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BIASES AND EFFECTIVENESS OF EXTENSION SERVICESTO MAIZE FARMERS IN KENYA BEFORE AND AFTER THE TRAINING AND VISIT SYSTEM

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The effectiveness of the training and visit (T&V) extension method in reversing typical biases of the previous conventional system of extension services in Kenya was investigated using multinomial logistic regression analysis. The study provided empirical evidence supporting reduction in biases against small-scale, young and uneducated farmers and remote areas. On the other hand, the bias against marginal production environments and women continued under the T&V system, though at lower rates than before. Efficacy of the T&V system was also confirmed through promotion of higher adoption of improved technologies. This was mainly attributed to the effective mechanisms and better quality of information delivered through the indirect contact methods of T&V.

1. INTRODUCTION

Over the past two decades, strengthening of agricultural support services dominated the World Bank strategy to promote agricultural growth in developing countries. Special emphasis was placed on the role of agricultural research and extension. As a result, a new approach to extension services known as the training and visit (T&V) system was introduced and supported by the bank as a major component of its agricultural revival strategy (Bindlish & Evenson, 1993, Feder & Slade, 1986 and Purcell & Anderson, 1997). The T&V approach was first tested in Turkey in the late 1960s and subsequently introduced in India and several other countries in Asia in the 1970s (Benor *et al*, 1984 and Purcell & Anderson, 1997).

Several merits of the T&V approach over conventional extension system were cited in the literature. First, by relieving extension from the responsibility of non-extension roles such as supervising input supply and credit, the T&V in turn helps eliminate biases towards high-potential areas, commercial cash crops, and well-to-do farmers usually associated with the dual or multiple roles of conventional extension systems. Second, the T&V approach focuses on improving the technical skills of front line extension workers through regular training and systematic linkages with research, and supporting more effective management

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of field operations through a fixed schedule of regular visits and the use of contact farmers (World Bank, 1985).

The success of the T&V system in India and other countries encouraged its introduction into Africa. Kenya was chosen for launching the first replica of the T&V experiment in Africa (World Bank, 1990 and Bindlish & Evenson, 1993). Publicly organised extension services were provided to Kenyan farmers long before the arrival of the T&V system, mainly to promote the production of tea and coffee. At that time, large commercial white settler-farmers in the highlands grew tea and coffee. Supply of key inputs such as fertilisers and pesticides constituted a major component of the extension service role. This service was later extended to other crops, groups of farmers, and regions through an extensive network of government field agricultural officers (Gatheru, 1989 and World Bank, 1990).

A comprehensive study was undertaken by the World Bank (Bindlish & Evenson, 1993) to assess the impact of the T&V system in Kenya. The mentioned study calculated high rates of return to the T&V investment for a wide range of crops, extension messages and regions. Kenya was consequently considered another success story for the T&V approach providing the justification for increased support to substantial investments by the bank to promote an Africa-wide expansion in the application of the T&V system (World Bank, 1990).

The present study represents an independent investigation into the impact of the T&V system on the conventional biases and deficiencies of the old extension system in Kenya. Our study differs from that of Bindlish and Evenson (1993) as it focuses on the maize sub-sector. The fact that maize farming in Kenya had witnessed significant technological and structural transformations over the past three decades justifies the distinction of maize from other crops in evaluating the impacts of extension services before and after the T&V system. First, rapid adoption of the first generation of maize hybrids, especially by large farmers in high-potential zones that paralleled the diffusion of hybrid maize in the USA, occurred in the early 1970s, long before the T&V system was introduced in Kenya in 1982 (Gerhart, 1975). The popularity of hybrid maize then spread to small holders and medium-potential zones during the 1970s. Also, in the past decade maize production has been steadily expanding into more marginal environments and highly diverse farming systems and circumstances (Hassan & Njoroge, *1996)*. Therefore, the evolution of maize production practices over the past three decades provides an interesting framework for an evaluation of whether and how the conventional biases and efficacy of extension have changed after the T&V system was introduced. Moreover, while the present study utilised the same sampling frame employed by the Bindlish and Evenson study (1993), significant variations exist between the two studies in the survey design and coverage and the approach and methods of the analysis (to be discussed later).

