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Assessing the role of public-private partnerships in the provision of agricultural extension services: the case of greenhouse tomato farming in Samburu County, Kenya

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Abstract

Agricultural extension services provide farmers with important information, such as patterns in crop prices, new seeds varieties, management practices and training in new technologies. Provision of such information enables farmers to optimize the utilization of the scarce resources at their disposal. In the past, a number of agricultural extension models have been employed with varying levels of success in developing countries. This study sought to document the effectiveness of the public-private partnership (PPP) model in provision of agricultural extension services in Samburu, a remote rural area of Kenya. Comparison of greenhouse tomato mean yields and standard deviations obtained by public private partnership was made using ANOVA and Chi square. Honest Significant Differences tests were also derived and used in this analysis The mean± standard error (se) yields per greenhouse varied significantly by the various models assessed (786.3±180.7, 1881.9±283.5 and 1909.1±213.5 kilograms corresponding to the public, PPP and private models respectively ($p<0.001$). Tomato productivity in greenhouse units under public model were statistically significantly less when evaluated against those under PPP model (mean± se difference of 1095.6±147.0 kilograms ($p<0.001$). Yields in greenhouse units under private and PPP models were not significantly different ($p=0.972$). These variations mirrored the levels of adoption of modern agricultural practices and technologies in the three models of extension services provision. The current study adds to the accumulating evidence that PPP may be the panacea to the ailing public agricultural extension services. Creating effective operational linkages between extension service providers and, perhaps, other key stakeholders such as input suppliers, credit and research institutions has the potential to improve the delivery of agricultural extension services to farming households in resource poor settings.

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Introduction

A general consensus exists that extension services in agriculture, if well designed and executed, improve productivity (Evenson and Mwabu, 1998). According to Katz (2002), the extension services support families in rural areas to make the best use of the resources available to them. Agricultural extension services generally provide farmers with vital information, including patterns in produce prices, new or improved varieties of seeds, management practices regarding crop cultivation as well as marketing, in addition to training in upcoming technologies.

Moreover, extension services advance the knowledge and information base of the farmers through an assortment of means, including demonstrations, targeted trainings, model plots plus group meetings. The exposure to such extension activities is mainly intended to boost the capacity of farmers to optimize the utilization of their resources ultimately leading to improvements in crops yields.

Additionally, extension services, ideally, should avail a feedback mechanism, specifically, from the farmers to the agricultural research centres.

It has been noted that even where agricultural technologies are affordable, relevant and easily available, smallholder farmers may have little access to them (Fliegel, 1993). For this reason, agricultural extension systems and the distribution systems of inputs are mutually reinforcing.

This implies that the contribution of extension services to overall agricultural productivity growth relies on a properly functioning input distribution system and vice versa. Besides, agricultural technologies are changing at a very rapid rate.

There is, thus, a need for farmers to be constantly informed of upcoming technologies and what works best. The farmers should know how to strategically employ those technologies to their advantage. Generally, such awareness creation generates demand for the most viable upcoming technologies which in turn signals the distribution system to supply the requisite inputs (Davidson *et al*., 2001).

The declining effectiveness of the extension services in agriculture in Kenya has been identified as a great impediment to the growth of this industry (Milu and Jaynef, 2006).

Indeed, the public extension systems in many countries, including Kenya, have not been able to address the issues and concerns of small and poor farmers. As a result, there has been a constant desire to reform the public agricultural extension system into a system that is responsive to the needs of farmers, accountable, cost effective, broad-based in delivery of services and with an inherent sustainability.

Anecdotal evidence indicates that public-private partnerships (PPPs) in provision of agricultural extension services have the potential to enhance the productivity of the agricultural sector. The efficiency, effectiveness and responsiveness of this multi-provider (pluralistic) extension model remain largely undocumented. In particular, there is inadequate understanding and limited literature on PPPs in agricultural extension services provision and specifically to small scale farmers in resource poor settings. The current study sought to address this gap by analyzing the PPPs in the provision of agricultural extension services in Samburu County, Kenya. The study focused on partnership in the area of greenhouse tomato production which involves the Ministry of Agriculture, World Vision, Farm Africa, Catholic Diocese of Maralal (CDM) and Red Cross Society.

