with crop diversification by the sample farmers, the Tobit model is used. The variables used in the Tobit model, their explanation and the a priori expectations are provided in table 4.

Table 4. Definition and Summary Statistics of selected variables

Variable	**Description**	**Hypothesis**
Dependent		
Herfindhal_Index		
Independent		
HHHSex	= 1 if head is male, 0 otherwise	+
HHHAge	Age of household head (years)	-/+
HH_Mems_Sec_Education	Number of household members with secondary education	+
Mem_employed_offfarm	= 1 if household has members employed off farm, 0 otherwise	-
DRAFT	= 1 if household has draft power, 0 otherwise	+
Livestock_Units	Number of livestock units	+
IRRIG	= 1 if household has irrigation on the farm, 0 otherwise	+
Tenure_Communal	= 1 if household has communal tenure, 0 otherwise	+
Member_Farmers_Group	= 1 if household is a member of a farmer	+

	group, 0 otherwise	
Marketsl	= 1 if household has access to markets, 0 otherwise	+
Years_Farming	Farming experience (years)	+
Soil_Fertility_High	= 1 if farm soil fertility is high, 0 otherwise	+
Soil_Fertility_Medium	= 1 if farm soil fertility is medium, 0 otherwise	+
Slope_Flat	= 1 if farm slope is flat, 0 otherwise	+
Happy_Extn_Contacts_per_Year	= 1 if household is happy with number of extension contacts per year, 0 otherwise	+
Training_FarmerFS	= 1 if household has been trained using the farmer field school training approach, 0 otherwise	+
Training_NonBlock	= 1 if household has been trained using the non-block training approach, 0 otherwise. Non-block training is where a farmer receives training at each stage of the production cycle.	+
Agric_Info_Farm2Farm	= 1 if household receives information through farmer to farmer extension approach	+
Extension_visits	Number of extension visits per year	+
Routine_ext	= 1 if household receives routine extension, 0 otherwise	+
AER_III	= 1 if farm is located in agro-ecological zone III, 0 otherwise	+
AER_IV	= 1 if farm is located in agro-ecological zone IV, 0 otherwise	+
Homestead_Town_Km	Distance of farm homestead from nearest	+

	town (km)	
Extension_Provider_NGO	= 1 if household receives extension support from NGOs	+
Commerc_FARM	= 1 if farm is commercialized, 0 otherwise	-
Ben_Extn	= 1 if household is a beneficiary of improved extension services, 0 otherwise	+
GV_per_Capita_USD	Farm gross value per capita in US dollars	+

4. Results and Discussion

4.1 Crops Produced

The percent distribution of households producing different crops is presented in Figure 1. The two most popular and important crops grown by at least 50% of the farmers are maize (92%) followed by groundnut (56%). At least 20% of the farmers produce sorghum and bambara nut. The three most popular vegetables grown by at least 10% of the farmers are covo, tomato and rape.

