Evaluation of agricultural technology adoption using the double difference evaluation method: The case of the Kenya Agricultural Productivity Project (KAPP)

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Abstract

Impact evaluation is undertaken to determine whether a program achieved desired effects on individuals, households, and institutions and whether those effects are attributable to the program intervention. Ultimately, the process validates outcomes and supports feedback mechanisms. This paper discusses evaluation of technology adoption within the Kenya Agricultural Productivity Programme (KAPP), a multi-sectoral and multi-institutional project, with the long-term objective of increasing agricultural productivity. Evaluation of technology adoption was based on the project baseline survey. Data was collected from 9 out of 15 districts covered by the baseline survey. A sample size of 800 households out of 1,209 households sampled in the baseline survey was determined. The sampled households were classified into target and control households. The Double Difference or Difference-in-differences method was chosen to evaluate impact on technology adoption. This method allows comparisons between a treatment and comparison group (first difference) before and after a program (second difference). The baseline and follow-up data from the same "target" and "control" groups was used. The treatments evaluated were utilization of improved seeds; fertilizer application; animal feed preservation technologies; market participation; uptake of improved livestock breeds; soil, water and environmental conservation technologies; and utilization of extension services. General results indicate positive project impacts on all the foregoing treatments with different impact levels in the different agro-regional zones (ARZs). Therefore, KARI must not only continue to generate technologies but should also develop strategies for technologies to reach the different target populations in different ARZs. A multi-institutional process such as the KAPP is beneficial as it ensures effective resources mobilization, creation of useful synergies, and sharing of lessons that support agricultural policy formulation processes. The evidence generated from such evaluation should form the basis for planning future research outputs so as to improve the quality of research.

Key words: Kenya Agricultural Productivity Programme (KAPP), evaluation, adoption, technology, double-difference

Background

The Kenya Agricultural Productivity Programme (KAPP) is a 12 year multi-sectoral and multi-institutional project being implemented in three phases from 2004-2012. KAPP aims at improving the overall agricultural system by supporting generation, dissemination and adoption of agricultural technology in a bid to synchronize research, extension and farmer empowerment initiatives. The first phase (2004-2008) supported the ongoing reforms in agricultural research, initiation of a participatory process of change in extension services, farmer/client empowerment and piloting of extension methods and delivery systems. The implementation of this phase was through four project components namely: facilitation of policy and institutional reforms; support to extension system reform; support to research system reform and support to farmer/client empowerment.

The first phase was implemented in 20 pilot districts to determine the most appropriate, effective and efficient delivery systems, method and approaches for extension services.

A baseline survey was conducted between July and September, 2006 in 15 out of the 20 pilot districts. The survey used two approaches: (a) a household survey encompassing the main aspects of agricultural development, and (b) a community survey to identify factors influencing access to technologies that are outside the ambit of the households. The main objective of the survey was to establish benchmarks from which to assess the impact of the project as a whole and to provide a credible evaluation of the extension pilots. This first phase of the KAPP came to an end by December 31, 2008.

The Government of Kenya, led by the implementing agencies decided to undertake a survey to evaluate the impact of the project on technology uptake by the target communities/households. In developing countries like Kenya, adoption of improved technologies is expected to increase productivity so as to meet the increasing demand for food and other livelihood demands of the rapidly growing population. The adoption of improved technologies is governed by a complex set of factors such as human capital, information, location, resource endowments and institutional support. Within this frame condition, farmers' decisions to adopt or reject a particular technology depend on their needs, as well as on costs and benefits accruing to them.

It is against this background that the household-based evaluation survey on adoption of technology was undertaken.