Material and methods

Study area

The study was conducted in Samburu County, Kenya (Fig. 1). The county is located between latitudes 0°36′ and 2°40′ N and longitudes 36°20′ and 38°20′ E. The altitude ranges between 850 to 2400 m above sea level.

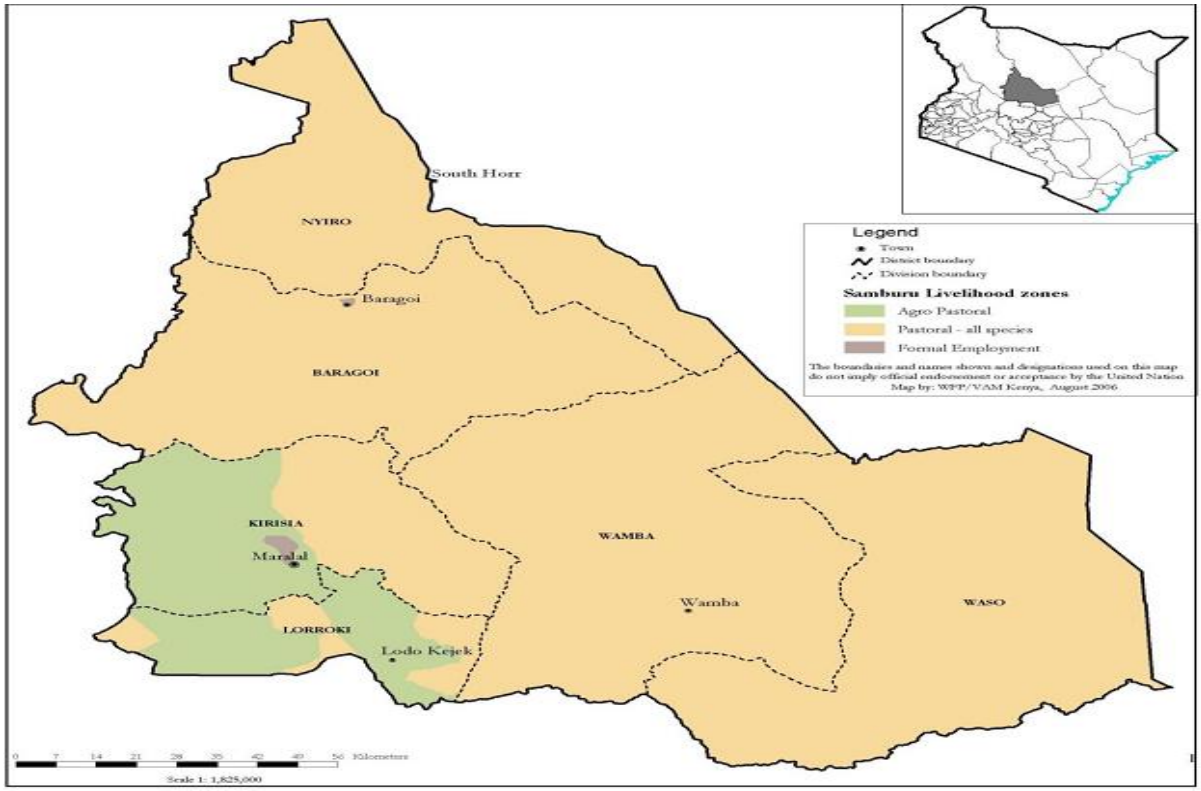

Fig. 1. Map of Samburu County 2016 (Source: National Drought Management Authority, Samburu County Office).

The area receives rainfall that is mostly erratic, in space and time. The annual rainfall ranges between 250 mm and 850 mm while temperatures are in the range of 24˚C to 33 ˚C. The County has scanty and sparse coverage of vegetation.

Data collection

Primary data were collected from, respectively, representatives of the greenhouse tomato farmers and agricultural extension service providers. Secondary data were abstracted from records maintained by the farmers and the funding organizations.

Data management and analysis

Coded data were entered and analysed using Statistical Package for Social Sciences (SPSS). Appropriate descriptive statistics such as means (standard deviations), frequencies and proportions as well as medians (interquartile ranges) were computed. Comparison of greenhouse tomato mean yields and standard deviations obtained by public private partnership was made using ANOVA and Chi square.