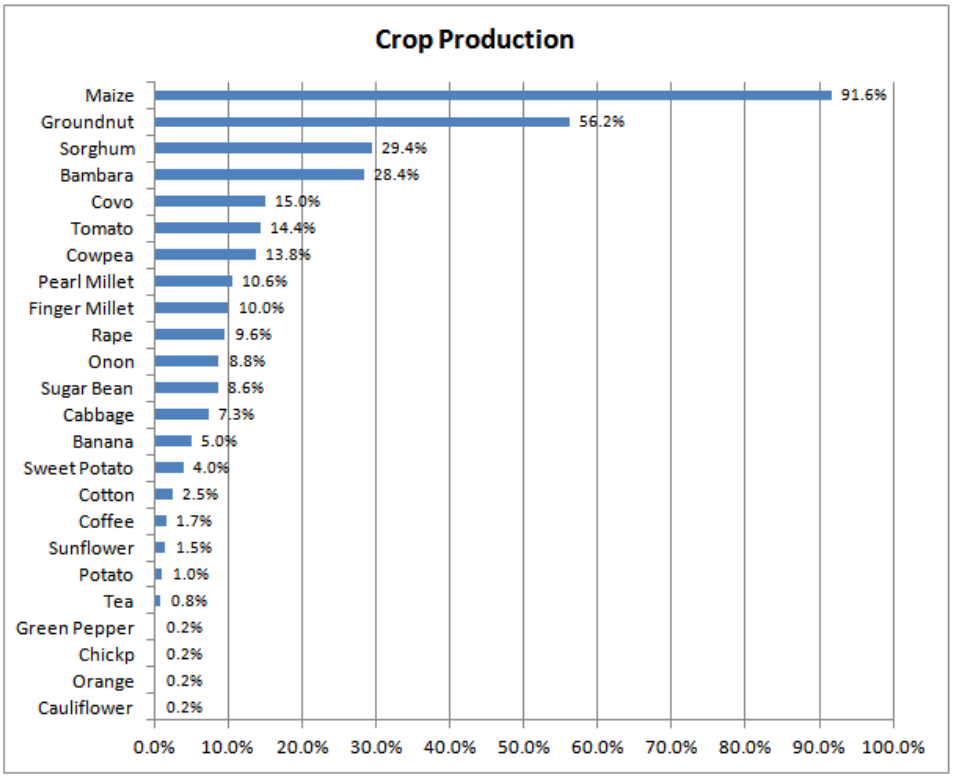

Figure 1. Percent Households Producing Crops

4.2 Area under Crops

The mean area under crop production is 1.76 ha ranging from 1.1 ha in Mutasa to 3.27 ha in Chiredzi (Table 5). The mean area under cultivation is higher for male headed households (1.89 ha) compared to 1.56 ha for female headed households. The mean area under vegetables is the same between male and female headed households. For grains, tubers, and pulses the area under cultivation is lower for female headed households. The area under cash crops for female headed households is 27 percent higher than that for male headed households.

Table 5. Mean Area under crop production by type by gender by district

District	Gender	Area Under Production (Ha)					
		Total	**Vegetables**	**Grains**	**Tubers**	**Cash Crops**	**Pulses**
Nyanga	Female	1.13	0.17	0.82	0	0	0.27
	Male	1.43	0.22	1.14	0.40	0.30	0.28
	Total	1.31	0.19	1.01	0.40	0.30	0.27
Mutasa	Female	1.08	0.27	0.67	0.10	0.50	0.06
	Male	1.13	0.21	0.73	0.19	0	0.09
	Total	1.11	0.24	0.70	0.14	0.50	0.08
Mutare	Female	1.30	0.11	0.87	0.16	0.25	0.44
	Male	1.14	0.18	0.93	0.05	0	0.18
	Total	1.20	0.16	0.91	0.11	0.25	0.28
Chiredzi	Female	2.80	0.04	3.95	0	2.00	0.04
	Male	3.68	0.09	4.63	0	1.56	0.04
	Total	3.27	0.06	4.32	0	1.65	0.04
Zaka	Female	1.34	0.01	0.83	0.09	0	0.49

	Male	2.18	0.04	1.37	0.46	0.55	0.71
	Total	1.89	0.03	1.18	0.33	0.55	0.64
Bikita	Female	1.05	0.07	0.87	0.01	0	0.25
	Male	1.46	0.03	1.06	0.16	0.38	0.40
	Total	1.32	0.05	0.99	0.14	0.38	0.35
Total	Female	1.56	0.11	1.58	0.11	1.19	0.23
	Male	1.89	0.11	1.73	0.26	0.94	0.30
	Total	1.76	0.11	1.67	0.20	0.99	0.27

Of the total area under crops, about 81% is under grains (i.e. maize, sorghum, pearl millet, and finger millet) (Figure 2). About 14% of the area is under pulses (groundnut, bambara nut, cow peas, chick pea, and sugar beans). Less than 5% of the area is under cash crops (sunflower, tea, cotton, soya bean, banana). Less than 1% of the area is under tuber crops (i.e. potato, sweet potato, yam, and cassava).