Technology Adoption: Theoretical and empirical foundations

Adoption of technologies occurs in an innovation-decision process that consists of a series of actions and choices over time through which individuals or other decision-making units evaluate a new idea and decides whether or not to include the innovation into existing practices (Rogers, 1995). It has been greatly demonstrated that technology uptake is a major contributory factor to increased agricultural productivity (Semana, (1999); Doss and Morris (2001); Neupane, et al., 2002; Marenya and Barrett, (2006); Kiptot, et al., (2007). Therefore, evaluation studies of technology adoption provide evidence-based information that is useful in decision making as well as in designing effective intervention programmes and projects in agriculture. They enable the enactment of a feedback mechanism in which lessons learnt from implementation of programmes, can be used in future, to support development objectives (Thornton, et al., 2003).

Adoption studies have also revealed pitfalls in agricultural research and extension systems by, among others, establishing that separate and poorly linked systems of research and extension yield low returns (Chema et. al., 2003). Lessons learnt from these studies have influenced governments in developing countries, including Kenya, to design and implement realistic programmes and extension service approaches that are properly linked with research with a view to enhancing technology adoption. Similarly, such studies have informed designs of programs involving extension service and agricultural research to take into account the dynamism evidenced within smallholder farms.

Materials and Methods

Study site

This impact evaluation was undertaken in 9 districts of Kenya, namely: Nyeri, Kwale, Embu, Makueni, Garissa, Gucha, Homa Bay, West Pokot, Butere/Mumias. The 9 districts were selected in such a way that they represented 8 agro-regional zones (ARZs) in Kenya with similar climatic conditions, agricultural activities and administrative boundaries. The districts are as shown in the map below (Figure 1)

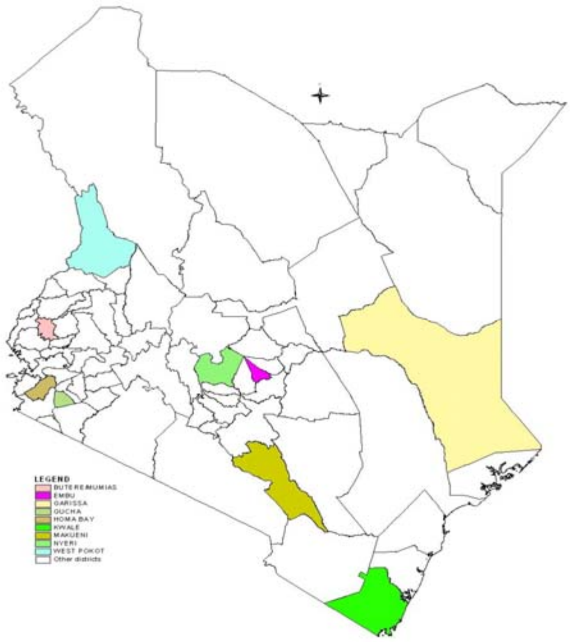

Figure 1: Map of Kenya highlighting the 9 districts of Kenya where impact evaluation was undertaken

Sampling procedures

The sample design and allocation was based on the sampling frame used by the baseline survey of 2006 that was conducted in 15 out of the 20 pilot project districts, and covered a total of 2,027 households. The sampled households were categorized into “target” (60%) and “control” (40%) households. The survey adopted a multi-stage sampling design, combining stratified random and proportional sampling techniques in selecting the districts and households. Global Positioning System (GPS) was used to capture the precise location/coordinates of the sampled households and hence digitally map of all the households/villages visited in the survey.

The technology adoption survey used a sub-set of the districts covered and households interviewed in the baseline survey. The lists of household heads interviewed in each of the 9 districts during the baseline survey together with their GPS coordinates were used to identify the households for the adoption survey. Since the number of households interviewed during the baseline survey was greater than the number sampled for the technology adoption survey, the required number of households was drawn from the lists through a systematic sampling approach; that is, by establishing a sampling fraction k =n/N, and picking every kth name in the list from a random start.

Sample size

A fixed sample size of 800 households out of the 1,209 households sampled for the baseline survey in 9 out of 15 districts was found to be representative of the farming communities in the project districts, and also manageable in terms of cost and time.