A comparative analysis of the intensity (quantity) and effectiveness (quality) of extension services to various maize farmer groups and production environments in Kenya before and after the T&V system is conducted in the subsequent sections. Findings of this research will inform extension policy makers and maize researchers on the shortfalls and strengths of current maize technology dissemination programs in Kenya.

2. ANALYTICAL APPROACH AND HYPOTHESES OF THE STUDY

This study examines whether and how supply of extension services to maize farmers has changed in pattern and effectiveness after the T&V system was introduced in Kenya. As none of the variables measured by this survey was considered to adequately capture attributes characterising farmers' demand for extension advice, no attempt was made to analyse the nature and determinants of demand. The proportion of farmers and villages reached by extension was used to analyse changes in the quantity (extensiveness) of services supplied. No information was available on the frequency of visits from the present survey to allow analysis of extension supply intensity. However, quantity variables measuring percentage of farmers reached by extension in various agroclimatic zones and farmer characteristics (sex, age, scale, etc.) were employed to test hypotheses about changes in the pattern of extension supply. The following set of hypotheses about the quantity of extension supply were advanced to be tested:

- Supply of extension services in terms of the ratio of farmers reached increased after the T&V system.
- The traditional bias of extension services toward high-potential areas, male farmers, and large-scale growers was reduced after the introduction of the T&V approach.
- The relative importance of direct contact by extension agents as a source of information on improved farming methods improved with the introduction of the T&V system.

On the other hand, changes in rates of adoption of improved production methods were used to measure and analyse changes in the quality (effectiveness) of extension services. As the T&V system in Kenya was established by reorganising and enhancing the capacity of existing extension service machinery (physical and human resources), some of the biases and deficiencies of the old system are expected to partially continue. Moreover, since the T&V system is a recent introduction following several years of conventional extension service and input

supply and promotion mechanisms, some of the post-T&V impacts may be attributed to the cumulative effects of the farmer-to-farmer dissemination of information and knowledge over time. For an improved approximation of the pure incremental effects of the T&V system, farmers and villages were classified according to the following source of advice categories:

- Never received any advice from extension,
- Received advice before the T&V system (e.g. before 1982),
- Received advice after the T&V system (after 1982) within an "*old village*". An *old village* is defined as any village in which some farmers were contacted by extension before 1982.
- Received advice after the T&V in a "*new village*" (e.g. where none of the farmers was contacted by extension prior to 1982).
- Received extension advice but doesn't remember the date. This category was included because a large number of the surveyed farmers could not recall the time when they were first contacted by extension and hence could not be classified in the before/after T&V categories.

3. DESIGN AND SOURCE OF THE DATA

This study used data collected from village and farm level surveys conducted by the Kenya Maize Database Project (KMDBP)[1] during the 1992/93 growing season. Geographic Information System (GIS) and spatial analysis tools were used to combine several geo-referenced data layers to develop the spatial sampling frame employed for designing the KMDBP farmers' surveys[2]. Climate attributes were first used to develop maize adaptation zones. Spatial coverages mapping the area planted to maize and the density and distribution of human population were then overlaid on the agroclimatic zonation to stratify maize production regions and determine sampling densities. A digital version of the National Sampling Frame developed and updated by the Central Bureau of Statistics (CBS) for the 1989 census was then used to locate and sample survey sites and farmers within sites using a digital random spatial search. The KMDBP survey covered 1407 maize farmers in 75 sites across 30 districts[3].

Information was collected on several farmers' characteristics, such as whether and when extension advice was provided, the source of advice, and if recommended practices were adopted. Data was also gathered on village attributes, such as marketing and extension services infrastructure, and proximity to and state of roads.

4. PATTERN OF EXTENSION ADVICE SUPPLY BEFORE AND AFTER T&V SYSTEM

A logistic regression model was developed to analyse and formally test hypotheses about the impact of the T&V system on conventional extension service biases among maize farmers in Kenya. Multinomial logit analysis was applied to measure the probability of occurrence of the extension event (e.g. Whether a farmer received extension advice or not) in the above described five response categories: never received, contacted before T&V, after T&V in an *old village*, after T&V in a new site, don't remember. A detailed description of the multinomial logit model and interpretations of its analytical results is given in the Appendix. Regressors of the model include factors reflecting sources of conventional extension biases, such as:

- The biological potential represented by three agroclimatic zones: highland tropics for high potential, mid-altitude tropics for medium potential and lowland tropics for low potential[5].