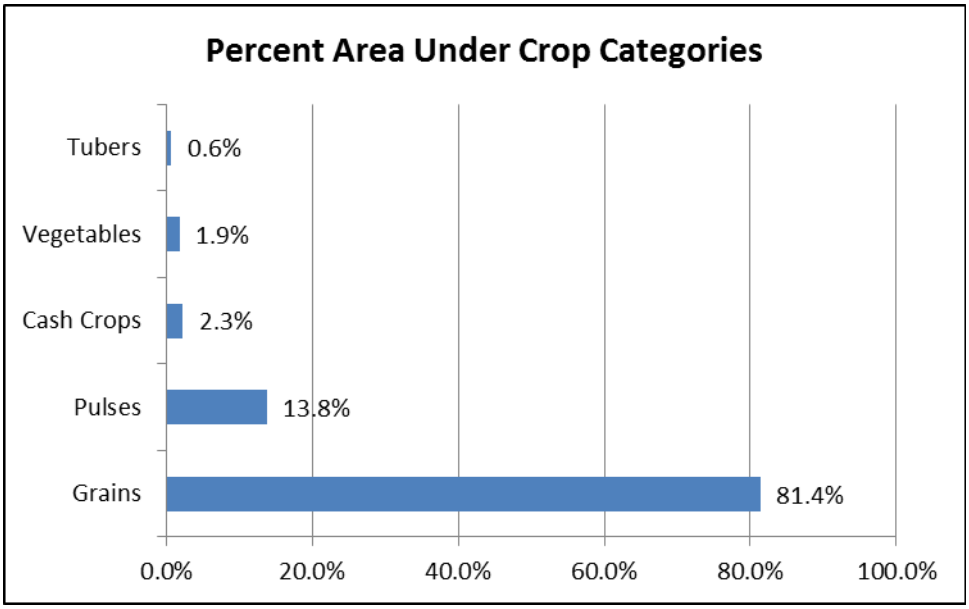

Figure 2. Percent area under crops

4.3 Crop Diversification

Table 6 shows that the mean crop diversity index as measured by the Herfindahl index is 0.54. On average households in Nyanga and Bikita are the most diversified with indices of 0.48 and 0.49 respectively. The most specialized households are in Mutasa and Chiredzi with indices of 0.62. An analysis by gender shows that male headed households are slightly more diversified than female headed households. The most diversified female headed households are in Mutare (0.48) whilst the most specialized female headed households are in Chiredzi (0.65).

Table 6. Mean farm herfindhal index by gender by district

District	Gender	Mean	Minimum	Maximum	N
Nyanga	Female	0.53	0.16	1.00	33
	Male	0.44	0.20	1.00	48
	Total	0.48	0.16	1.00	81
Mutasa	Female	0.64	0.27	1.00	26
	Male	0.62	0.22	1.00	38
	Total	0.62	0.22	1.00	64
Mutare	Female	0.48	0.16	1.00	23
	Male	0.53	0.20	1.00	37
	Total	0.51	0.16	1.00	60
Chiredzi	Female	0.65	0.33	1.00	45
	Male	0.60	0.34	1.00	52
	Total	0.62	0.33	1.00	97
Zaka	Female	0.53	0.25	1.00	26
	Male	0.52	0.25	0.93	50

	Total	0.52	0.25	1.00	76
Bikita	Female	0.54	0.22	1.00	35
	Male	0.47	0.19	1.00	66
	Total	0.49	0.19	1.00	101
Total	Female	0.57	0.16	1.00	188
	Male	0.52	0.19	1.00	291
	Total	0.54	0.16	1.00	479

About 32% of the farmers have diversification indices of between 0 and 0.4. About 16% of the households are highly specialized with diversification indices between 0.8 and 1.0 (Figure 3). The percent households with diversification indices of between 0 and 0.4 is higher for male headed households (35%) compared to 27% for female headed households. The percent households that are highly specialized is higher for female headed households (21%) compared to 12% for male headed households.