Proportional allocation of 60% "target" and 40% "control" households was used in distributing the 800 households among the 9 districts. However, the "target" group was further split into two categories of "Common Interest Group (CIG)" and "non CIG" households by using complimentary proportions of 40% and 60%, respectively.

The three categories are illustrated as follows:

(i) Category 1: A subset of "target" households residing in the KAPP intervention areas/sub-locations which were interviewed during the 2006 baseline survey, but have no active CIG members.

(ii) Category 2: A subset of "control" households residing outside the KAPP intervention areas which were interviewed during the 2006 baseline survey.

(iii) Category 3: A subset of "target" households residing in the KAPP intervention areas, which were interviewed during the 2006 baseline survey and have active CIG members.

The Common Interest Group (CIG) is an approach that was employed by the Kenya Agricultural Productivity Programme (KAPP) as part of the extension process. The approach sought to incorporate the attributes of service delivery, farmer empowerment for demand and access of agricultural services, good practices that do not perpetuate dependency and provide the opportunity for evaluating different extension delivery systems (KAPP, 2005).

In operations, the CIG was linked to the District Service Unit (DSU) whose coordinator steered and mobilized all stakeholders to form a Service Providers Forum (SPF) at the district level. The SPF was made up of subject matter specialists from government ministries, NGOs, religious organizations, research organizations, educational institutions and private sector agencies that provided expertise in agriculture, livestock, fisheries, forestry, and water. The forum set out the community resource assessment in which the communities were mobilized through a participatory process that established their circumstances, their opportunities and challenges. In mobilizing the communities, all potential service providers advertise and market themselves with a view to triggering demand or interest for specific services among the farming communities. These services may be in regard to introduction of new or improved crops or animals, value addition, agro-processing, packaging, marketing and branding for niche markets. Farmers interested in pursuing certain promoted opportunities formed the Common Interest Group (CIG).

The impact evaluation approach

The method chosen to evaluate impact on technology adoption is the Double Difference or Difference-in-differences method in which one compares a treatment and comparison group (first difference) before and after a program (second difference).. The method requires baseline and follow-up data from the same "target" and "control" groups; and compares levels of treatments (Baker, 2000). The treatments evaluated in this project were: (a) utilisation of improved seeds; (b) fertilizer application; (c) animal feed preservation technologies; (d) value addition technologies; (e) market participation; (f) uptake of improved livestock breeds (g) soil,water and environmental conservation technologies; and (g) utilisation of extension services.

The method enables specific attribution of improvements in these outcome indicators to the project and also allows an examination of whether some households are able to benefit from the project relatively more than others - and why. It is quite appropriate as it eliminates fixed differences not related to treatment, but can be biased if the assumption that two groups are growing at similar rates or same direction is violated. The approach provides valuable insights for making potential improvements in the design and implementation of future phases of the project as well as new projects.

Comparisons of levels of treatments are carried out as follows:

(i) Between a target (treatment) and a control (comparison) group - first difference; and
(ii) Before and after the intervention - second difference.

In the KAPP case, a baseline survey was conducted for the outcome indicators for the "target" group as well as a "control" group. A follow-up survey (the technology adoption survey) was conducted in 2009 for a subset of the same households and areas covered by the baseline survey. The design of the two surveys therefore makes the Double Difference method quite plausible in evaluating the impact of the KAPP interventions with respect to technology adoption.

Steps followed in estimating impact of the interventions using the method are:

(i) Calculating the mean difference between the "after" and "before" values of the outcome indicators for each of the "target" and "control" groups.
(ii) Calculating the difference between these two mean differences.

Impact of the project interventions is therefore the difference in treatment group over the two periods less difference in the control group over the same period that is calculated as follows:

Impact = (Yt1-Yt0) - (Yc1-Yc0)

Where:

(Yt1-Yt0) = difference in treatment (target households) group over the two periods

(Yc1-Yc0) = difference in the control group over the two periods.