- Farmers' characteristics, capturing the following attributes:

  - Age of the head of the household in years.

  - Sex of the head of the household as a male-female dummy.

  - Level of education of the head of the household. Survey results revealed that maize farmers received only two basic levels of education: few years of primary education and informal training. Accordingly, this variable was transformed into a dichotomous dummy, controlling for no education versus some level of basic education that includes the few years of primary and informal schooling.

  - Farm size (scale of production). The effect of this variable was tested in both continuous and discrete forms. The dichotomous variable of large farmers (more than 2 ha) and small farmers (less than 2 ha) performed much better statistically in all models than the continuous form (size in ha). The cut boundary of 2 ha was based on the formal definition of small-scale farms in Kenya's agriculture (Hassan *et al*, 1998a).

- Infrastructure factors, reflecting proximity to extension services and markets are included in the model. Distance to the nearest major market centre in kilometres was included to control for access to output marketing and input supply services. Availability of extension services was modelled using a categorical variable indicating whether an extension agent was based within the village (survey site) or not. While extension advice is provided in a package of services that include direct contact by agent, field days and contact farmers, these were assumed to be highly correlated with the location of extension staffing. However, information gathered on modules of extension advice followed was utilised to analyse the impact of various sources of information to farmers on improved practices.

- Cultivation of high-value cash crops such as tea and coffee. Inclusion of these factors was motivated by the fact that, extension support services for tea and coffee production in Kenya are considered the oldest and most developed compared to the Ministry of Agriculture general extension services. This is mainly because of the highly commercialised nature of tea and coffee production and the fact that they cater for a relatively smaller number of specialised farmers (Bindlish & Evenson, 1993). Therefore, it is hypothesised that the chances are higher for maize farmers to receive extension advice if they also produce tea or coffee (Hassan *et al*, 1998b). A dummy, indicating whether or not tea or coffee was planted on the farm with maize was therefore used to control for this factor. The impact of T&V on provision of extension advice to maize farmers was analysed for three practices: use of improved seed, fertiliser, and pest control.

The logit analysis results confirmed the biases of extension services before T&V in favouring high-potential zones; villages nearer to markets and extension services; large-scale, educated, male farmers; and growers of cash crops (Table 1)[6]. This was consistently true across the three practices: seed, fertiliser, and pest control. The bias against less favourable environments was reduced after the T&V, especially in sites where previous extension contact was established (*old village*). In villages where some farmers were reached by extension before T&V (*old village*), emphasis has shifted significantly from high-potential zones (value of the regression coefficient dropped from .33 before to .02 after) to medium and low-potential zones, where coefficients either switched sign (from -ve to +ve) or had smaller negative value (Table 1)[7]. This suggests that relatively more farmers were reached by extension in *old villages* in the medium and low- potential zones than in high-potential zones after the T&V.

On the other hand, the emphasis of extension in sites contacted for the first time after the T&V (*new villages*) continued to concentrate on high-potential zones. That is evident from the fact that the odds of getting advice after T&V increased for *new villages* in high-potential areas (larger +ve value of coefficient), whereas the opposite was true for medium-potential zones, especially in the case of fertiliser and pest control (where coefficients switched sign from +ve to -ve). This result suggests that, while more farmers in medium and low potential areas are reached by extension in *old villages*, relatively more farmers in newer sites are reached in the high-potential zones after the T&V system. This may be consistent with the T&V strategy to focus on high-potential zones (Bindlish & Evenson, 1993). Like zones of high biological potential, proximity to extension services factors (in-village agent and nearer markets) showed high statistical significance. While the bias towards areas where an extension agent is based nearby increased after T&V in *old villages*, this was reversed after T&V in *new villages* (coefficients switched sign from +ve to -ve). This result indicates that extension contact became more extensive in *old villages* where an extension agent is based, as the odds of receiving advice increased after T&V. However, in supplying extension advice to *new villages*, the T&V system placed more emphasis on sites with no extension agent.