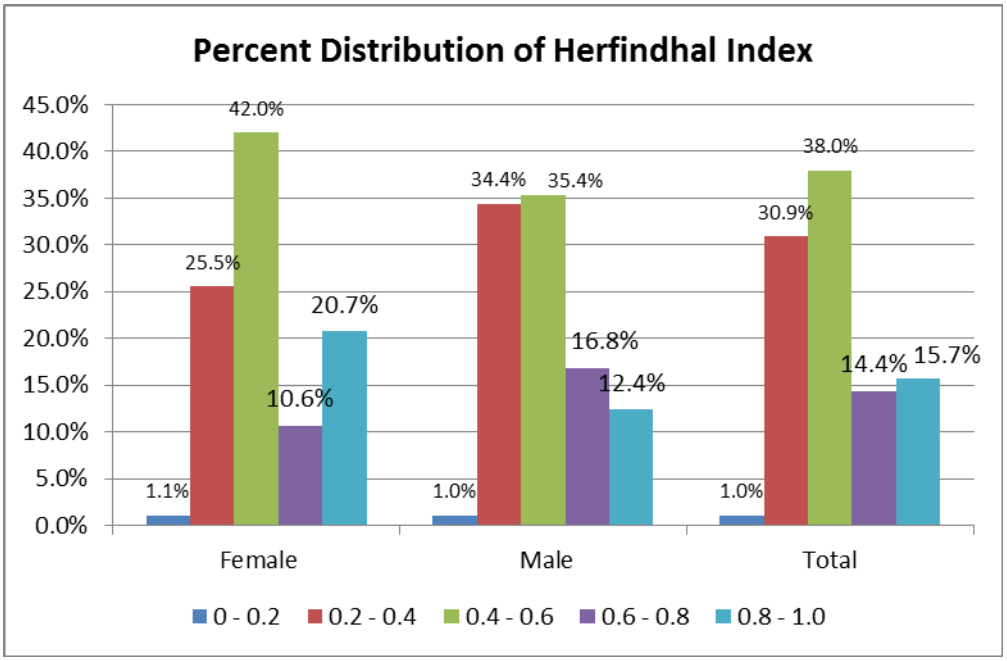

Figure 3. Percent distribution of herfindhal index by gender

The percent distribution of the diversification index shows that percent diversified households is highest for Nyanga, Mutare and Bikita with about 45% of the households having indices of between 0 and 0.4 (Table 7). Bikita and Nyanga have a high percentage of male headed households (52% and 53% respectively) that are diversified (i.e. indices between 0 and 0.4) whilst Mutare has the highest percent of diversified female headed households (57%).

Table 7. Percent distribution of herfindhal index by gender by district

		Herfindhal Index				
District	**Gender**	**0 - 0.2**	**0.2 - 0.4**	**0.4 - 0.6**	**0.6 - 0.8**	**0.8 - 1.0**
Nyanga	Female	3.0%	27.3%	54.5%	0%	15.2%
	Male	2.1%	52.1%	35.4%	6.3%	4.2%
	Total	2.5%	42.0%	43.2%	3.7%	8.6%
Mutasa	Female	0%	19.2%	30.8%	23.1%	26.9%
	Male	0%	21.1%	31.6%	26.3%	21.1%
	Total	0%	20.3%	31.3%	25.0%	23.4%
Mutare	Female	4.3%	52.2%	21.7%	4.3%	17.4%
	Male	0%	37.8%	29.7%	10.8%	21.6%
	Total	1.7%	43.3%	26.7%	8.3%	20.0%
Chiredzi	Female	0%	6.7%	46.7%	17.8%	28.9%
	Male	0%	11.5%	55.8%	17.3%	15.4%
	Total	0%	9.3%	51.5%	17.5%	21.6%
Zaka	Female	0%	30.8%	42.3%	7.7%	19.2%
	Male	0%	30.0%	40.0%	22.0%	8.0%