The main assumption in the application of the method is that the two groups are growing at similar rates or in the same direction. Figure 2 illustrates this assumption; where the average treatment effect is shown as the difference between the projected dotted line for the treatment group and the higher parallel line for the same group.

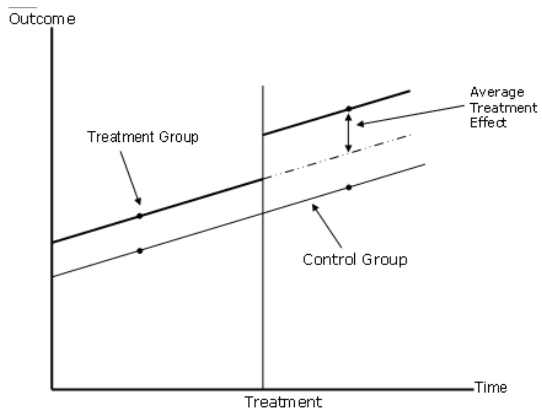

Figure 2: Illustration of the assumption underlying the double-difference method of impact evaluation

Results

Use of hybrid maize seeds

The overall impact estimate of 6.6 percentage points presented in Table 1 gives an indication of a positive project impact on the adoption of hybrid maize seeds across the regions. The highest rates of adoption were recorded in the Northern Arid Zone (26.7 percentage points), the Western Transitional Zone (34.1 percentage points) and the Eastern Lowlands (21.9 percentage points).

Table 1: Adoption of hybrid maize seeds by ARZ

	Before Project (KAPP Baseline)		**After Project (Technology Adoption)**		**Double Difference**
	Target	**Control**	**Target**	**Control**	
Agro-regional Zone	**(1)**	**(2)**	**(3)**	**(4)**	**(5)=(3-1)-(4-2)**
Central Highlands	86.0	86.0	89.8	89.6	0.2
Coastal Lowlands	29.0	26.0	35.4	26.7	5.7
Eastern Lowlands	7.0	25.0	30.8	26.9	21.9
High Potential Maize Zone	93.0	95.0	94.4	95.8	0.6
Western Highlands	87.0	89.0	91.7	91.8	1.9
Western Lowlands	19.0	22.0	19.7	26.0	-3.3
Western Transitional Zone	26.0	53.0	69.3	62.2	34.1
Northern Arid Zone	0.0	0.0	26.7	0.0	26.7
Overall	**59.0**	**61.0**	**62.3**	**57.7**	**6.6**

Fertilizer application

The project had an overall positive impact of 4.9 percent points on the adoption of fertilizer use as shown on Table 2. In particular, target farmers in the Western

Transitional Zone and the Western Lowlands had positive double differences of 38.7 and 20.5 percentage points, respectively. The project impact on fertilizer adoption for target farmers in the Central Highlands was minimal, but almost all the farmers (94.0%) were using the technology before the project started. However, the negative difference of (-2.7 percent points) for the Eastern Lowlands indicates that the project had no impact on fertilizer use for the target farmers in that region.

Table 2: Fertilizer use on all crops by ARZ

Agro Regional Zone	Before Project (KAPP Baseline)		After Project (Technology Adoption)		Double Difference
	Target	Control	Target	Control	
	(1)	(2)	(3)	(4)	(5) = (3-1)-(4-2)
Central Highlands	94.0	97.0	98.0	97.3	3.7
Coastal Lowlands	22.0	5.0	52.1	21.3	13.8
Eastern Lowlands	12.0	8.0	28.2	26.9	-2.7
High Potential Maize Zone	84.0	85.0	48.5	37.5	12.0
Western Highlands	99.0	99.0	87.5	77.1	10.4
Western Lowlands	36.0	22.0	65.3	30.8	20.5
Western Transitional Zone	60.0	83.0	93.2	77.5	38.7
Northern Arid Zone	11.0	7.0	7.5	0.0	3.5
Overall	**63.0**	**60.0**	**60.0**	**52.1**	**4.9**

Animal Feed Preservation Technologies

The overall positive impact estimate of 4.3 percent points computed in Table 3 indicates that the project had a positive impact on the adoption of animal feed preservation technologies. With the exception the Eastern Lowlands, impact estimates for the other regions indicate positive returns to animal feed preservation. In particular, project farmers in the Coastal Lowlands and the Western Highlands had positive project impact estimates of 16.0 and 8.0 percentage points, respectively.

