89- Assessment of Metal Silo Business Up-Take among the CIMMYT-Trained Artisans in Kenya

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Abstract

This paper establishes level of up-take of the business opportunities provided by the metal silos technology among the artisans who were trained on how to make metal silos. It also assesses the factors that determine the practice of the metal silo business among the trained artisans. A third of the artisans takes orders directly from individual farmers, grain traders, institutions, etc and makes metal silos at their own workshops, a third does not engage in metal silos business at all while a third is normally hired by the first category. The likelihood to make metal silos either at own workshop or as a hired artisan reduces with age while the same increases with years of experience in technical work. The likelihood to make silos at own workshops also increases with ownership of a workshop before training, running a workshop as the primary occupation and metal work as the main professional training for the artisans.

Key words: artisan training, metal silo business,

1. Introduction

Safe storage of grains at farm level is very crucial since it directly contribute to food security as it mitigates the impact of dismal and non-consistent harvests. Traditional storage practices in developing countries cannot guarantee protection against major storage pests of staple food crops like maize leading to 20-30 percent grain losses, particularly due to post harvest insect pests and grain pathogens (Tefera et al., 2010). This loss is valued at 4 billion dollars annually (Fishler et al., 2011).

A possible sustainable solution, the metal silo technology was introduced to the rural farmers who practice subsistence agriculture. The technology ensures safe on-farm grain storage which reduces after harvest crop loss substantially thereby encouraging the farmers to maintain their harvest beyond the low price glut period either for food or to trade later when the prices are higher and therefore gain more from their farming activity. A pilot project to promote this technology among the rural farmers was implemented by International Maize and Wheat Improvement Center (CIMMYT) between 2008 and 2010. The Effective Grain Storage for Sustainable Livelihoods of African Farmers" project (EGSP1) was implemented in Kenya and Malawi (Luz George, 2011). By training local artisans on metal silo fabrication, the project hoped to make the silos locally available to the farmers. Besides, the promotion of the technology was to create business opportunities for the trained artisans as they were expected to make and sell the silos to the interested individuals in their vicinity.

Although empirical findings from the implementation of a similar project in Central America reveals high and reliable profit potential on the side of the artisans (Fishler et al., 2011), the adoption of the business opportunities provided by the silo making venture to the trained artisan in Kenya is low. Informal project assessments and preliminary analysis indicate only less than 40% of the artisans trained during the pilot phase who are practicing the silo business. This paper aims at establishing the level of the business opportunities take-up and identifying the factors affecting take-up among the trained artisans.

Different studies have described the metal silo and outlined their history and potential (Tefera et al., 2010); have shown that metals silos are highly effective in protecting maize grain from storage pests (De Groote et al., Forthcoming), and that it has a substantial impact on reduction of losses and improving food security. The benefit cost analysis of the metal silos based on average annual production of 720 bags for each household in Kenya, showed that the NPV, IRR and BC ratio all favor investing in the metal silo technology (Kimenju et al., 2009).

Some studies propose training on entrepreneurial skills for artisans, since these have been shown to have a positive impact on the performance of *Jua Kali* artisans in Kenya (Berengu, 2012). A major factor in sustaining employment in the informal sector is training in entrepreneurial, managerial, and technical fields (Maundu, 1997). In research undertaken in Kenya involving over 800 entrepreneurs in 19 towns, about 43 training needs were identified. The majority of the entrepreneurs interviewed expressed a preference for financial management and marketing as top priorities (Maundu, 1997; Yambo, 1991). Other skills requested included: fashion design,

product development and improvement, product finishing, use and maintenance of machines, personnel management, welding, metal work and body building, etc (Maundu, 1997; Yambo, 1991) In addition, about 78% of the respondents indicated that they would like to be trained as trainers of other artisans or entrepreneurs (Maundu, 1997).

