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RESEARCH ARTICLE

SOCIO-ECONOMIC CHARACTERISTICS OF SORGHUM AND MILLET FARMERS IN LUANSHYA DISTRICT OF ZAMBIA: DOES IMPROVED SEED MATTER?

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ABSTRACT

This study uses data from a census of sorghum and/or millet growing households in two agricultural blocks of Luanshya Distict to compare socio-economic characteristics, perceptions and practices among adopters and non-adopters of improved cereal crop varieties. The results suggest that adopters of improved varieties of cereal crops are generally better off, more market oriented, and more likely to purchase their inputs. Therefore, interventions aimed at increasing use of improved technologies need to be cognizant of these inherent variations in farmer characteristics and behaviour as the responsiveness is also likely to vary.

INTRODUCTION

Sorghum, millet and maize are the three most commonly grown cereal crops by smallholder farmers in Zambia. Although maize is the main staple food crop, sorghum and millet are traditionally considered close substitutes. In some drier parts of the country, sorghum and millet are grown more than maize as the two crops are relatively more drought tolerant. Over time, sorghum and millet production has increased. However, this growth has been hampered by the lack of market for surplus production. The recent developments in which these cereals are being utilized in the beer brewing industry and the promotion of sorghum and millet fortified stock feed present the much needed market opportunities for these crops (Larson *et al*., 2006). As productivity is generally low, increased market opportunities could translate into significant income effects only if the smallholder farmer can also increase productivity. Thus, improved production technologies, such as high-yielding varieties, are directly important. However, although plant breeders at Golden Agricultural Research Trust (GART) and Zambia Agricultural Research Institute (ZARI) have been developing new varieties for several decades, adoption rates among smallholder farmers have remained low. With an under-funded and, hence, incapacitated, public extension system, some non-governmental organizations (NGOs) have increasingly tried to take improved varieties to the communities. In Luanshya District, and surrounding areas, CARE International has been collaborating with GART and ZARI in the bid to introduce sorghum and millet varieties that are not only high-yielding but also agro-ecologically suitable (Chisi, personal communication). Whereas existing improved varieties are designed for low-rainfall areas, Luanshya is generally a very wet district as it belongs to agro-ecological region III. Agro-ecological region III is characterized by rainfall averaging more than 1,000 mm per annum.[1] Thus, until this recent effort, smallholder farmers in Luanshya grew only low-yielding traditional varieties.

As these efforts take root, it is important to identify and understand farmer characteristics that are associated with improved seed adoption in these areas. Adoption of sorghum and millet improved seed has been studied in drier parts (e.g Tembo *et al*., 2010), where agricultural potential is much lower and alternative economic activities are much less vibrant. To the best of our knowledge, no study has studied and compared the socio-economic characteristics, perceptions and behaviours of adopters and non-adopters of improved varieties of maize, sorghum and/or millet in these conditions in Zambia. Understanding adopters of improved cereal crop seed can help shape the strategies for ensuring uptake of the newly introduced sorghum and millet varieties. This study uses data from a census of sorghum and/or millet growing households in two agricultural blocks of Luanshya Distict to identify and

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[1] Most improved varieties of sorghum and millet were not developed for the high rainfall areas in agro-ecological region (AER) III. Thus, this new effort represents the first attempt to introduce varieties specifically developed for these agro-ecological conditions.

compare the socio-economic characteristics, perceptions and behaviours of adopters and non-adopters of improved cereal crop seed. Because very few of the sorghum and millet growers had adopted improved varieties at the time of the survey, we define a cereal improved seed adopter as one that had used such varieties in either of the two crops and/or maize. The rest of the report is organized as follows. Section 2 presents a summary of the sampling and analytical procedures used. Section 3 presents the results, presented in two major sub-sections – capital ownership (3.1) and economic activities (3.2). Section 4 presents the summary and conclusions.