Table 3: Animal feed preservation by ARZ

Agro-Regional Zone	Before Project (KAPP Baseline)		After Project (Technology Adoption)		Double Difference
	Target	Control	Target	Control	
	(1)	(2)	(3)	(4)	(5) = (3-1)-(4-2)
Central Highlands	50.0	50.0	51.2	49.6	1.6
Coastal Lowlands	21.0	79.0	37.3	79.3	16.0
Eastern Lowlands	62.0	38.0	60.5	40.2	-3.7
High Potential Maize Zone	43.0	58.0	50.0	62.9	2.1
Western Highlands	66.0	34.0	68.3	28.3	8.0
Western Lowlands	78.0	22.0	79.2	23.1	0.1
Western Transitional Zone	64.0	36.0	71.3	39.1	4.2
Northern Arid Zone	69.0	31.0	79.6	35.0	6.6
Overall	**56.7**	**43.5**	**62.2**	**44.7**	**4.3**

Participation in formal markets

The overall positive impact estimate of 7.8 percent points in Table 4 indicates an improvement in the selling of crops to formal markets. The highest positive impact on the participation in formal markets was for farmers in the High Potential Maize Zone (25.8 percentage points) and the Western Highlands (10.3 percentage points). The project had little or no impact on participation in formal markets for the Western lowlands (-2.6 percentage points) and for the Northern Arid zone.

Table 4: Participating in formal crop markets by ARZ

Agro-Regional Zone	Before Project (KAPP Baseline)		After Project (Technology Adoption)		Double Difference
	Target	**Control**	**Target**	**Control**	
	(1)	**(2)**	**(3)**	**(4)**	**(5) = (3-1)-(4-2)**
Central Highlands	42.3	49.1	43.0	49.1	0.7
Coastal Lowlands	0.5	0.3	1.2	0.9	0.1
Eastern Lowlands	0.7	0.0	2.0	0.0	1.3
High Potential Maize Zone	4.9	7.4	30.7	7.4	25.8
Western Highlands	8.8	16.7	15.4	13.0	10.3
Western Lowlands	4.6	2.9	13.3	14.2	-2.6
Western Transitional	0.3	8.7	11.9	12.9	7.4
Northern Arid	0.0	0.0	0.0	0.0	0.0
Overall	**8.9**	**14.2**	**14.7**	**12.2**	**7.8**

Uptake of Improved Cattle Breeds

A high proportion (41.0%) of households owned local cattle. Exotic cattle were reportedly owned by a small proportion of households (only 15.1% had grade cattle and 22.8% cross breed cattle). Across the regions, the Central Highlands, the Western Highlands and the High Potential Maize zones had the largest proportions of households owning grade and cross breed cattle. No households in the Western Lowlands reported owning grade cattle. Poultry, sheep and goats were owned by majority of the households. The Northern Arid zone had the largest proportion of households owning local sheep, goats and camels.

Ownership of improved cattle breeds improved during the project period, as demonstrated in Table 5 by an overall project impact estimate of 11.4 percentage points. Farmers in the Western Highlands and the Central Highlands recorded the highest project impact on ownership of grade cattle. There is, however, no measurable project impact on improved cattle breeds in the Northern Arid Zone and the Western Lowlands.