		Herfindhal Index				
District	**Gender**	**0 - 0.2**	**0.2 - 0.4**	**0.4 - 0.6**	**0.6 - 0.8**	**0.8 - 1.0**
	Total	0%	30.3%	40.8%	17.1%	11.8%
Bikita	Female	0%	31.4%	45.7%	8.6%	14.3%
	Male	3.0%	48.5%	21.2%	18.2%	9.1%
	Total	2.0%	42.6%	29.7%	14.9%	10.9%
Total	Female	1.1%	25.5%	42.0%	10.6%	20.7%
	Male	1.0%	34.4%	35.4%	16.8%	12.4%
	Total	1.0%	30.9%	38.0%	14.4%	15.7%

4.4 Determinants of Crop Diversification

The descriptive statistics of the variables used in the Tobit model are provided in table 8. As observed in the table, 61% of the sample households were male headed and the average age of the household heads was 49.8 years. Thirty-three percent of the sample households had household members who were employed off-farm and 83% of the households had communal tenure. The average farming experience was 20.6 years. The average number of extension visits per household was 26.5 and 77% of the households were receiving routine extension. Fifty-one percent of the sample households were receiving extension services from GIZ AISP supported extension workers.

Table 8. Summary Statistics of selected variables

Variable	**Description**	**Mean**	**Std. Deviation**
Dependent			
Herfindhal_Index		0.54	0.22
Independent			

HHHSex	= 1 if head is male, 0 otherwise	0.61	0.49
HHHAge	Age of household head (years)	49.80	15.27
HH_Mems_Sec_Education	Number of household members with secondary education	1.69	1.52
Mem_employed_offfarm	= 1 if household has members employed off farm, 0 otherwise	0.33	0.47
DRAFT	= 1 if household has draft power, 0 otherwise	0.70	0.46
Livestock_Units	Number of livestock units	3.17	4.53
IRRIG	= 1 if household has irrigation on the farm, 0 otherwise	0.11	0.32
Tenure_Communal	= 1 if household has communal tenure, 0 otherwise	0.83	0.38
Member_Farmers_Group	= 1 if household is a member of a farmer group, 0 otherwise	0.75	0.43
Markets	= 1 if household has access to markets, 0 otherwise	0.45	0.50
Years_Farming	Farming experience (years)	20.85	16.37
Soil_Fertility_High	= 1 if farm soil fertility is high, 0 otherwise	0.25	0.43
Soil_Fertility_Medium	= 1 if farm soil fertility is medium, 0 otherwise	0.54	0.50
Slope_Flat	= 1 if farm slope is flat, 0 otherwise	0.49	0.50
Happy_Extn_Contacts_per_Year	= 1 if household is happy with number of extension contacts per year, 0 otherwise	0.68	0.47
Training_FarmerFS	= 1 if household has been trained	0.19	0.39

	using the farmer field school training approach, 0 otherwise		
Training_NonBlock	= 1 if household has been trained using the non-block training approach, 0 otherwise. Non-block training is where a farmer receives training at each stage of the production cycle.	0.10	0.30
Agric_Info_Farm2Farm	= 1 if household receives information through farmer to farmer extension approach	0.43	0.50
Extension_visits	Number of extension visits per year	26.50	26.15
Routine_ext	= 1 if household receives routine extension, 0 otherwise	0.77	0.42
AER_III	= 1 if farm is located in agro-ecological zone III, 0 otherwise	0.12	0.33
AER_IV	= 1 if farm is located in agro-ecological zone IV, 0 otherwise	0.48	0.50
Homestead_Town_Km	Distance of farm homestead from nearest town (km)	92.52	24.82
Extension_Provider_NGO	= 1 if household receives extension support from NGOs	0.12	0.33
Commerc_FARM	= 1 if farm is commercialized, 0 otherwise	0.19	0.40
Ben_Extn	= 1 if household is a beneficiary of improved extension services, 0 otherwise	0.51	0.50
GV_per_Capita_USD	Farm gross value per capita in US dollars	163.90	282.24

The log likelihood for the fitted model is6.69 and the chi-square is 113.73 and strongly significant at 1% level. Thus the overall model is significant and the explanatory variables used in the model are collectively able to explain the variations in crop diversification.