Honest Significant Differences tests were also derived and used in this analysis. Categorical variables were compared using chi-square (χ^2) tests. The threshold for significance in all statistical tests was set at $p < 0.05$.

Result and discussion

The current research involved a total of twenty greenhouses in Samburu County served by five agricultural extension service providers (ESPs), namely; Red Cross Society, Catholic Diocese of Maralal (CDM), World Vision (WV), Farm Africa and Ministry of Agriculture. All the greenhouses were of the same size, that is, 120 m^2 (8 by 15 metres). The ESPs represented the three models in provision of extension service; private, public and public-private partnership (PPP).

CDM and WV utilized their own agronomists in providing extension services to greenhouse tomato farmers. Farm Africa and Red Cross Society had no agronomist of their own and partnered with the public/MoA agronomists for extension services thus PPP.

Table 1. Profile of the greenhouse tomato farmers by three ESP models.

Characteristic	Type of ESP							
	Overall		Public		Private		PPP	
	No. (n=708)	%	No. (n=126)	%	No. (n=298)	%	No.(n=284)	%
Age								
<25	42	5.9	6	4.8	20	6.7	16	5.6
25-35	170	24.0	23	18.2	78	26.2	69	24.3
>35	496	70.0	97	77.0	200	67.2	199	70.1
Gender								
Male	331	46.8	79	62.7	150	50.3	134	47.2
Female	377	53.2	47	37.3	148	49.7	150	52.8
Marital status								
Married	583	82.3	77	61.1	240	80.5	266	93.7
Not married	125	17.7	49	38.9	58	19.5	18	6.3

Source: Author's survey (2016).

The four greenhouses that were financed through the Constituency Development Fund (CDF) relied on MoA officials for extension services. Overall four greenhouses under public ESP were studied while in private and PPP extension service providers, eight greenhouses were investigated in each category.

Table 2. Assessment of improved agricultural practices under the three ESP models.

Agronomic Practice	Type of ESPs			
	Overall (n=20)	Public (n=4)	Private (n=8)	PPP (n=8)
Use of certified seeds/improved varieties	17(85%)	1	8	8
Recommended application of fertilizer	17(85%)	1	8	8
Planting at the optimum time (morning&/or evening)	20(100%)	4	8	8
Crop pests and diseases control	18(90%)	2	8	8
Optimum irrigation (amount, frequency & timing of watering)	17(85%)	1	8	8
Grading of tomatoes before marketing	13(65%)	0	6	7
Staking of plants	20(100%)	4	8	8

Source: Author's survey (2016).

Overall, the twenty greenhouses belonged to a total of 708 farmers thus an average of about 35 farmers per group/greenhouse. The demographic characteristics of the farmers are outlined in Table 1 with majority being female (53%), married (82%) and aged more than 35 years (70%).The low prevalence of young people participating in the greenhouse tomato farming may be a reflection of the trend in Sub-Saharan Africa whereby young people have a low preference for farming and getting them to work in agriculture remains a challenge (OXFAM, 2014). Additionally, higher participation of females in farming reported in this study is in concordant with the findings by a team led by Ngugi (2014) who on studying a PPP model (Kenya Agricultural Productivity and Agribusiness Project (KAPAP)) reported enhanced participation of women in all the PPP project activities.

Practices in greenhouse tomato farming

The findings on the practices in greenhouse tomato farming are outlined in Table 2.

Improved agricultural practices were generally well observed in greenhouses under private and PPP models. Indeed, of the seven agronomic practices under review, only one (grading of tomatoes before marketing) failed to attain full compliance among sixteen greenhouse tomato farming classified under the two models. One unit under private model and two units under PPP model had failed to grade tomatoes before marketing at least once in the season preceding the study, while all units under public had not graded their products prior to marketing at least once in the season studied.

Table 3. Description of the tomato yields (kg) by the ESP providers.