Table 5: Ownership of grade cows by ARZ

Agro-Regional Zone	Before Project (KAPP Baseline)		After Project (Technology Adoption)		Double Difference
	Target	**Control**	**Target**	**Control**	
	(1)	**(2)**	**(3)**	**(4)**	**(5) = (3-1)-(4-2)**
Central Highlands	18.5	19.8	46.5	30.1	14.0
Coastal Lowlands	0.2	1.8	4.2	2.1	3.7

Eastern Lowlands	0.0	0.0	5.1	3.8	1.3
High Potential Maize Zone	2.3	6.2	9.1	4.2	8.8
Western Highlands	1.8	2.4	35.0	10.4	25.2
Western Lowlands	0.0	0.0	0.0	0.0	0.0
Western Transitional Zone	0.0	0.7	5.1	2.1	3.7
Northern Arid Zone	0.0	0.0	2.5	3.7	-1.2
Overall	**5.0**	**7.0**	**19.3**	**9.9**	**11.4**

Soil, Water and Environment Conservation Technologies

The project seems to have had mixed performance on the adoption of conservation technologies. Table 6 shows improvement in the adoption of crop covers and mulching conservation technologies. However, there were negative differences in the Central Highlands (-1.3 percentage points), Northern Arid Zone (-4.6 percentage points) and the Western Transitional Zone (-0.8 percentage points); which gives an indication that the project had no measurable impact on this conservation technology in these regions.

Table 6: Mulching/Cover Crop as a conservation technology by ARZ

Agro-regional Zone	Before Project (KAPP Baseline)		After Project (Technology Adoption)		Double Difference
	Target	Control	Target	Control	
	(1)	(2)	(3)	(4)	(5) = (3-1)-(4-2)
Central Highlands	7.8	10.0	17.5	21.0	-1.3
Coastal Lowlands	15.3	19.3	16.7	11.4	9.3
Eastern Lowlands	1.1	1.6	1.8	2.2	0.1
High Potential Maize Zone	4.1	8.0	6.1	5.4	4.6
Western Highlands	10.5	15.5	21.5	17.1	9.4
Western Lowlands	6.4	4.3	17.3	10.9	4.3
Western Transitional Zone	10.9	7.3	15.4	12.6	-0.8
Northern Arid Zone	5.9	10.5	8.3	17.5	-4.6
Overall	**7.5**	**9.9**	**13.1**	**12.4**	**3.1**

Table 7 indicates minimal impact on the adoption of minimum tillage technology, as reflected in the negative (-0.8) percentage points impact estimate. The only regions where the project had positive impact on the adoption of minimum tillage technology were the High Potential Maize zone (7.9 percentage points), the Western Transitional zone (9.4 percentage points), and the Northern Arid zone (4.6 percentage points)

Table 7: Adoption of minimum tillage by ARZ

Agro-Regional Zone	Before Project (KAPP Baseline)		After Project (Technology Adoption)		Double Difference
	Target	Control	Target	Control	
	(1)	(2)	(3)	(4)	(5) = (3-1)-(4-2)
Central Highlands	0.5	0.7	2.0	2.9	-0.7
Coast al Lowlands	1.5	0.7	4.7	19.2	-15.3
Eastern Lowlands	0.0	0.0	13.5	26.9	-13.4
High Potential Maize zone	0.2	1.4	6.7	0.0	7.9

Western Highlands	0.4	0.6	0.0	2.4	-2.2
Western Lowlands	0.9	0.7	2.1	0.0	1.9
Western Transitional Zone	0.0	0.0	12.3	2.9	9.4
Northern Arid Zone	5.9	10.5	0.0	0.0	4.6
Overall	**0.5**	**0.9**	**4.6**	**5.8**	**-0.8**

The negative impact estimate of (-6.8) percentage points computed in Table 8 indicates that the project had no measurable impact on the adoption of terraces as a conservation method. Across the 8 regions, it is only the Central Highlands and the Western Highlands which had positive impact estimates of 6.4 and 14.6 percentage points respectively.