Table 9. Tobit regression estimates of factors influencing crop diversification

Variable	**Coefficient**	**Std. error**	**T**	**Significance**
Constant	0.7807553	0.0610083	12.800	0.000
HHHSex	-0.0318391	0.0186589	-1.710	0.089
HHHAge	0.0009281	0.0006922	1.340	0.181
HH_Mems_Sec_Education	-0.0232401	0.0059632	-3.900	0.000
Mem_employed_offfarm	0.0583581	0.0198319	2.940	0.003
DRAFT	-0.0258394	0.0224753	-1.150	0.251
Livestock_Units	-0.0033193	0.0020153	-1.650	0.100
IRRIG	-0.0535303	0.028688	-1.870	0.063
Tenure_Communal	-0.0228246	0.0246451	-0.930	0.355
Member_Farmers_Group	-0.0543225	0.02123	-2.560	0.011
Markets	-0.0335418	0.0186008	-1.800	0.072
Years_Farming	-0.0013364	0.0006453	-2.070	0.039
Soil_Fertility_High	0.0675647	0.0238584	2.830	0.005
Soil_Fertility_Medium	0.0340766	0.0201504	1.690	0.092
Slope_Flat	-0.0341052	0.018536	-1.840	0.066
Happy_Extn_Contacts_per_Year	0.0611497	0.0229763	2.660	0.008

Training_FarmerFS	0.0563622	0.0246543	2.290	0.023
Training_NonBlock	-0.0464696	0.0310238	-1.500	0.135
Agric_Info_Farm2Farm	-0.0360982	0.0186141	-1.940	0.053
Extension_visits	-0.0003549	0.0003974	-0.890	0.372
Routine_ext	-0.0566409	0.0276369	-2.050	0.041
AER_III	-0.0226911	0.0307463	-0.740	0.461
AER_IV	-0.1108177	0.0280049	-3.960	0.000
Homestead_Town_Km	-0.0006232	0.0004705	-1.320	0.186
Extension_Provider_NGO	0.0467394	0.0281882	1.660	0.098
Commerc_FARM	-0.0077239	0.0246078	-0.310	0.754
Ben_Extn	0.0226813	0.0210626	1.080	0.282
GV_per_Capita_USD	-0.0000585	0.000034	-1.720	0.085
Log likelihood = 113.73283				
LRchi2(27) = 143.58				
Prob>chi2 = 0.0000				
Pseudo R^2 = -1.7117				

The variables that do not significantly influence crop diversification are age of the head of household (HHHAge), availability of draft power (DRAFT), communal tenure (Tenure_Communal), non-block training approach (Training_NonBlock), number of extension visits (Extension_visits), distance of farm homestead from nearest town (Homestead_Town_KM), farm commercialization (Commerc_FARM), and improved extension support from GIZ AISP (Ben_Extn).

The variables that significantly and positively influence crop diversification by farmers are gender of the head of household (HHHSex), number of household members with secondary

education (HH_Mems_Sec_Education), number of livestock units (Livestock_Units), access to irrigation (IRRIG), membership to a farmers group (Member_Farmers_Group), access to markets (Markets), farming experience (Years_Farming), farm terrain (Slope_Flat), farmer to farm extension (Agric_Info_Farm2Farm), routine extension (Routine_ext), agro-ecological zone (AER_IV) and household income (GV_per_Capita_USD).

On the other hand, crop specialization is significantly associated with off-farm employment (Mem_employed_offfarm), soil fertility (Soil_Fertility_High and Soil_Fertility_Medium), farmers who are happy with extension contacts per year (Happy_Extn_Contacts_per_Year), farmers trained using the farmer field school approach (Training_FarmerFS) and farmers who receive NGO extension support (Extension_Provider_NGO).

Male headed households are 3.2% more likely to diversify their crop production enterprises when compared to female headed households and is significant at 10% level. This finding is also supported by earlier findings of Mwangi et al. (2013), Dube *et. al.* (2016) and Ghimire et al. (2014).