ESP	N	Total	Mean	95% CI*		Min	Max
				Lower	Upper		
Catholic Diocese of Maralal	4	7809	1952.25	1482.8	2421.7	1724	2380
World Vision	4	7464	1866.00	1675.6	2056.4	1759	2030
Farm Africa	4	7350	1837.50	1433.8	2241.3	1574	2181
Red Cross Society	4	7705	1926.25	1379.9	2472.6	1688	2436
Ministry of Agriculture	4	3145	786.25	498.9	1073.6	581	976
Total	20	33473	1673.65	1435.5	1911.8	581	2436

*Confidence Interval

Source: Author's survey (2016).

All the units had embraced the practice of planting at the ideal time (morning&/or evening) as well as that of staking of plants (Table 2).

Generally, agricultural practices in greenhouses under PPP mirrored those of greenhouses under private ESPs. Utilization of improved agricultural practices was lowest in public greenhouses showing that PPP approach resulted in an improvement. This aspect was also noted by Kavoi *et al* (2013). The research team recounted that initiatives that embraced the PPP approach promoted the diffusion and adoption of improved technologies and innovations and, hence, improved and sustainable farm productivity.

Table 4. Tomato yields (kg) by the extension services provision model.

ESP* model	N	Total	Mean	95% Confidence Interval	
				Lower	Upper
Public	4	3145	786.3	498.9	1073.6
Private	8	15273	1909.1	1730.7	2087.6
PPP	8	15055	1881.9	1644.9	2118.9
Overall	20	33473	1673.7	1435.5	1911.8

*Extension services provision

Source: Author's survey (2016).

In a study done in Bihar and India similar observations were made with Singh (2008) perceiving the PPP model as one that encouraged sustainable and eco-friendly, agricultural practices and technologies.

These included integrated management of pests and nutrients, water conservation practices and organic farming.

Assessment of yields

In total, 33.473 tonnes of tomatoes were harvested in the twenty greenhouse units in the season under inquiry thus an average (standard error (se)) of 1.7±0.1 tonnes of tomatoes per unit. Greenhouses managed by Catholic Diocese of Maralal had the highest yields (7.8tonnes) followed by those of the Red Cross Society (7.7 tonnes) and World Vision (7.5tonnes).

Greenhouses that were under GoK/Ministry of Agriculture initiative had the lowest total yields (3.2 tonnes) in the season appraised by the present research.

The unit that produced the overall maximum yield (2.4tonnes) was funded by the Red Cross Society while the one that recorded the overall minimum yield (0.6tonnes) was under Ministry of Agriculture. Noteworthy, is that the highest tomatoes' yield in the units initiated by Ministry of Agriculture was far much below the lowest yields recorded in the units managed by the other organizations (Table 3).

The mean ± SE yields per unit managed by the Catholic Diocese of Maralal, Red Cross Society and World Vision were 1952.3 ± 147.5 kg, 1926.3 ± 171.7 kg and1866.0 ± 59.8 kg respectively. The mean ± SE yields per Ministry of Agriculture greenhouse unit was 786.3 ± 90.3 kg. Analyses of variance in greenhouse tomato yields by the extension service providers showed that the mean yields varied in a statistically significant manner in at least two of the organizations ($F_{4, 19}$= 15.696, p<0.001). Multiple Comparisons based on Tukey HSD as a post-hoc test showed that Ministry of Agriculture's greenhouses had statistically significantly lower yields per unit as compared to the mean yields of units from other organizations (p<0.001).

Table 5. Evaluation of adoption of modern practices and technologies.

Practice	Status	ESP type*			P-value
		Public	Private	PPP	
Certified seeds	Yes	1(25)	8(100)	8(100)	0.001
	No	3(75)	0(0)	0(0)	
Recommended planting time	Yes	1(25)	8(100)	8(100)	0.001
	No	3(75)	0(0)	0(0)	
Recommended pests/diseases control	Yes	1(25)	8(100)	8(100)	0.002
	No	3(75)	0(0)	0(0)	
Optimum irrigation approaches	Yes	1(25)	8(100)	8(100)	0.002
	No	3(75)	0(0)	0(0)	
Grading before marketing	Yes	0(0)	8(100)	8(100)	<0.001
	No	4(100)	0(0)	0(0)	
Staking of plants	Yes	4(100)	8(100)	8(100)	_____
	No	0(0)	0(0)	0(0)	
Application of inorganic fertilizer (recommended doses & proper timing)	Yes	1(25)	8(100)	7(88)	0.007
	No	3(75)	0(0)	1(13)	

*Extension services provision

Source: Author's survey (2016).