MATERIALS AND METHODS

The data on which this study is based were collected through a census of sorghum and millet growing households in Kafubu and Chilabula Agricultural Blocks of Luanshya District. Agricultural Blocks are administrative units demarcated by the Ministry of Agriculture and Livestock mainly for purposes of facilitating the provision of agricultural extension services. Each agricultural block is further divided into agricultural camps. Each of the agricultural camps has a junior extension worker called Camp Extension Officer (CEO), who is in close interaction with the farming community. All the CEOs in an agricultural block are supervised by the Block Supervisor (BS). The choice of the two blocks was informed by consultations with GART and the District Agricultural Coordinators' (DACO) offices in Luanshya and Masaiti Districts. Criteria such as the extent to which the two crops were being grown and the location of the CARE interventions were used in the selection. Because there were not many households that grew sorghum and/or millet in Luanshya, an attempt was made to interview every household that had grown the two crops. In the end, complete interviews were conducted with 169 households who had grown at least one of the two crops (sorghum or millet) in the 2007/08 agricultural season. A formal questionnaire was used to collect data on household characteristics, crop production (including varieties), economic activities, and social and other forms of capital.

Data collected on materials used to construct the main dwelling (roof, walls, floors, and doors), as well as the household's access to amenities such as portable water and electricity were used to construct a dwelling modernity index. By this index, a house is fully modern if the index has a maximum value of 6 and fully traditional if it has a value of zero. The data from the questionnaires were entered in Microsoft Access, and cleaned and analyzed in Stata. The data set was organized into 11 files, each representing a unique module-specific data structure in accordance with the level at which the data were collected. For much of the analysis, these multi-level variables were used to generate household-level aggregate variables. Analysis, for most part, involved generation of descriptive statistics and mean comparisons between the two strata – adoptors and non-adopters of improved varieties. These include access to human, physical, natural and institutional capital, as well as the households' economic activities. The idea was to compare household attributes, as well as to identify the factors that are associated with high levels of adoption. Because preliminary frequencies indicated that government input subsidy programs (Fertilizer Support Programme or the Food Secuirty Pack) were not active in the area, a household was referred to as an adopter of improved seed varieties if it used improved varieties in at least one of the three staple food crops (maize, sorghum and millet) during the 2007/08 agricultural season and if such seed had been acquired by purchasing from retailers. The latter part of this definition ensures that recycled improved seed is excluded. Because the stratification was only done after the survey, it was also possible to measure the prevalence of improved technology usage in the area.

RESULTS

Capital endowment

Human capital

Table 1 presents the demographic characteristics and other human capital variables for the studied households and also compares these attributes across improved seed adoption strata. Of the 169 households on which data were collected, 48.5 percent used improved grain seed during the 2007/08 season. The Luanshya sample also had an unusually large household size of 8.5, compared to the national average of 5.1 (LCMS, 2006), and low dependency ratios. On average, each household member was responsible for about 0.4 persons; and 81 percent and 72 percent of the households had male and married heads, respectively. All these and several other indicators in Table 1 confirm the assertion that the sorghum-growing households in this study area are generally better off, compared to their counterparts in Siavonga.[2] Table 1 also shows, as expected, that adopters of improved varieties are significantly more educated - a finding that is consistent with Alene *et al*. (2007), Marenya and Barrett (2006), Kaliba *et al*. (2000), Nkonya *et al*. (1997) and Zeller *et al*. (1997) - and that they tend to have younger members and heads. Non-adopters, however, are also significantly more likely to be female-headed, and to have unmarried heads.

Table 1. Selected household characteristics for adopters and non-adopters of improved seed varieties, 2007/08 agricultural season

Variable	Full sample	Sub-samples	
		Non-adopters	Adopters
	(1)	(2)	(3)
Number of households	169	87	82
Household size	8.5	8.6	8.3
Dependency ratio (%)[a]	36.0	40.0	35.0
Education attained by female members (years)	4.6	4.4	4.9
Education attained by male members (years)	5.6	5.4	5.9
Education attained by the head (years)	6.0	5.3	6.8**
Age of the household head (years)	57.8	60.9	54.5**
Average age of the household members (years)	28.4	31.0	25.6**
Male-headed households (%)	81.0	71.0	91.0**
Married heads (%)	72.0	63.0	80.0**
Widowed heads (%)	4.0	6.0	2.0
Single heads (%)	4.0	3.0	4.0

Notes: Level of significance for unequal-variance *t* tests, *=10%, **=5%, ***=1%
[a]Defined as the number of inactive members per household member. Inactive members are those whose age is lower than 15 years and higher than 59.