As indicated by Table 4, this implied increased use of components of extension services and information dissemination mechanisms other than direct farmer-to-farmer contact by agents (e.g. field days, contact farmers, etc.) after the T&V. While it is a bit confusing to see a negative correlation between the odds of receiving advice and availability of extension agents, this result simply indicates that relatively more farmers were reached through other delivery methods in new sites with no agents than in sites where an agent is posted. One explanation for this could be the more reliance within sites where agents are located on direct contact with individual farmers than on other methods compared to away sites where it is more cost effective to communicate with farmer groups through field days and use of contact farmers. Nevertheless, this sends an important policy message about the redundancy of direct contact and posting of staff compared to the efficacy of other components of the information dissemination technology and process. This however, is one of the merits of the T&V system that recognises this implication and promotes mechanisms to mobilise and stretch extension resources especially other than the conventional method of posting of agents.

The odds of getting advice decreased with distance from the nearest market centre before T&V (Table 1). It is clear that this trend was reversed after T&V in both new and *old villages*, as coefficients became larger in value (smaller negative value), indicating that more farmers in more remote areas were reached after the T&V. While the odds of getting extension advice continued to be higher, (+ve coefficient) for male farmers, the bias is reduced after the T&V (smaller magnitudes), except for pest control where the bias toward males increased after the T&V. This may be attributed to the fact that pest control is usually practised by large-scale commercial farmers, who are mainly males (Hassan and Salasia, 1994).

Table 1: Results of the multinomial logistic analysis of the provision of extension advice to maize farmers on improved seed, fertiliser, and pest control

Regressors	Improved seed			Fertiliser			Pest control		
	Before T&V	After T&V		Before T&V	After T&V		Before T&V	After T&V	
		Old[b] site	New[b] site		Old[b] site	New[b] site		Old[b] site	New[b] site
Agroclimate									
• High-potential zone	.330***	.020	.518***	.374**	.014	.447**	.315**	-.071	.451**
• Medium-potential zone	-.054	.036	.266	.001	.124	-.198	.045	.015	-.325
• Low-potential zone	-.276	-.056*	-.252*	-.375*	-.137	-.245*	-.360	.057	-.127*
Village attributes									
• Extension agent in village	.412*	.846***	-.376**	.603**	.835***	-.420**	.655**	.773***	-.601***
• Distance to nearest market (km)	-.018**	-.009	.012	-.012*	-.017*	.031	-.009	-.013*	.014*
Farmer attributes									
• Male	.183*	.179*	.155	.237**	.168*	.154	.128	.227**	.234*
• Large-scale (> 2 ha)	.454***	.092	-.186	.332***	.066	-.188	.335***	.007	-.147
• Received some education	.386***	.060	-.107	.434***	.061	-.031	.425***	.057	-.037
• Age (years)	.018***	-.005	-.007	.021***	-.001	-.007	.019***	-.001	-.009
• Tea or coffee farmer	.297***	.131	-.021	.305**	.088	-.139	.294**	.114	-.080
• Constant	-3.2***	-2.3***	-2.4***	-3.8***	-2.6***	-2.7***	-3.7***	-2.6***	-2.54
Number of valid cases	1031	1031	1031	1031	1031	1031	1031	1031	1031
-2 Log likelihood	69.9***	22.8***	12.5*	66.99***	21.43**	9.68	58.3***	18.4**	14.0*

, **, * indicate statistical significance at the 10%, 5%, and 1% levels, respectively.*

a. *Figures in the table denote estimates of the regression parameter β_i. When $\beta_i < 0$, the odds factor $P_j/P_k = exp(\beta' x_i) < 1$ (see Appendix). The reverse hold for $\beta_i > 0$.*

b. *An old site refers to villages in which some farmers were reached by extension before T&V was introduced. A new site is any village where no farmer was contacted by extension prior to the T&V.*

The results of Table 1 showed very clearly that the bias toward large-scale farmers was reduced in the *old villages* and reversed in newly contacted villages (coefficient changed sign) after T&V. The same applied to biases against illiterate farmers. The chance of younger farmers receiving advice was lower before, than after T&V (either through switching sign or smaller magnitude of coefficient). The logit results also, support the hypothesis of better access to extension among tea and coffee farmers before T&V across all technology messages. In fact, the effect of tea/coffee planting on the probability of extension contact is statistically very significant. While the bias toward tea/coffee farmers continued in *old villages* after T&V, the trend was reversed in newly contacted villages.