Others propose alternative training models for engineering artisans. In Zimbabwe, the apprenticeship model is recommended because in this model recurrent formal training costs were lowest, mainly because of the limited amount trainees spent off the job receiving theoretical and workshop instructions hence it is cost effective (Bennell, 1993). In Kenya, It has been established that most entrepreneurs and artisans acquire their *Jua Kali* skills through on-the-job training and apprenticeship. The duration of the training is quite varied depending on the kind of trade or skill one is going in for. Training may range from six months to five years. This training is important as it seeks to develop essential work skills and attitudes required for survival at the informal sector of *Jua Kali*. (King, 1996; Maundu, 1997; Twoli and Maundu, 1994). Whatever the source and duration of training and subsequent experience in the work environment, training in entrepreneurial, technical, and managerial fields does offer the way forward to the success in and creation of employment opportunities in the *Jua Kali* sector (Maundu, 1997)

So far, no studies on the impact of artisans' training on metal silo fabrication for rural areas in East Africa and the factors that affect the artisans' practice of the business have been undertaken. This paper therefore: i) establishes level of up-take of the business opportunities provided by the technology among the trained metal silo artisans, and ii) assesses the factors that determine the practice of the metal silo business among the trained artisans.

A survey was conducted among the artisans trained in metal silo production in Embu and Homa Bay regions, the pilot regions in Kenya. The survey sought to interview all the artisans trained under the auspices of the EGSP1 as implemented by CIMMYT and those who had been trained before by other projects. In total, the survey team interviewed 20 artisans in Embu and 38 in Homa Bay. The survey also included key informant interviews from line government ministries and other key stakeholders and FGDs including a representation of the adopting and non-adopting farmers, practicing and non-practicing artisans as well as stakeholders and local opinion leaders.

2. Methodology

2.1 Conceptual Framework

The study used ex-post design since we attempt to identify the major factors which has led to a difference in two/more groups of individuals after both the effect and the alleged cause have already occurred. With this label are named those studies in whose the independent variable could not be manipulated (Ignacio and Orfelio, 2007) and are studied by the evaluator in retrospect. Some authors (Heiman, 1995) name them "correlational studies" in reference to the way their data is analyzed. others take the other option of considering them different because of the useful methodological distinction between "prospective" and "retrospective" categories developed under the ex post approach (Dunham, 1988). Retrospective qualifier is assigned to a study when the researcher begins by registering the values of the dependent variable and afterwards those of the independent one while prospective qualifier is assigned to studies which begin by registering the values of an independent variable and afterwards, measuring the dependent one (Ignacio and Orfelio, 2007). We take the former reasoning (considering them as same) since; i) of importance is that the gap between both registers should permit that the action of the independent one has taken place (Ignacio and Orfelio, 2007), ii) there are some correlational analysis in this study and finally iii) there is no conceptual difference between the two for this particular paper. Therefore, this paper takes a simple retrospective design with one group since we begun by selecting the participants due to the same singular characteristic; this is "persons trained as metal silo artisans" (Fernandez, 1994)

The dependent variable is the take-up level of the metal silo business after artisans' training. The independent variables which we hypothesized as to have effect on the dependent variable are: artisans' level of education, the artisans' income level, the main occupation of the artisan before the training, the age and experience of the artisan. The researchers identified the purchasing capacity among the farmers, community awareness levels on metal silos and preference to traditional methods of storage as the main moderating variables which are beyond the scope of this study.

2.2 Empirical Framework

This paper uses qualitative and quantitative methods to address its objectives. It uses descriptive analysis to characterize the respondents and assess the silo business take up level. It then uses a multinomial logit model to examine the factors that determine the artisans' take up of the business opportunity provided by the training in metal silo production.