[2] Siavonga sorghum growers were interviewed three years earlier (see Tembo *et al*. 2010).

Physical capital

Overall, a typical household owns about 4.8 hectares of land, One Thousand One Hundred re-based Zambian Kwacha (ZMW 1,100) worth of physical assets, and livestock worth about ZMW 1,500. It also has the main house that is 23 percent modern (see Table 2).[3] Comparatively, adopters of improved seed varieties have more than twice as much value of physical assets as do their non-adopting counterparts, a difference that is statistically significant at 1 percent level. Furthermore, although the main houses in the area are generally traditional, adopters' homes were significantly more modern at 10 percent level.

Table 2. Physical capital owenership, 2007/08 agricultural season

Variable	Full sample	Sub-samples	
		Non-adopters	Adopters
	(1)	(2)	(3)
Number of households	169	87	82
Farm size (hectares)	4.8	4.3	5.3
Dwelling index (0-6), 6=fully modern	1.4	1.2	1.7**
Value of assets (ZMW)	1,104	681	1,552**
Value of livestock owned (ZMW)	1,489	1,000	2,007

Notes: Level of significance for unequal-variance *t* tests, *=10%, **=5%, ***=1%

The most common livestock types reared by the households in the area include poultry (by 79 percent of the households), pigs (23 percent) and goats (12 percent). Only 4 percent and 10 percent had oxen and other cattle types, respectively (Figure 1). Adopters have more of each of these livestock types but the differences are significant only with respect to poultry (at 1 percent level) and goats (10 percent level) (Figure 1). Zegeye *et al*. (2001) also found similar results for bread wheat in the Yelmana region of Ethiopia.

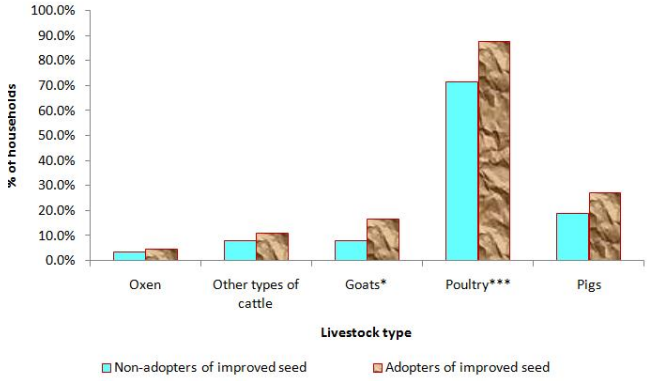

Figure 1. Livestock ownership by adopters and non-adopters of improved seed varieties, 2007/08 agricultural season

Note: Significance of between mean differences: *=10%, **=5%, ***=1%

Natural and institutional capital

As the Copperbelt Province generally has a high concentration of working-class families, agricultural communities in these areas have greater access to most infrastructure and markets than their counterparts in most other parts of the country. Thus, Copperbelt districts can be regarded as high-potential agricultural areas, whereas most other sorghum-growing areas, such as Siavonga District (AER I) in the Southern Province, are low potential. In Luanshya District, the study households are within 3 kilometers of the nearest main road and within 9 kilometers of the nearest main market. There are no significant differences between adopters and non-adopters with respect to these attributes. However, smallholder access to agricultural services is generally low in the area. Figure 2 groups these services into three major categories – business training, crop production training, and marketing services (market discovery, market information, quality certification, etc) – and presents smallholder access levels with respect to each during the 2007/08 cropping season. Crop production extension, the most prevalent service, was accessed by only 25 percent of the households, whereas business training and marketing services were accessed only by 5 percent and 8 percent of the households, respectively (Figure 2). Comparatively, adopters are more likely to receive marketing services whereas non-adopters are more likely to receive business and crop production training, although the differences were not statistically significant. Interestingly, empirical evidence in the literature is mixed, with some studies being perfectly consistent with our findings (Kaliba *et al*., 2000; Sserunkuuma 2005; and Morris *et al*., 2005) and others finding the complete opposite (Zavale *et al*., 2005).