The number of household members with secondary education positively and significantly increases the probability of crop diversification at 1% level of significant. An additional member with secondary education increases the probability of crop diversification by 2.3%. This finding is consistent with other studies that found that improved managerial skills, education, and training better prepare the farmers to run farms which are more diversified (Pope & Prescott, 1980, Bravo-Ureta et al., 2006 and Ashfaq et al., 2008). Farm diversification places greater demands on management and coordination skills.

An additional unit of livestock owned increases the probability of diversification by 0.3% at 10% level of significance. This result is consistent with the results of Feiten et al. (2009) who also found that crop diversification is positively related to livestock ownership but in contrast with Mesfin et al. (2011) and Benin et al. (2004) who found farmers who own livestock are likely to specialize.

Access to irrigation was found to significantly and positively affect crop diversification at 10% significance level. Farmers who have access to irrigation are 5.3% more likely to grow more crops. Bazaz and Haq (2013), Rahman and Kazal, 2015, Kumar and Gupta (2015), Abro (2012), Mesfin et al. (2011) and Lonnie et al. (1989) also found a positive relationship between irrigation and enterprise diversification.

Membership to a farmers group significantly and positive influences crop diversification. A farmer who is a member of a farmers group is 5.4% more likely to grow more crops when compared to a farmer who does not belong to a farmers group and this is significant at 5% level. This explanation for this is that farmers within a group learn from each other how to grow and market new crop varieties. This is consistent with Andrew and Rosenzweig (1995), Bravo-Ureta et al. (2006), and Conley and Udry (2010).

Access to agricultural markets was also found to positively and significantly influence crop diversification and is significant at the 10% level. Farmers with access to agricultural markets are 3.4% more likely to diversify their cropping enterprises when compared to farmers with

no access to markets. This result supports the findings of Benin et al. (2004), Mwangi et al. (2013), Mwangi et al. (2011) and Sichoongwe et al. (2014) found that access to agricultural markets positively influences crop diversification. Access to markets encourages crop diversification as access provides better opportunity to the farmers to market their farm produce

An additional year of farming experience increases the probability of crop diversification by 0.1% and the result is significant at 5% level of significance. This result is also consistent with the finding of Pope and Prescott (1980), Mwangi et al. (2013) and Ashfaq et al. (2008).

Farmers whose farms are located in flat terrains are 3.4% more likely to diversify their cropping enterprises when compared to farmers in sloppy terrains and this result is significant at 10% level. This maybe because farms located in flat terrains are more suitable to a wide variety of cropping enterprises when compared to farms located in sloppy terrains and hence offers more opportunities for diversified cropping patterns. Mishra, El-Osta, and Sandretto (2004) also notes that location places constraints (climatic, soil characteristics, topographic, etc.) on potential farm business strategies and imposes limitations on human capital development opportunities.

Farmers who receive farming information from other farmers are 3.6% more likely to practice crop diversification when compared to farmers who get their farming information from other sources. This result is significant at 5% level. This is because network effects are important for individual decisions and in the context of agricultural innovations, farmers share information and learn from each other (Rosenzweig, 1995), and Conley and Udry (2010).

Farmers who receive routine extension services are 5.7% more likely to adopt crop diversification when compared to farmers who do not receive routine extension service support and this is significant at 5% level. This result is consistent with Bravo-Uretaet. al. (2006) who also found a positive relationship between frequency of extension visits and crop diversification. Routine extension support also increases the farmers' access to information and this inturn positively influences crop diversification (Pitipunya, 1995).

Farmers with farms located in the drier agro-ecological zone IV were also found to have an 11.1% probability of adopting crop diversification when compared to farms in the better agro-ecological zones. This result is significant at 1% level of significance. There is a high risk of crop failure in this agro-ecological zone due to erratic rainfall patterns and farmers hedge against this risk by growing different crops.

High household per capita income was also found to positively influence crop diversification and is significant at 10% level of significance. This is supported by Abro (2012) who also found per-capita positively and significantly impacts on crop diversification towards high value crops.