Table 8: Adoption of Terracing as a Conservation Technology by ARZ

Agro-Regional Zone	Before Project (KAPP Baseline)		After Project (Technology Adoption)		Double Difference
	Target	Control	Target	Control	
	(1)	(2)	(3)	(4)	(5) = (3-1)-(4-2)
Central Highlands	59.7	56.8	57.9	57.3	6.4
Coastal Lowlands	63.4	56.4	60.6	54.5	-14.9
Eastern Lowlands	89.1	88.9	90.4	89.9	-0.8
High Potential Maize Zone	72.7	65.7	74.7	67.1	-37.0
Western Highlands	64.5	62.7	66.6	63.9	-13.9
Western Lowlands	59.8	69.8	57.4	68.3	14.6
Western Transitional zone	67.2	73.6	68.4	74.7	-6.7
Northern Arid zone	88.2	78.9	88.7	78.5	-2.2
Overall	**65.9**	**63.9**	**70.6**	**69.4**	**-6.8**

Extension Services

Table 9 shows that the project had a positive impact on the adoption of integrated extension services approach, as indicated by an overall positive impact estimate of 21.9 percentage points. With the exception of the Western lowlands, the project recorded positive returns on adoption of integrated extension services in all the other regions.

Table 9: Percentages of households actively seeking extension services by ARZ

Agro-regional Zone	Before Project (KAPP Baseline)		After Project (Technology Adoption)		Double Difference
	Target	Control	Target	Control	
	(1)	(2)	(3)	(4)	(5) = (3-1)-(4-2)
Central Highlands	77.0	69.0	71.3	47.9	15.4
Coastal Lowlands	28.0	23.0	45.8	19.1	21.7
Eastern Lowlands	44.0	50.0	69.2	68.0	7.2
High Potential Maize Zone	73.0	73.0	54.5	12.5	42.0
Western Highlands	46.0	44.0	85.0	37.5	45.5
Western Lowlands	76.0	54.0	40.8	25.6	-6.8
Western Transitional Zone	41.0	58.0	71.2	42.5	45.7
Northern Arid Zone	53.0	58.0	47.5	30.8	21.7
Overall	**60.0**	**55.0**	**63.2**	**36.3**	**21.9**

Discussions

Technology adoption in agriculture involves very complex, interdisciplinary processes and inter-institutional relationships. Single farm households are involved in decision-making processes for adoption of multiple agricultural technologies as exemplified by 8 different treatments discussed in this paper. Generally all technologies availed to farmers are relevant for the varied production systems. The CIG approach in KAPP supports the achievement of the project's objective of promoting a pluralistic, efficient, farmer-led extension system. In this system farmer were able to adopt various technologies.

Hybrid maize seed remains an important technology that is expanding in range as shown by the high adoption rates in the northern arid zones (26.7 percentage points), a non-traditional maize zone. The study established increased use of hybrid maize seeds technology by farmers, with an average 62.3% (Table 1) of the target households adopting the technology. The impact estimate of negative (-3.3) percentage points for the Western Lowlands, indicates absence of measurable impact on this technology on the farmers interviewed in the region.

Fertilizer application technologies are widely used in Kenya. The project had a positive impact on the adoption of fertilizer use. The impact was however more pronounced in some regions and minimal in others (Table 2). The downward trend in use usage of fertilizers in the eastern lowlands (-2.7 percent points) could partly be attributed to high fertilizer prices recorded in the recent past against a backdrop of poor harvests attributed to climatic conditions including drought in the region.

Animal feed preservation technologies could indicate increasing populations of zero-grazed animals. This in turn is indicative of intensified systems. The low double difference of -2.7 percent points recorded for the eastern lowlands and that of 0.1 for the western lowlands, could indicate more extensive feeding regimes for livestock in these areas.