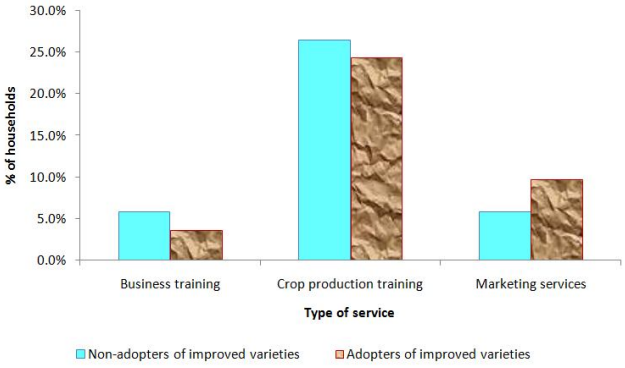

Figure 2. Access to extension and marketing services

Economic activities

In many Zambian rural communities, agriculture constitutes the most important source of food and income. Most smallholder farming activities are seasonal, given the heavy reliance on rain-fed agriculture. As a result, a large proportion of the rural poor supplement their agriculture-based livelihoods with off-farm, and even non-farm income generating activities. In the Luanshya survey, a diverse set of livelihood activities were identified, including agricultural activities (crop production, livestock rearing), and a range of off-farm and non-farm income-generating activities.

Cropping patterns, input use and productivity

Though most of the land is customary, the land 'owners' have considerable use rights. This includes, for example, the

[3] Mean dwelling index = 1.4, which is close to the value for fully traditional houses (=0) and much further from the value for fully modern houses (=6). That is, the houses were on average 24 percent modern (and 76 percent traditional). Moreover, 25 percent of the households had a dwelling index of zero whereas none had a value of 6.

decision to reserve land for other purposes like grazing or fallowing. In a lot of cases, however, land is also left idle, not as part of a well-articulated plan, but merely because the 'owners' lack complementary resources. In any case, crop agriculture constitutes the most important livelihood activity. Figure 3 presents the prevalence of individual cropping activities among study households. Maize is by far the single most important crop as it is grown by almost all (or 96 percent of) the households, followed by sorghum (69 percent), millet (50 percent), groundnuts (47 percent), and a number of minor crops combined (together grown by 61 percent of the households). A fifth of the households also supplement these field crops with dry-season gardening. About half of the interviewed households had virgin or fallow land.

external inputs in the production of all other crops, including sorghum and millet. Less than two percent and less than six percent of the households growing these other crops used improved varieties and inorganic fertilizers, respectively. Yields of maize, sorghum and millets, though generally below potential, are higher than national averages and levels most observed in other parts of the country. For maize, for example, the Luanshya farmers achieved more than six times the yields observed in Siavonga in 2005 (Tembo *et al*., 2010). Sorghum and millet yields were also more than three times as much.

Table 4 summarizes usage and sources of inputs, comparing adopters of improved seed varieties with non-adopters. Although the landholding size is not significantly different

Table 3. Cropping pattern, land productivity and use of productivity-enhancing inputs, 2007/08 agricultural season

Land use or crop	Mean area (ha)	Mean yield (kg/ha)	% of households using…		
			Improved varieties	Manure	Fertilizer
	(1)	(2)	(4)	(5)	(6)
Maize	0.79	1,709	49.1	8.0	83.4
Sorghum	0.24	827	2.6	3.4	5.2
Millet	0.12	1,012	1.2	1.2	4.8
Groundnuts	0.12	2,144	2.5	2.5	3.8
Other field crops	0.23	-	1.0	1.0	2.9
Garden	0.05	-	75.8	51.5	84.8
Fallow or virgin	3.25	-	-	-	-