The metal silo business uptake level is measured in this study using a multinomial choice variable of 0=does not practice at all, 1=practice at own workshop and 2=hired by the second category. The most commonly used approaches for estimating such discrete dependent variable regression models are the Logit and Probit regression techniques (Gujarati, 2004). The two

models are similar and generate predicted probabilities that are almost identical (Gujarati, 2004; Liao, 1994). The main difference between the two is the nature of their distribution. The Probit has a normal distribution while Logit has a logistic (slightly fatter tail) distribution. The choice between Probit and Logit regression model depends, therefore, on the distribution assumption one makes (Okello et al., 2011). However, the Logit regression model is more powerful, convenient and flexible and is often chosen if the predictor variables are a mix of continuous and categorical variables and/or if they are not normally distributed (Okello et al., 2011). Some of the predictor variables in this study are categorical and therefore this study adopt Logit regression model. Further, the dependent variable for this study takes more than two unordered categories and therefore we use multinomial Logit regression model to identify the drivers of metal silo business uptake among the trained artisans.

The established generic multinomial Logit model can be expressed as;

$$\ln Y = \alpha + \sum_{k=1}^{k} \beta_{mk} X_{ik} + \varepsilon \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where Y is a latent variable that takes the value of 2 if one makes silos at own workshop, 1 if one is hired and 0 if one does not make silos at all. β is the vector of coefficients, X is a vector of explanatory variables, α is the constant and ε is the stochastic term. The empirical model estimated contains the following variables: Artisans age (in years) at the point of training, Years of formal education, Geographic region (1=Embu, 0=Otherwise), Distance (KM) to the nearest main shopping centre, Main professional training (1=Tinsmith, 0=Otherwise), Experience in technical work (years), Primary occupation at the point of first training (1=Workshop, 0=Otherwise), Workshop ownership before training (1=Yes, 0=Otherwise), and Income level (Ksh) at the point of training.

The implied functional form estimated to assess the factors of metal silo business take up among the trained artisans is therefore given by:

2.3 Study Design

This study uses data collected from persons who were trained as metal silo artisans from Embu, Homa Bay and Migori counties from Kenya. The counties were selected for the survey since they were the project sites for the implementation of EGSP1 between 2008 – 2010 which was a pilot project for the fabrication of metal silos through the artisans in rural farming communities and disseminating them to the farmers for safe farm level grain storage.

The study targeted individuals who had been trained as metal silo artisans, whether practicing the business or not. Since the population target was so small, (60 artisans), there was no random sampling done. Rather, a census of all the trained artisans was carried out. A list of all the trained

artisans was obtained from CIMMYT and was verified on the ground by Caritas (Catholic Charity Organization) who were the local partners for the project. The list had the artisans' mobile contacts and their physical addresses for tracing. Snow ball method was also used to reach some of the artisans who we initially did not have them in the list as well as those whose mobile numbers were not working and those who had changed base. The survey team was able to interview a total of 58 artisans; 20 from Embu region and 38 from Homa Bay region.

The data was collected through personal interviews using pretested questionnaire. For the triangulation of the information, key informant interviews targeting the stakeholders in the project and FGDs targeting the community members were conducted. The survey was commissioned by CIMMYT Kenya and carried out by a team of 3 MSc students from the University of Nairobi and the supervisor. It was conducted in January and February 2013.

2.4 Data Analysis

Descriptive statistics are used to characterize the respondents. Cross tabulations were used to generate composite graphs and correlation coefficients to put the predictor variables into perspective in reference to uptake level. Further, a multinomial logit regression was run to identify determinants of metal silo business uptake among the trained artisans.

3. Results

3.1 Artisans Characteristics

Of all the interviewed artisans, 67 percent are from Homa Bay region while 33 percent are from Embu region. All of them were males. There was no any female artisan trained on silo business in the regions covered by the research. At the point of training in metal silo production, majority (57 percent) operated workshops as their primary occupation. This has now gone up to 60 percent. Majority (86 percent) are farmers though only 36 percent of them have metal silos for their domestic use. There is a significant difference in their mean of age whereby artisans making silos at own workshops have the highest mean (44) followed by those who do not make silos at all (38) and the least being hired artisans (35). Their level of education is considerably low with a mean of 9 years which is barely above primary education. Suffice it to say that the informal sector is generally considered to be an avenue for entry by those school leavers who either cannot afford or qualify to enter the formalized vocational training (Maundu, 1997). Years of experience in technical work as a variable is also significantly different with artisans making silos at own workshop being the most experienced with a mean of (22 years) followed by the hired lot (13 years) and those who are not making silos at all being the least experienced in technical work (11 years). The mean of income both now and at the time of training is also significantly different for the artisans making silos at their own workshop (before Ksh 5520, now Ksh 11335) from that of the other categories (Approx. Ksh. 2000 before, Ksh. 5000 now).