In particular, mean tomato yields per greenhouse unit initiated by Ministry of Agriculture were, on average, at least one tonne less than those of the counterparts. Those units managed by Catholic Diocese of Maralal and Red Cross Society had mean ± SE difference in tomato yields of 1140.0±177.8 and 1166.0±177.8 kilograms, respectively as compared to the Ministry of Agriculture's greenhouses.

Analysis of tomato yields by extension service provision model

Analysis of greenhouse tomato yields by extension service provision model was also conducted. The total tomato yields were 3.1, 15.1 and 15.3tonnes, respectively, for Public, PPP and Private extension service provision models.

The mean yields were 786.3 ±1 80.7, 1881.9 ± 283.5 and 1909.1 ± 213.5 kilograms corresponding to Public, PPP and Private extension service provision models respectively (Table 4). Analysis of this variance in greenhouse tomato yields by the model of extension service provision showed that at least one of the models had significantly different greenhouse tomato yields ($F_{2, 19}$ = 34.200, p<0.001).

Table 6. Evaluation of adoption of modern practices and technologies.

Practice	Status	ESP type (n %)			P-value
		Public	Private	PPP	
Water management	Yes	1(25)	5(63)	8(100)	0.028
	No	3(75)	3(75)	0(0)	
Soil water improvement	Yes	1(25)	7(88)	7(88)	0.039
	No	3(75)	1(13)	1(13)	
Transplanting	Early morning/Evening	4(100)	8(100)	8(100)	_____
	Other	0(0)	0(0.0)	0(0)	
Seeding	Nursery	1(25)	8(100)	8(100)	0.004
	Nursery & others	3(75)	0(0)	0(0)	
Foliar use	Yes	0(0)	8(100)	7(88)	0.001
	No	4(100)	0(0.0)	1(13)	

Source: Author's survey (2016).

Comparative analysis of the greenhouse tomato yields by the three models of agricultural extension provision showed that a statistically significant difference existed between mean yields of greenhouse units under private and public ESPs with the latter producing less by an average of 1122.9 ± 147.0 kilograms per unit (p<0.001). Furthermore, mean tomato productivity of greenhouse units under public extension service provider was statistically significantly less when evaluated against those under PPP models of extension service provision by a mean of 1095.6 ± 147.0 kilograms (p<0.001). Contrary to this, greenhouse units under private and PPP models of ESP were not statistically significantly different in tomato productivity as assessed by yields in the season preceding the survey (p=0.972).

The higher performance observed in the greenhouses under PPP ESP model collaborates findings from other studies to indicate that PPP model can promote sustainability of rural livelihoods even in resource poor settings. Indeed, a study in Eastern Kenya reported that the production of sorghum went up by 72%, while maize increased production by 84%. Poultry production increased by 72% following introduction of the innovative approach based on PPP model of agricultural extension (Ngugi *et al.,* 2014). In India, Tyagi and Verma (2004) reported that introduction of a PPP model resulted in the area dedicated to planting of cereals (rice, maize wheat, etc) declining by 8 percentage points. Noteworthy was that, in spite of this development, yields improved and thus no substantial loss in crop production of staple foods. This implies that the adoption and utilization of improved agricultural practices extended to crops other than the targeted ones.

There has been general consistency on the positivity of embracing PPP in agricultural extension services even amongst the various variants of this approach. For instance, Costa Rica has a system which is unique involving the state providing agricultural extension services vouchers to farmers. The vouchers are used for acquisition of agricultural extension services and advice from specialists in the private sector. The trend in services provision resulted in a demand driven extension services (Farrington and Lewis, 2002). All these point out to the fact that PPP model may be the panacea for the poor linkages and coordination that have been noted particularly in agricultural extension in the current devolved government system (Karembu, 2011).