Table 4. Input use and sources by adopters and non-adopters of improved seed varieties, 2007/08 agricultural season

Selected variable	Full sample	Sub-samples	
		Non-users of improved varieties	Improved variety users
Number of households	169	87	82
Total cropped area (ha)	1.54	1.39	1.70**
Cost of fert and seed (ZMW)	428.57	244.06	617.57***
Maize yield (kg/ha)	1,709	1,389	2,033***
		---------- % of households ----------	
Sorghum growing households	68.6	70.1	67.1
Millet-growing households	49.7	44.8	54.9
Manure usage	17.8	14.9	20.7
Fertilizer application	84.0	74.7	93.9***
Perception towards choice of seed			
Early maturing	24.9	18.4	31.7**
High-yielding	53.3	36.8	70.7***
The only one available	82.8	82.8	82.9
Other reasons	23.1	21.8	24.4
Sources of seed			
Own production	84.0	86.2	81.7
Gifts	33.1	43.7	22.0***
Government programs	5.3	6.9	3.7
Cash purchased	68.0	37.9	100.0***
Other seed sources	5.9	9.2	2.4
Sources of fertilizer			
Gifts	10.7	13.8	7.3
Cash purchases	53.3	35.6	72.0***
Credit	7.1	11.5	2.4**
Government programs	8.9	9.2	8.5
Other sources of fertilizer	2.4	2.3	2.4

Notes: Level of significance for unequal-variance *t* tests, *=10%, **=5%, ***=1%

Table 3 presents for a typical household the land area allocated to each land use activity and, for cropping activities, the realized mean yield and use of yield-enhancing inputs. The results on cropping land area reaffirm the dominant position occupied by maize, averaging about 0.8 hectares per household compared to 0.24 for sorghum (the next largest cropping activity). Gardens are proportionately the greatest users of productivity-enhancing inputs (improved seed, manure and fertilizer), followed by maize. There is not much use of

between adopters and non-adopters of improved seed, on average, the adopters allocate significantly larger portions of land to crop production (significant at 5 percent). Also, consistent with expectations, adopters are significantly more likely to apply inorganic fertilizers, and to obtain significantly higher maize yields (Table 4). This result is similar to the finding of Ransom *et al*. (2003) who also found a significant positive effect between these factors and adoption of improved maize varieties in the hills of Nepal.

There are interesting differences in the way decisions about the source of inputs are made between the two groups. Adopters are significantly more likely to concern themselves with attributes such as early maturing and high-yielding in their choice of seed. This result supports the earlier findings of Shiyani *et al*. (2002), who contends that adoption of improved varieties is expected to be higher if the time taken to maturity is shorter. Adopters are also more likely to purchase the seed by cash, whereas non-adopters are more likely to acquire their seed through gifts and own production. Similarly, adopters are more likely to purchase their fertilizer while non-adopters are more inclined towards loan facilities, if they can get them (Table 4).

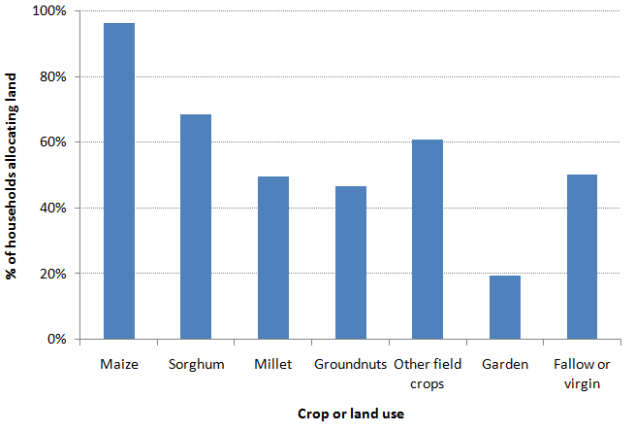

Figure 3. presents the prevalence of individual cropping activities, 2007/08 agricultural season