Table 1. Artisans' Characteristics

	Not Practicing (n=19)		Hired Artisans (n=19)		Practices at own workshop (n=20)	
Variable	Mean	SD	Mean	SD	Mean	SD
Artisan's current age (years)	38.2	11.3	34.5	10.5	43.9	10.4
Age at the point of first training (years)	32.8	10.9	28.7	9.1	36.1	12.1
Years of formal education	8.7	3.4	8.9	2.9	9.2	2.8
Distance (KM) to the main centre	.5	1.0	1.2	1.7	1.0	3.4
Years of experience in technical work	10.8	8.4	12.9	8.4	21.5	8.3
Years of experience in primary occupation before training	10.1	8.4	7.2	7.1	13.2	10.0
Years of experience in the current primary occupation	12.9	8.7	11.8	9.1	20.5	9.1
Combined income before ('000' Ksh)	2.4	2.3	2.4	1.7	5.5	5.1
Combined Income now('000' Ksh)	5.3	6.5	5.0	3.7	11.3	8.7
Number of days trained	27.0	82.2	18.1	40.0	9.9	9.0
Change in income since they were firstly trained ('000' Ksh)	2.9	4.8	2.7	2.6	5.8	4.9
Number of silos made so far					42.1	103.5
Number of silos sold so far					41.9	103.6
Total bags of grains stored annually	14.6	11.7	9.6	5.8	10.9	8.2

Out of all the interviewed artisans, 94 percent have technical training as their main formal professional training in life, mostly as tinsmith which was proxied by training in welding and metal work and stands at 84 percent (Table 2). Majority (57 percent) attained their training through apprenticeship, 26 percent from vocational centers while 17 percent attended colleges for their professional training. This supports previous argument that not all training of informal sector artisans occurs at specific worksites since some formal institutions also offer some training but in Kenya, the informal sector trains substantially more artisans per year than those trained at the formal institutions (Maundu, 1997; Yambo, 1991). Most artisans (58 percent) have

no certification for their technical skills while 39 percent have grade 3 which is the lowest level of grading. Only 6 percent have attained grade 1 which is the highest level.

Table 2. Artisans' Formal Professional Training

	Tinsmith	Otherwise	Total
College	50%	50%	17%
Vocational center	87%	13%	26%
Apprenticeship	94%	6%	57%
Total	84%	16%	100%

3.2 Current Status

Third of trainees make the silos in their own workshop, another third make them when hired by the first group, while a third does not practice the silo business at all. In Embu 37 percent do not practice, 37 percent are normally hired while 26 percent make silos at their own workshops. In Homa Bay 33 percent do not practice, 36 percent are hired while 31 percent practice at their own workshops.