In summary, except for the case of age, the above results suggest that the T&V system was more effective in reversing the biases of conventional extension services in newly contacted sites than in *old villages*. This correlation between the persistence of previous biases and areas where conventional methods were used suggests that although the quantity of services was improved via increased resources or staffing, the approach and patterns of the past remained unchanged in *old villages*. In general, the results suggest that biases against small-scale, younger, and uneducated farmers in remote areas are reversed with the introduction of the T&V system. Nevertheless, the bias against relatively more marginal zones and women continued, although reduced after T&V. The above findings are further confirmed by the patterns revealed in Table 2, where the rate at which *new villages* and more farmers were reached by extension increased significantly after the T&V system. However, the emphasis on high-potential zones continued, as many more villages and farmers were reached by extension after the T&V in high potential than in areas of low and medium-potential (8.8 farmers per year compared to only two). It is also clear that the rate at which more farmers were contacted was higher within *old villages* compared to *new villages* after T&V (Table 2).

5. EFFICACY OF THE T&V SYSTEM

The quantity (incidence) and pattern of extension advice to maize farmers were analysed in the preceding section. This section examined the quality (effectiveness) of the received advice in inducing adoption of the recommended practices. For lack of data, this study made no attempt to assess the effectiveness of extension by measuring productivity changes (Hussain *et al*, 1994; Feder & Slade, 1986 and Bindlish & Evenson, 1993). Alternatively, the extent to which advice induces adoption was used as a proxy measure of its efficacy. The results of table 3 show that in general, adoption was higher among farmers reached by extension irrespective of whether before or after T&V. However, the percentage of farmers adopting recommended practices was higher after the change to the

T&V system in the same "old" village. This indicates that the T&V approach was more effective in causing adoption, which can be attributed to the improved quality of the extension advice. The reverse was true for the *new villages* reached by extension after the T&V.

Table 2: Distribution of villages and maize farmers reached by extension services by agroclimatic zone before and after the Training and visit (T&V) system[a]

	Never reached	Reached before T&V	Reached after T&V		Don't remem-ber	Total
			Old[b] village	New[b] village		
Low-potential						
Number of villages	1 (6)	7 (47)	-	7 (47)	-	15(100)
Villages per annum[c]	-	.23	-	.70	-	.35
Number of farmers	152 (54)	14 (5)	27 (10)	20 (7)	68 (24)	281(100)
Farmers per annum[c]	-	.47	2.7	2.0	-	3.2
Medium-potential			-			
Number of villages	0 (0)	7 (54)	-	6 (46)	-	13 (100)
Villages per annum[c]	-	.23	25 (10)	.60	-	.33
Number of farmers	110 (42)	21 (8)	2.5	20 (8)	87 (32)	263(100)
Farmers per annum[c]	-	.70		2.0	-	3.8
High-potential						
Number of villages	0 (0)	32 (68)	-	15 (32)	-	47 (100)
Villages per annum[c]	-	1.07	-	1.5	-	1.18
Number of farmers	263 (30)	123(14)	125(15)	88 (10)	264 (31)	863(100)
Farmers per annum[c]	-	4.1	12.5	8.8	-	15.0

a. Figures in brackets denote percentages.

b. An old site refers to villages in which some farmers were reached by extension before T&V was introduced. A new site is any village where no farmer was contacted by extension prior to the T&V.

c. 1952 was reported in the survey as the year when the earliest extension contact was made with maize farmers. Accordingly, it is assumed that extension services extended over a total period of 40 years at the time of the survey (1952-92), 30 of which were in the pre-T&V and 10 in the post-T&V era.