Farmer perceptions about cropping and marketing obligations

Almost 90 percent of the households reported facing production problems, most common being input scarcity (mentioned by 56 percent of those who had problems) and labour bottlenecks (37.7 percent). Furthermore, 54 percent of the households reported facing crop marketing problems with low prices being central. There were significant differences in the attitudes towards crop marketing obligations between adopters and non-adopters of improved seed varieties, which seem to indicate that the former are more market oriented. Consistent with expectations, for example, adopters are more likely to consider harvesting, threshing, quality grading and transportation as important obligations than their non-adopting counterparts (Table 5).

Table 5. Marketing obligations considered important by adopters and non-adopters of improved seed varieties

		Sub-samples	
Obligation	Full sample (1)	Non-adopters (2)	Adopters (3)
	---------- % households ----------		
Harvesting	82.0	76.7	87.7*
Threshing	72.7	67.1	78.6*
Drying	41.4	35.6	47.6
Cleaning	47.7	43.7	51.8
Quality grading	44.6	37.9	51.9*
Bagging	49.4	47.1	51.9
Transport	74.0	66.7	81.7**
Total	53.9	50.1	57.9***

Off Farm income sources

An average household earned ZMW 1,513 from off-farm activities. More than 76 percent of this income is from business sources, which collectively are undertaken by 63 percent of the households (Table 6). Firewood and charcoal selling, local beer brewing, and agricultural trading are some of the important business activities in the area. Besides having higher yields and crop income, adopters of improved seed varieties also have almost twice as much off-farm income as their non-adopting counterparts. While businesses are the most important source of off-farm income for both groups, adopters are more likely to earn business income, a result that is consistent with the findings of Asfew *et al*. (2010), Shiferaw *et al*. (2008), Sserunkuuma, (2005), Zavale *et al*. (2005) and Ranson *et al*. (2003). Improved seed adopters are also relatively less likely to receive remittances than non-adopters (Table 6).

Table 6. Off-farm income sources, 2007/08 agricultural season

Income-generating activity	% of households	Mean income earned (ZMW)[a]	
		Per household	Per capita income
	(1)	(2)	(3)
Non-adopters of improved seed			
Farm wage employment	10.3%	66.51	7.70
Non-farm wage employment	8.0%	38.68	4.48
Businesses	60.9%	893.08	103.37
Remittances	27.6%	107.49	12.44
Adopters of improved seed			
Farm wage employment	11.0%	108.54	13.14
Non-farm wage employment	8.5%	171.71	20.79
Businesses	65.9%	1,426.83	172.74
Remittances	20.7%	233.91	28.32
All households			
Farm wage employment	10.7%	86.90	10.27
Non-farm wage employment	8.3%	103.22	12.20
Businesses	63.3%	1,153.85	136.39
Remittances	24.3%	168.83	19.96

[a] Mean exchange rate in 2007/08 = ZMW 4.00/USD in rebased Kwacha (or ZMK4,000/USD in old currency)

Summary and Conclusion

This study identified and compared the socio-economic characteristics, perceptions and practices of adopters and non-adopters of improved cereal crop varieties in a sorghum and millet growing area that had been recently introduced to improve sorghum and millet varieties.. The results point to a number of salient conclusions about adoption of improved seed and its interface with farmer socio-economic characteristics, perceptions and practices . First, adopters are more likely to be younger and married than non-adopters. Second, adopters own more assets, have better houses, earn more business income, and receive less remittances than their non-adopting counterparts. Third, compared to non-adopters, adopters perceive high-yielding and early maturing as important attributes of an improved variety. They also regard harvesting, threshing and quality grading as important marketing obligations because they have a bearing on income earned from sale of sorghum and/millet. Fourth, improved seed users are more likely to access their seeds and inorganic fertilizers through cash purchase; contrasted with non-adopters, who are more inclined towards relying on gifts and credit. Therefore,

interventions aimed at increasing use of improved technologies need to be cognizant of these inherent variations in farmer characteristics and behaviour as the responsiveness is also likely to vary.