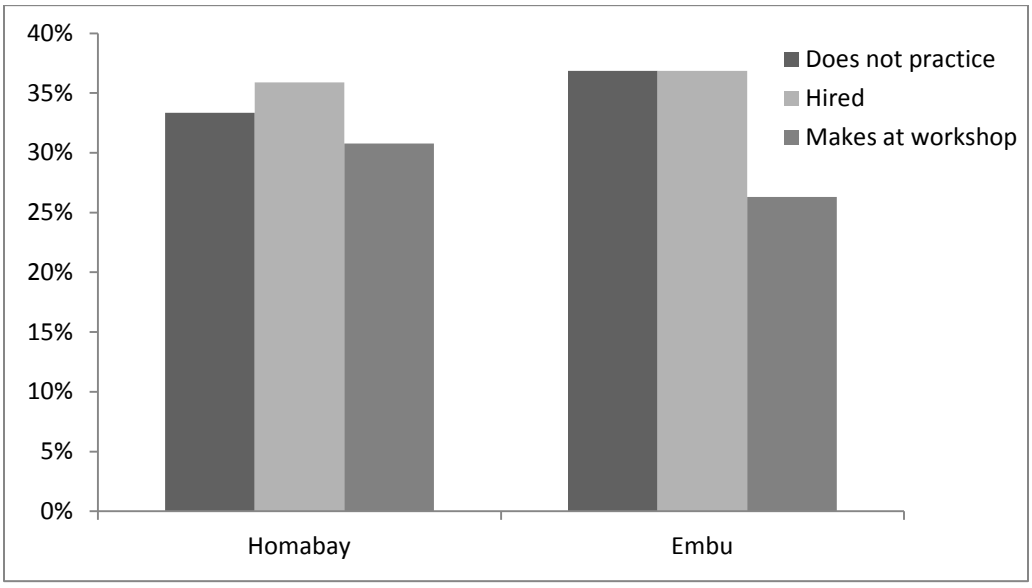

Figure 1. Metal Silo Business Take-up by Regions

3.3 Factors of Metal Silo Business Uptake

Table 3. Factors of Metal Silo Business Take-up

	Makes silos at own workshop			Hired Artisans		
Variables	Coef.	S.E.	P>z	Coef.	S.E.	P>z
Age at first training	-0.23	0.10	0.02	-0.13	0.07	0.08
Years of formal education	0.06	0.31	0.86	0.19	0.15	0.21
Distance (KM) to the nearest shopping centre	0.22	0.44	0.62	0.25	0.39	0.53
Experience in technical work	0.31	0.11	0.00	0.15	0.08	0.05
Ownership of workshop before training	4.00	2.10	0.06	0.58	1.27	0.65
Income before training	0.00	0.00	0.40	0.00	0.00	0.45
Primary occupation at the time of training	3.07	1.52	0.04	-0.01	0.83	0.99
Field of professional training	0.33	1.34	0.08	0.49	0.98	0.62
Geographical region	-1.45	2.38	0.54	-1.19	1.31	0.37
Constant	-2.65	4.96	0.59	1.45	2.45	0.55
The base outcome is ‘does not practice at all’						
Number of objects	57					
LR chi2(18)	53.1					
Prob > chi2	0.0					
Pseudo R2	0.4					
Log likelihood	-36.1					

As shown, a number of factors influence the likelihood to practice metal silo business either at own workshop or as a hired artisan. Among them, age, experience in technical work, ownership of a workshop at the point of training, primary occupation at the point of training and main professional training stand out. The probability to start a silo business at own workshop or practice on hire basis decreases with age. Holding other factors constant, an increase in age by 1 year decreases the likelihood to do silo business at own workshop by 0.1 percent while it decreases the likelihood of being hired by 0.07 percent. A unit increase in years of experience in technical work increases the likelihood of starting a metal silo business at own workshop by 0.11 percent and that of making silos as a hired artisan by 0.08 percent holding other factors constant. Similarly, holding other factors constant, ownership of a workshop at the point of training increases the likelihood of one starting a silo business and receiving tenders directly by 2.1 percent while this has no statistical significance on the likelihood of one practicing as a hired silo artisan. The study associates this to the strong positive relationship between years of experience in technical work and ownership of a workshop by the time of first training whose Pearson’s R is 0.5 and as shown by the Fig 3. most of the artisans without workshops at the time of training lie below 14 years of experience in technical work while most of those with workshops are above 14 years of experience.