The improved yields observed in PPP model may be attributed to increased adoption of modern agricultural practices and technologies. A survey done by Tegemeo Institute (2006) shows that, households which utilized hybrid seeds, in addition to applying fertilizer, reported the highest levels of crop productivities. According to the Tegemeo study households that reported using a combination of the prescribed fertilizer and maize seed of the hybrid variety registered that there was a growth in productivity of 291 per cent when assessed against farmers who did not engage in the technologies that stimulated increased productivity in the entire period. It was also notable that farmers using hybrid maize seeds without application of any fertilizer increased their production by 133 percent. The farmers who applied the recommended fertilizer on the non-hybrid varieties of maize seeds were found to have increased the yields by 88 percent. The research also concluded that services provided tended to be correlated with the uptake of productivity enhancing technologies in small scale farmers studied. This underscores the crucial role of PPP extension service provision and the need to strengthen it.

Adoption of modern practices and technologies

Adoption of selected modern farming practices and technologies in greenhouse tomato farming was assessed based on the farming activities conducted in the current season as well as the documentation of the farming activities for the season prior to the survey. Analysis based on the use of certified seeds in the current season and the one preceding the survey showed that all the greenhouses under PPP and private ESPs had utilized certified tomato seeds while only one group under public ESP had consistently used certified seeds. This variation in utilization of certified seeds amongst greenhouses under different ESPs was statistically significant ($p=0.001$). A similar pattern was observed amongst the greenhouse under various ESPs with respect to abiding by the scheduled/recommended planting time and adoption of recommended pests and diseases control practices and technologies ($p= 0.002$). Only one out of the four greenhouses under public ESP was compliant with the optimum irrigation approaches while the rest of the greenhouses (under private and PPP) were able to maintain irrigation technologies and irrigation practices that were able to optimize productivity of greenhouse tomatoes ($p=0.002$). All greenhouses graded their tomatoes before marketing but for all the groups which relied on the public ESPs. This difference exhibited by the three ESPs was statistically significant ($p<0.001$). In all the study greenhouses, staking of plants was practiced as required in tomato farming in greenhouses. A probe into the application of inorganic fertilizers based on a set of following criteria; recommended fertilizer type, optimum doses, appropriate mode and timing of application showed that greenhouses whose ESP arrangement were either private or PPP satisfactorily conformed with the guidelines and recommendations. On the contrary, only one greenhouse of the four under public ESPs fulfilled the set of evaluation criteria (Table 5).

Further evaluation of the adoption of modern practices and technologies in greenhouse tomato farming showed that greenhouses under public ESPs had statistically low adoption of water management and soil water improvement technologies when compared with their counterparts ($p=0.028$ and $p=0.039$ respectively). In all the greenhouses assessed, the practice of transplanting was satisfactorily observed including the prime time for transplanting (early morning and/or late evening). Assessment of seeding practices showed that greenhouses in which ESPs were either private or PPP always planted the seeds in the nursery before transplanting in contrast with greenhouses under public ESPs which sometimes deviated from this practice. Greenhouses under private ESPs applied foliar fertilizers as, and when, required in contrast with greenhouses under public ESPs which reported erratic application of foliar fertilizers and in some cases missing to use the foliar fertilizer completely for a season. Further, one of the eight greenhouses under PPP system failed to apply foliar fertilizer at the suitable time at one point. The dissimilarities in compliance with utilization of foliar fertilizer between the three ESP systems were statistically significant ($p=0.001$) as presented in Table 6.

The enhanced adoption of modern practices and technologies under PPP model as compared to the Public model of ESP indicated that effective agricultural extension programmes are key policy instruments used to foster agricultural productivity. This may be due to amelioration of information and knowledge transfer under PPP model. The two factors are considered important for accelerating agricultural development through appropriate production planning, adoption and realization of the full potential in agricultural activities (Pontius *et al*., 2002).

Conclusion

The PPP model seems to offer a good solution to the challenges facing the current ESP approaches. The PPP model is just as efficient as the private model in the promoting improvement and adoption of modern agricultural practices. The yields were also comparable in the two models.

Recommendation

There is a need to embrace pluralistic approaches in provision of agricultural extension services including the PPP as they have the potential to transform the livelihoods of the farming communities residing in resource constrained settings.

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