The project had little or no impact on participation in formal markets for the Western lowlands, the Northern Arid zone, the coastal lowlands, and the central highlands. Participation in formal markets is dependent upon many factors including the level of infrastructural development. The level of infrastructural development in the Western lowlands and the Northern Arid zone is relatively lower compared to other parts of Kenya. The Central highlands were already well integrated with markets even at setting the baseline.

Ownership of exotic cattle improved during the project period. The high overall project impact estimate of 11.4 percentage points may signify the popularity of livestock based enterprises among the CIGs supported through the KAPP project. There were, however, disparities across the eight ARZs with regard to ownership of improved livestock breeds. The lack of any measurable project impact on improved cattle breeds in the Northern Arid Zone and the Western Lowlands could be attributed to the prevailing climatic conditions that may not be favourable to certain breeds of improved livestock that require cooler temperatures in their management regimes.

Activities that support the sustainable use of soil and water resources as the principle natural elements to livelihoods in any farming community must be emphasized in projects. However, in the KAPP, the overall levels of utilization of soil, water and environment conservation technologies were low in all ARZs. The paradox is that the low levels of adoption of technologies for conservation of soil, water and environment goes against the expected maxim that farming households are likely to undertake various sustainable soil and water management technologies because their livelihoods are mostly dependent on natural resources. Efficient use of water and improvements in soil health and fertility are technical options for improving food production and agricultural sustainability (Pretty, et. al., 2002).

The adoption of integrated extension services approach remains relevant and critical in 7 out of 8 ARZs. Negative results were recorded for Western Lowlands. Effective and sustainable integrated extension services need to be fashioned into an innovation system where institutions facilitate flow of information and good partnership coalitions between key actors over time (Biggs and Matsaert, 2004).

Conclusions

Evaluation of technologies is important as it causes research scientists and managers to focus on the ultimate impact of the research being conducted. The 8 foregoing technologies support the notion that KARI must not only continue to focus on generating technologies but should also develop strategies for technologies to reach the target population efficiently. The different treatments examined are all relevant for different production zones.

The involvement of stakeholders and beneficiaries in the research process is critical to implementation of research, monitoring and evaluation of the activities carried out by the institute and also in participating in the technology dissemination activities.

Programmes such as the KAPP facilitate the strengthening of linkages between various institutional partners in the private, public and civil society sectors, and donors. This ensures resources mobilization, creation of useful synergies, and sharing of lessons effective in the agricultural policy formulation processes. Such multi-institutional programmes should be encouraged. Interactions of researchers with different stakeholders must be encouraged for improved capacity of scientists. This is critical considering the dynamism of the production systems that they have to deal with.

The evidence generated from evaluation and lessons learned should form the basis for planning future research outputs so as to improve the quality of research. High quality research outputs would positively impact the agricultural sector.

Recommendations

The double difference method of evaluating project impact provided useful guidance and direction in impact evaluation but use of other traditional M&E methods should be considered for triangulation of results of evaluation. Maize remains the dominant food crop for majority of the rural farmers, but the need exists for more emphasis on research and extension service delivery systems on the growing of drought resistant crops such as cassava, millet and sorghum as well as re-forestation. This should be done in response to prevailing climate change dynamics.

To counter the low market participation by farmers it is recommended that in addition to increased crop production, more emphasis should be put on market opportunities through an agribusiness approach that would take advantage of improvements in transportation, packing, storage, increasing the value and competitiveness of farm produce.

The study also established ownership of exotic cattle had slightly improved during the project period, but there were regional disparities. It is recommended that the project through advocacy groups, forums and CIGs promotes keeping of improved livestock breeds among farmers in all the agro-regional zones.

Research should endeavour to generate and promote low cost and sustainable land management practices and technologies with a view to empowering poor farmers and communities to adopt them. This may be carried out through advocacy and awareness creation.

The study results indicate increased adoption of a more pluralistic, efficient, and farmer-led extension system. The gains made by the project in the extension service reforms should be consolidated by, among others, promoting equitable geographical distribution of extension services.

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