A logit model was used to measure and perform formal tests of hypotheses about the efficacy of extension advice before and after the T&V system. Whether or not the recommended practices are adopted is used to index the binary dependant variable defining efficacy (adoption). The logistic regression results confirmed the previous findings, as the odds of adoption were higher among farmers reached by extension in general, and especially in old villages before and after T&V (Table

3). The relatively slower adoption rates in *new villages* may be attributed to their remoteness from input supply centres and the relatively poorer road access (Table 3). While confirming the importance of awareness through extension advice, the above results also suggest that access to and availability of the recommended technologies are crucial for higher adoption. Moreover, adoption

Table 3: Adoption rates and maize yield levels by zone before and after T&V

	Never reached	Reached before T&V	Reached after T&V		Don't remember
			Old[a] village	New[a] village	
Low-potential					
Percent adopted improved seed	8.7	71	81	40	38
Percent adopted fertiliser	2.9	29	46	10	10
Percent adopted pest control	10.0	43	65	25	13
Medium-potential					
Percent adopted improved seed	16.0	70	78	35	42
Percent adopted fertiliser	10.0	55	43	25	38
Percent adopted pest control	8.7	37	50	20	32
High-potential					
Percent adopted improved seed	48	88	89	76	76
Percent adopted fertiliser	32	70	71	53	58
Percent adopted pest control	25	63	64	51	50
Logistic regression results[b]					
Adoption of improved variety	-1.54***	.96***	1.01***	-.11	-.36
Adoption of fertiliser	-1.26***	.73***	.71***	-.11	-.07
Adoption of pest control	-1.22***	.61***	.80***	.02	-.21
Distance to primary market(km)	55	24	24	127	37
% on all weather road	41	60	60	47	46

, **, * indicate statistical significance at the 10%, 5%, and 1% levels, respectively.*

a. *An old site refers to villages in which some farmers were reached by extension before T&V was introduced. A new site is any village where no farmer was contacted by extension prior to the T&V.*

b. *Figures denote estimates of the regression parameter β_i. When $\beta_i < 0$, the odds factor $\frac{P_i}{P} = \exp \beta X_i) < 1$. The reverse holds for $\beta_i > 0$ (see Appendix).*

had taken place in the *old villages* a long time ago and as a result, more information and experiences on adaptation of the recommended practices were available to farmers compared to the newly reached villages. This suggests that

there is a learning time lag between arrival of information (awareness) and adoption which is an important demand factor that existed in the *old villages* leading to the establishment of a sizeable market to attract input supply services. It is clear from Table 3 that, although T&V reduced the biases against remote areas, it is still crucial to improve access to and availability of inputs through improved roads and input supply services for faster adoption.

Another feature of the results of Table 3 is the fact that the adoption rates for improved crop management methods such as fertiliser and pest control was in general lower than those for improves varieties across all zones. Efficacy of extension advice, however, is hard to separate from the quality and relevance of advice, e.g. content of the extension message. Although less and relatively simpler information may be required for promotion of improved varieties, the extension message on crop management practices is more complicated. This is especially true for fertiliser use recommendations which are usually conditioned by source, dose, timing, etc.

6. RELATIVE IMPORTANCE OF EXTENSION AS A SOURCE OF INFORMATION FOR FARMERS

Farmers learn about new technologies from various sources besides the extension system. For instance, firms marketing agricultural inputs, such as seed, fertiliser, and pesticide dealers, disseminate information about new inputs and methods of production to promote their sales. Also, farmers gather information about new production methods by observing each other's practices. The majority (about two thirds) of maize farmers in Kenya who received advice on new methods acquired the information through direct (visits of extension officers) and indirect (contact farmers, field days, demonstration trials, radio programs, etc.) extension means (totals row of Table 4). Other farmers were the second most important source of information about new practices, particularly on varieties (34%). The vast majority of those acquiring information from other farmers were those who could not remember the year when they first became aware of the improved methods (77% in the case of varieties and 65% for the other technologies).