On the other hand, off farm employment was found to negatively and significantly affect crop diversification at 5% level of significance. Households who had some of their members employed off-farm are 5.8% more likely to specialize when compared to households with no

members employed off farm. Off-farm employment offers opportunities for households to increase their incomes and to reduce the variability in household income associated with fluctuations in farm income (Mishra & Goodwin, 1997). Thus, if a household receives income from off farm work, it is less likely to pursue crop diversification as a method of reducing financial risk associated with farming (Mishra, El-Osta, & Sandretto, 2004)

The study also found that soil fertility negatively and significantly affects crop diversity. Farmers whose farms have high soil fertility and medium soil fertility are 6.8% and 3.4% more likely to specialize respectively when compared to farmers who farm have low soil fertility. These results are significant at 1% and 10% level respectively. This is consistent with the finding Rehima (2013) who also found that a fertile plot had a significant and negative effect on crop diversification. This maybe because farmers on fertile land are motivated to produce a more profitable because they can easily increase production and yield levels. However, this finding is contrary to the notion that if the soils are productive, the farmer will have more cropping pattern options available, and therefore be more inclined to engage in more than one crop enterprise on the farm. Farmers with low sol fertility farms are more likely to adopt diversified crop rotations as they have been shown to contribute to higher and more stable net farm income when compared to traditional monoculture which, over extended periods of time, has shown evidence of degradation of soil quality and reduced crop productivity (Clark, 2004; Zentner et al., 2002).

Farmers who are happy with the number of extension contacts they receive per year are 6.1% more likely not to adopt crop diversification when compared to farmers who are not happy and this is significant at 10% level.

Farmers who are trained using the farmer field school approach are 5.6% more likely to specialize when compared to farmers who are trained using other approaches. This result is significant at 5% level. The farmer field school training approach is mainly focused on specific crops and this in turn encourages participants to specialize in the production of those crops they are trained in. This is also consistent with Jamagani and Bivan (2013) who found that lack of special skills on any specific crop was one of the main reasons forfarmers' diversification of their cropping enterprises.

Farmers who receive extension support from non-governmental organizations (NGOs) are 4.7% more likely not to adopt crop diversification when compared to farmers who receive extension support from other sources. This is because most NGO supported extension interventions come with free production inputs and in some cases supported marketing of the produce. As a result farmers will then specialize in the production of the NGO supported crops. This result is consistent with Mesfin et al. (2011) who suggested that an extension system that is concentrated on enhancing farmers' productivity and profitability and favors specialization at micro-level overlooks the role of crop diversification in risk minimization. It also the explanation of Richard (1998) who stated that extension contact has discouraged intercropping for a number of years and haspromoted the growing of pure crops targeted for commercial purposes.

5. Conclusion and Recommendations

The objectives of this study were to analyze the degree of crop diversification and assess the factors associated with crop diversification among 479 smallholder farmers from 6 districts in Manicaland and Masvingo provinces of Zimbabwe. The mean crop diversity index as measured by the herfindahl index was found to 0.54. The results further reveals that shows that male headed households are slightly more diversified than female headed households. The percent households that are highly specialized is higher for female headed households (21%) compared to 12% for male headed households.

The variables that significantly and positively influence crop diversification by farmers are gender of the head of household, number of household members with secondary education, number of livestock units, access to irrigation, membership to a farmers group, access to markets, farming experience, farm terrain, farmer to farmer extension, routine extension, agro-ecological zone and household income. On the other hand, crop specialization is significantly associated with off-farm employment, soil fertility, farmers who are happy with extension contacts per year, farmers trained using the farmer field school approach and farmers who receive NGO extension support.

Given the negative effects of climate change on agriculture, there is now a strong need to find appropriate technologies to help smallholder farmers mitigate its effects. Crop diversification is one viable strategy that farmers can adopt. Based on the findings of this study, we recommend that efforts must be made to strengthen the role of smallholder farmer groups in information dissemination, farmer to farmer extension and strengthening smallholder farmers' access to markets and their bargaining power for higher producer prices. Extension services providers particularly NGOs should also be encouraged to promote a diversified crop farming system and specialized training approaches like the farmer field schools should also focus on building farmers' capacities to manage diversified cropping systems.

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