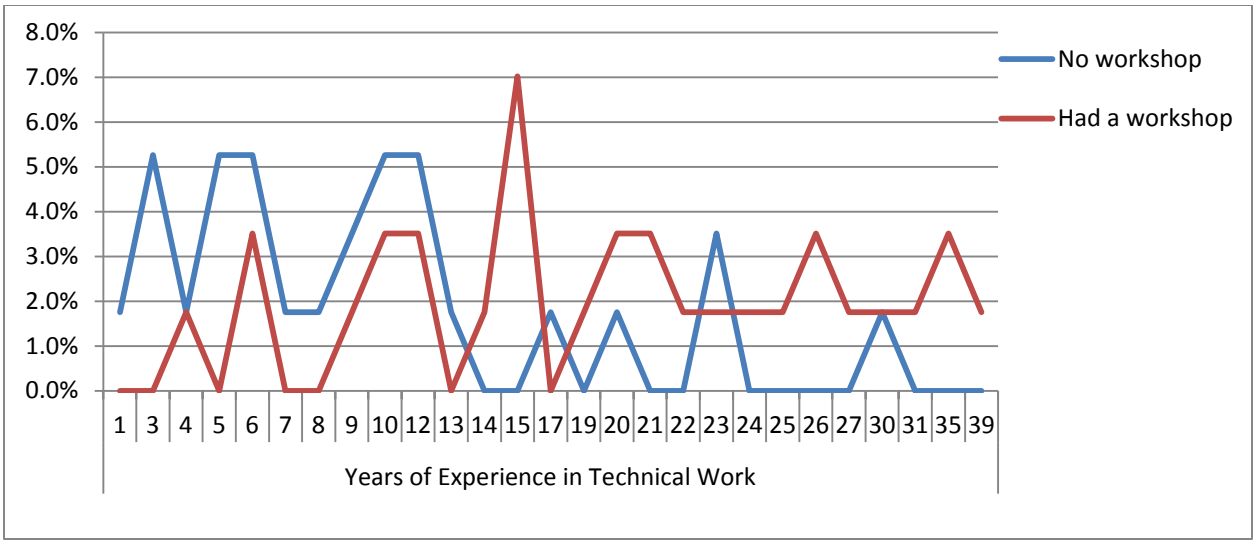

Figure 2. Workshop Ownership by Years of Experience in Technical Work

Further, the probability of metal silo business take up at own workshop increases with primary occupation at the point of training. This was a dummy variable which took the value of 1 if one operated a workshop as their primary occupation at the point of training and 0 if otherwise. Holding other factors constant, this increases the likelihood to start a silo business by 1.5 percent. Also, the probability of metal silo business take up at own workshop increases with professional training as a tinsmith. Professional training was a dummy variable taking value 1 if one is trained as a tinsmith and 0 if otherwise. Holding other factors constant, training as a tinsmith increases the likelihood of an artisan starting the metal silo business by 1.34 percent.

As outlined, experience in technical work, workshop ownership, tinsmith as the main professional training and workshop operation as the primary occupation as independent variables have a positive relationship with the likelihood to start a silo business. This finding is in line with our apriori expectation. Metal silo business largely involves working with metal sheets and soldering rods. The artisans who had received professional training as tinsmiths and have sufficient experience in technical work especially running their own workshops as their primary occupation are expected to have more advanced expertise and experience in metal work which increases their chances of metal silo business up take whether at their own workshops or hired. They are also likely to have the necessary tools required for silo business and have necessary market linkages and experience for the raw materials. This corroborates previous study which concluded that what is eventually a more significant determinant of entry into self-employment (for *Jua Kali* artisans) is the range of experience obtained over many years in the manufacture, design, sourcing of materials, knowledge of clients, marketing, etc (King, 1996).

4. Conclusions

The results of the study establish the metal silo business up take by the trained artisans at their own workshops to be a third. Another third is hired by the above category while another third does not practice at all. The likelihood to start the business reduces with age and increases with experience in technical work, workshop ownership, running a workshop as the primary occupation and artisans' main professional training in metal work.

4.2 Recommendations

For maximum outcome, programmes and projects of similar nature should consider young artisans with sufficient experience in technical work and are professionally trained as tinsmith. They preferably should have their own workshops though this need not be a strict prerequisite since those without workshops are likely to be hired by those with workshops.