On the other hand, the proportion of farmers receiving advice through indirect extension means after the T&V was higher in new sites than in old villages and than before T&V. This shows the higher reliance on methods of dissemination other than agents' visits to reach farmers in new sites than in old villages after T&V. It is more likely that the '*other farmers*' source reflects the effect of increased reliance on contact farmers and groups under the T&V approach. If this is the case, the impact of T&V may consequently be underestimated. It is also clear from Table 4, that the contribution of input supply systems to maize technology dissemination was relatively low. This may be attributed to the fact that input delivery systems in Kenya are still dominated by inefficient publicly managed agencies and poor marketing and physical and financial infrastructure that limit the incentive to private sector to enter input delivery.

Table 4: Source of information on maize production practices by type of message before and after T&V (% farmers)

Technology Message	Extension-Direct[1]	Extension-Indirect[2]	Input-supplier[3]	Other[4]
Improved variety				
Before T&V	19	72	8	1
After T&V	-	-	-	-
Old Village[a]	22	76	1	1
New Village[a]	5	89	1	5
Don't remember	5	16	2	77
Total	**18**	**44**	**4**	**34**
Fertiliser use				
Before T&V	17	74	5	4
After T&V				
Old Village[a]	20	71	3	6
New Village[a]	5	83	2	10
Don't remember	8	14	12	66
Total	**17**	**47**	**6**	**24**
Pest control				
Before T&V	19	72	8	1
After T&V	-	-	-	-
Old Village[a]	20	74	4	2
New Village[a]	6	80	9	3
Don't remember	8	18	9	65
Total	**19**	**48**	**5**	**24**

[a] *An old site refers to villages in which some farmers were reached by extension before T&V was introduced. A new site is any village where no farmer was contacted by extension prior to the T&V.*
[1] *Direct contact by extension agent.*
[2] *Through contact farmer, radio broadcast, field day, or demonstration trial.*
[3] *Trader/dealer selling agricultural inputs (seed, fertiliser, pesticides, etc).*
[4] *Other farmers and formal training.*

6. CONCLUSIONS

The effectiveness of the T&V system compared to the conventional extension approach to maize farmers in Kenya was evaluated in this study. This was

achieved through formal empirical testing of hypotheses about the quantity and quality of extension services under the T&V, especially with respect to their impact on reducing biases of conventional approaches to extension advice. Results of a multinomial logistic regression analysis suggest that biases against small-scale, young and uneducated farmers and remote areas were, at least reduced if not reversed after introducing the T&V system. However, the bias against marginal zones and women in terms of number farmers reached by extension (incidence) continued under the T&V, though at reduced rates. The evidence provided for the superiority of methods of dissemination other than direct agents' contact (e.g. through contact farmers, field days, etc.) in delivering extension advice quantity wise (e.g. number of farmers reached), has important policy implications for packaging extension services. It also confirms the appropriateness of the T&V as it promotes reliance on indirect methods of contact.

The quality of extension advice under the T&V system in terms of efficacy in inducing adoption of recommended practices was also analysed using logistic regression. Results indicate that the T&V approach was effective in promoting higher adoption. This suggests that better quality information and effective dissemination mechanisms were delivered by the T&V system compared to the previous conventional approach. The analysis also confirmed the crucial role of improved access to and availability of inputs and better roads in enhancing the effectiveness of awareness through extension advice. This is because, while T&V reduced the bias against remote areas (by reaching proportionally more farmers than before), adoption of improved practices remained low in these areas as a result of infrastructure and input supply services constraints. It has also been revealed that there is a learning time lag between arrival of information or awareness and adoption, during which period cumulative knowledge and experiences build up among farmers to establish effective demand for agricultural innovations.

NOTES

1. *The KMDBP was a collaborative research project between the International Maize and Wheat Improvement Center (CIMMYT) and the Kenya Agricultural Research Institute (KARI) with partial funding from The Rockefeller Foundation and United States Agency of International Development (USAID).*

2. *For further details see Hassan et al. (1998a).*

3. *Although the Bindlish and Evenson (1993) study employed the same sampling frame of the CBS clusters, their sampling design was based on very different criteria. For instance, sites and farmers were selected in their study on basis of administrative*

boundaries, whereas the KMDBP employed a rigorous geo-referenced digital spatial frame. Also, the spatial spread of the KMDBP sample, which covered all the 30 districts included in the first Kenya National Extension Project (KNEP) is much wider than the Bindlish and Evenson's (1993) study survey which was conducted in only 7 of the 30 districts. However, their survey covered more sites from fewer districts.