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REFERENCES

Alene, A.D. and Manyong, V.M. 2007. The effect of education on agricultural productivity under traditional and improved technology in Northern Nigeria; an endogenous switching regression analysis. Empirical Economics, 32: 141-159.

Asfaw, S., Shiferaw, B. and Simtowe, F. 2010. Does Technology Adoption Promote Commercialization? Evidence from Chickpea Technologies in Ethiopia. CSAE 2010 Conference on Economic Development in Africa, University of Oxford, UK, pp. 21-23.

Kaliba, A.R.M., Verkuiji, H. and Mwangi, W. 2000. Factors Affecting Adoption of Improved Maize Seeds in the intermediate and Lowland Zones of Tanzania. *Journal of Agricultural and Applied Economics*, 32: 35-47.

Larson, D., Erbaugh, J. M., Mbiha, E.R., Kilima, F., Hamukwala, P. and Tembo, G. 2006. An Evaluation of New Market Development and Marketing Strategies on Sorghum and Millet Farmers' Income in Tanzania and Zambia. Ohio State University, Columbus, OH.

Marenya, P.P. and Barrett, C.B. 2006. Household-Level Determinants of Adoption of Improved Natural Resource Management Practices Among Smallholder Farmers in Western Kenya. Food Policy, 32: 515-536.

Morris, M.L., Tripp, R. and Dankyi, A.A. 1999. Adoption and impacts of Improved Maize Production Technology: A case study of the Ghana Grains Development Project. Economics Program Paper 99-01. Mexico, D.F.: CIMMYT.

Nkonya, E., Schroeder, T. and Norman, D.. 1997. Factors Affecting Adoption of Improved Maize Seed and Fertilizer in Northern Tanzania. *Journal of Agricultural Economics*, 48: 1-12.

Ransom, J.K., Paudyal, K. and Adhikari, K.. 2003. Adoption of Improved Maize Varieties in the hills of Nepal. Agricultural Economics, 29: 299-305.

Shiferaw, B.A., Kebede, T.A. and You, L. 2008. "Technology adoption under seed access constraints and the improved Pigeonpea varieties in Tanzania." Agricultural Economics, 39: 309-323.

Shiyani, R.L., Joshi, P.K., Asokan, M. and Bantilan, M.C.S. 2002. Adoption of Improved Chickpea Varieties: KRIBHCO experience in tribal region of Gujarat, India. Agricultural Economics, 27: 33-39.

Sserunkuuma, D.2005. The Adoption and Impact of Improved Maize and Land Management Technologies in Uganda. *Electronic Journal of Agricultural Development Economics*, 2: 67-84.

Tembo, G., Kalinda, T.H., Hamukwala, P., Larson, D.W. and Erbaugh, J. M. 2010. Adoption of Improved Maize, Sorghum and Millet Technologies by Smallholder Cereal Producers in southern Zambia. *UNZA Journal of Science and Technology*, 14: 27-39.

Zavale, H., Mabaya, E. and Christy, R. 2005. Adoption of Improved Maize Seed by Smallholder farmers in Mozambique. Staff Paper 03.

Zegeye, T., Taye, G., Tanner, D., Verkuijl, H., Agidie, A. and Mwangi, W. 2001. Adoption of Improved Bread Wheat Varieties and Inorganil by small-scale farmers in Yelmana Ethiopia. Ethiopia Agricultural Research Organisation (EARO) and International Maize and Wheat Improvement Center (CIMMYT), Addis Ababa, Ethiopia.

Zeller, M., Diagne, A. and C. Mataya. 1997. Market access by smallholder farmers in Malawi: Implications for Technology Adoption, Agricultural productivity, and crop income. Discussion Paper No.35, Food Consumption and Nutrition Division, Lilongwe, Malawi.

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