Programmes should develop an integrated training curriculum for the artisans which includes both the technical skills training and other business management skills to support them in running their businesses. For the technical skills, we recommend entrepreneurship training in a concerted manner whereby trainees are attached to practicing artisans who are in turn accountable to the organizers of the programme. Both the trainer and the trainee should receive training on business management skills.

Strong linkages with organizations and government line ministries should be developed particularly to create awareness on the silo among the rural farmers so as to create a demand for the artisans. Such linkages will also enhance sustainability of the results beyond the project period.

Professional associations should be formed which brings all the silo artisans from a particular region together. The association should facilitate the process of bringing the raw material closer, help in marketing the members' product, enforce quality control through branding silos produced by the members and receive and train new and interested artisans. This will also enhance the sustainability of such technology promotion projects and that of the members businesses. Besides, the members will create networks within which those who have workshops can hire those who are trained but have no workshops and hence cannot take orders.

We also recommend further research on the impact of metal silo business on the artisans' income.

References

Bennell, P. 1993. The Cost-Effectiveness of Alternative Training Modes: Engineering Artisans in Zimbabwe. Comparative Education Review 37:434 - 453.

Berengu, P.T. 2012. Influence of entrepreneurial skills on the performance of *Jua Kali* artisans in Kenya: a case of *Jua Kali* artisans in Meru town, University of Nairobi, Nairobi.

De Groote, H., S.C. Kimenju, T. Tefera, P. Likhayo, F. Kanampiu, and J. Hellin. Forthcoming. Effectiveness of hermetic systems in controlling maize storage pests in Kenya. Journal of Stored Products Research.

Dunham, P.J. 1988. Research methods in psychology Harper & Row, New York.

Fernandez, C. 1994. El suicidio consumado en Madrid capital; Unpublished Doctoral Dissertation., The Complutense University of Madrid, Spain.

Fishler, M., R. Berlin, R. Bokusheva, R. Finger, Y. Marin, F. Pais, K. Pavon, and F. Perez. 2011. 5 Year Ex-Post Imapct Study Intercooperation Switzerland

Gujarati, D.N. 2004. Basic Econometrics. 4th ed. McGraw-Hill Companies, New York.

Heiman, G.W. 1995. Research methods in psychology Houghton Mifflin Boston.

Ignacio, M., and G.L. Orfelio. 2007. A guide for naming research studies in Psychology. International Journal of Clinical and Health Psychology 7:847-862.

Kimenju, S.C., H. De Groote, and H. Hellin. 2009. Preliminary Economic Analysis: Cost effectiveness of the use of improved storage methods by small scale farmers in east and southern Africa countries. International Maize and Wheat Improvement Center (CIMMYT):17.

King, K. 1996. *Jua Kali* Kenya: change and development in an informal economy, 1970-1995 Ohio State University Press, Ohio.

Liao, T.F. 1994. Interpreting probability models: Logit, probit, and other generalized linear models Sage Publications, Incorporated, CA.

Luz George, M. 2011. EGSP Completion Report - June 2008 to February 2011. CIMMYT, Nairobi.

(ed.) 1997. FSU/ADEA Conference.

Okello, J.J., O.K. Kirui, G.W. Njiraini, and Z.M. Gitonga. 2011. Drivers of Use of Information and Communication Technologies by Farm Households: The Case of Smallholder Farmers in Kenya. Journal of Agricultural Science 4:111-124.

Tefera, T., F. Kanampiu, H. De Groote, J. Hellin, S. Mugo, S. Kimenju, Y. Beyene, P.M. Boddupalli, B. Shiferaw, and M. Banziger. 2010. The metal silo: An effective grain storage technology for

reducing post-harvest insect and pathogen losses in maize while improving smallholder farmersâ€™ food security in developing countries. Crop Protection 30:240-245.

(ed.) 1994. Basic Education Forum.

Yambo, M. 1991. Training Needs Assessment of the Kenya Informal Sector. Research Paper.