4. *The several zones separated by the KMDBP to characterize adaptation environments for maize production (Hassan & Njoroge, 1996) were grouped into three agricultural potential categories in this study: high, medium and low-potential zones. The three zones of production potential refer to the highland tropics, mid-altitude areas, and lowland tropics of Kenya, respectively.*

5. *The several zones separated by the KMDBP to characterize adaptation environments for maize production (Hassan & Njoroge, 1996) were grouped into three agricultural potential categories in this study: high, medium and low-potential zones. The three zones of production potential refer to the highland tropics, mid-altitude areas, and lowland tropics of Kenya, respectively.*

6. *Results of the "don't remember" category are not reported in Table 1 for space limitations.*

7. *Smaller negative values of the coefficient means that the odds factor,* $\frac{P_j}{P_k} = \exp(\beta' X_i)$ *is larger.*

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APPENDIX

THE MULTINOMIAL LOGIT (MNLO) MODEL

The MNLO model extends the binary (dichotomous) dependent variable logistic model to the case of multicategories (polychotomous) dependant variable[2]. Consider the following polychotomous response variable:

$$Y_{ij} = 1 \quad \text{if the ith individual falls in the jth category}$$
$$= 0 \quad \text{otherwise} \tag{1.1}$$

The probability regression model for this response variable is:

$$\text{Prob}\,(Y = j) = P_{ij} = \beta' X_i + \mu_{ij} \tag{1.2}$$

Where j refers to response categories (1,2,...,m)and i denotes cases (1,2,...,n). β is the vector of model parameters, X_i is the matrix of values of observed regressors for individual i and μ_{ij} defines the matrix of unobserved random effects. When the logistic distribution is used for μ_{ij}, then equation 1.2 becomes:

$$P_{ij} = \frac{\exp(\beta' X_i)}{1 + \sum_{j=1}^{m-1} \exp((\beta' X_i)}$$

$$P_{ij} = \frac{1}{1 + \sum_{j=1}^{m-1} \exp((\beta' X_i)} \tag{1.3}$$

Model 1.3 is estimated using the maximum likelihood procedure. As P_{ij} is nonlinear in all the likelihood function of model 1.3 is also nonlinear in , which requires an iterative nonlinear optimisation method[3]. The marginal effects of the regressors on the probabilities are derived as follows:

$$\frac{\partial P_j}{\partial X_i} = P_j(\beta - \sum_k P_K \beta_K) = P_j(1 - P_j)\beta_i$$

[2] *Variants of MNLO were applied to cases where response categories are unordered (Schmidt and Strauss, 1975), ordered (Ashford, 1959) and sequential (Cragg & Uhler, 1970) and when choice attributes are considered in addition to individual characteristics in determining choice probabilities (McFadden, 1974).*

[3] *Maddala (1983).*

$$\frac{\partial P_j}{\partial X_K} = -P_j P_k \beta_k \tag{1.4}$$

The odds ratio (i.e. factor by which odds change as X changes) is obtained from:

$$\frac{P_j}{P_k} = \exp(\beta' X_i) \tag{1.5}$$

Accordingly, when β_i is zero the odds ratio is 1 meaning that the odds do not change when the value of changes (i.e. X_i has no effect). When $\beta_i > 0$, odds factor is less than 1 (odds of response j increases). The reverse is true for $\beta_i < 0$.

The logistic procedure of the computer software SAS was used to estimate the model 1.3 for the polychotomous dependant variable under study, which had the following response categories:

Y	=	0	if farmer never received extension advice,
	=	1	if farmer received extension advice before the Training and Visit (T&V) system was introduced.
	=	2	Received advice after the T&V in an old village,
	=	3	Received advice after the T&V in a new village,
	=	4	Received but didn't remember when

The SAS logistic procedure estimates the model based on the cumulative distribution probabilities of the response categories (i.e. not the individual probabilities). SAS procedure uses an Iteratively Weighted Least Squares Algorithm to estimate the MNLO model parameters[4].

[4] *SAS/STAT (1990).*

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