ACTION-BASED VERSUS OUTCOME-BASED PAYMENTS FOR ENVIRONMENTAL SERVICES – AN EXPERIMENTAL AUCTION FOR TREE PLANTING CONTRACTS IN KENYA

Lucie Andeltová[a]*, Tobias Wünscher[b], Karin Holm-Müller[c] and Elsa Cardona Santos[d]
In cooperation with World Agroforestry Center (ICRAF)

Abstract

Several conservation programs are based on the landholders' activities rather than on the desired environmental outcome. This is claimed to lead to economic inefficiencies due to the lack of incentives for innovation, use of site-specific knowledge and provision of the services at lower costs. Outcome-based payments, on the contrary, are argued to have many advantages in terms of cost-effectiveness by offering more flexibility, enhancing innovations and improving landholders' intrinsic motivation for the actual conservation outcome. The latter are however associated with risk, which might give landholders an incentive to ask for higher payments. In this paper we analyze the cost-effectiveness of both contract types by means of a tree planting experiment in Kenya. Our results suggest that the average bid under the outcome-based scheme is higher than the one under the action-based scheme due to the difficulty of landowners to calculate the costs they will incur, related to the outcome uncertainty they face. Nevertheless, participants perceived the action-based scheme as more risky. Although were able to confirm that an outcome-based scheme offers more flexibility, most of the landowners preferred the action-based scheme since it clearly stipulates which activities they are supposed to undertake.

[a] Center for Development Research, University of Bonn, Walter-Flex-Str. 3 53113, Bonn, Germany, lucie.andeltova@gmail.com
[b]Center for Development Research, University of Bonn, Walter-Flex-Str. 3 53113, Bonn, Germany, tobias.wuenscher@uni-bonn.de
[c]Institute for Food and Resource Economics, University of Bonn, Nussallee 21, 53115 Bonn, Germany, karin.holm-mueller@ilr.uni-bonn.de
[d]Institute for Food and Resource Economics, University of Bonn, Nussallee 21, 53115 Bonn, Germany, elsa.cardona@ilr.uni-bonn.de

Keywords

Payments for Environmental Services, Outcome-based and Action-based Contract, Conservation Auction, Cost-effectiveness, Kenya, Field Experiment.

1. Introduction

Biodiversity and ecosystems provide services of direct value to people such as food, clean water, and fuel, but also many indirect services including water filtration, climate regulation, flood protection, nutrient cycling and pollination (OECD, 2010). Ecosystem services are therefore extremely valuable in terms of economic, social and cultural aspects, and are being increasingly demanded due to rapid world population growth (Millennium Ecosystem Assessment, 2003). The high degradation is however altering the capability of ecosystems to meet these demands, which is very alarming (Millennium Ecosystem Assessment, 2003). A major reason for the systemic degradation of ecosystems is their public good nature, which results in a lack of valuation of environmental services in the economic system (Engel et al., 2008; Swallow et al., 2009).

To address this problem, payments for environmental services (PES) have become an increasingly applied mechanism in the past decade. It relies on the compensation of landowners for their provision of environmental services (Pagiola et al., 2005). PES convert external, non-market and environmental values into financial incentives for the providers of environmental services (Engel et al., 2008, p.664). These schemes offer potentially large savings relative to other indirect and regulatory approaches, allowing for a more efficient use of available funds for conservation (Ferraro and Simpson, 2000; Engel et al., 2008; OECD, 2010).

How cost-effective PES schemes are depends however on their design and implementation. This study focuses on the design of the conservation contracts and more specifically on the payment conditions. Payments can either be tied to precisely specified actions that are expected to deliver environmental services, or be directly linked to a desired environmental

outcome (Zabel and Roe, 2009), here referred to as action-based and outcome-based conservation payments, respectively[1]. Paying farmers for undertaking the pre-specified activities, as primarily carried out in such schemes, is claimed to lead to economic inefficiencies because it does not provide incentives for farmers to innovate and to achieve the agency's desired outcome (Latacz-Lohmann and Schilizzi, 2005). Moreover these activities are specified ex-ante so that in an uncertain environment these might not lead to the expected results. Action-based contracted farmers cannot counteract such random events with site specific knowledge to optimize their effort because they would be violating the contract specifications (Latacz-Lohmann and Schilizzi, 2005).

Outcome-based payments, on the contrary, are argued to have many advantages in terms of cost-effectiveness as compared to action-based payments. Gorddard et al. (2008) explain that this payment scheme may provide an incentive for landholders to reveal private information about the potential value for biodiversity of their conservation effort, allowing for a more efficient allocation of resources. Outcome-based payments are expected to offer more flexibility, to improve landholders' intrinsic motivation for the actual conservation outcome and thus enhance innovations, meaning the application of better solutions to meet the contract requirements (Matzdorf andLorenz, 2010), which may reduce costs to the landholders and governments (Gorddard et al., 2008). However, these kind of contracts imply a higher risk for farmers because their payments do not only depend on their effort but also on exogenous factors (Wätzold and Schwerdtner, 2004), which can induce them to request for higher contract prices (Matzdorf and Lorenz, 2010). Moreover, the measurability of the outcomes might be problematic in some schemes (Latacz-Lohmann and Schilizzi, 2005). Schilizzi et al. (2011) declare that theoretical predictions about the efficiency of these kind of payments are far from clear, since even though they induce landholders to behave in the interest of the conservation agency, the risk implied is likely to reduce participation and thus reduce the environmental effectiveness, so that the agency faces a trade-off between the incentive effect and the participation effect.

[1] Synonyms for action-based conservation payments: A scheme based on rewards for compliance with prescribed actions. Synonyms for outcome-based payments: A result-oriented conservation approach.

The objective of this paper is to compare empirically the cost-effectiveness of both contract types by means of a tree planting experiment undertaken in Kenya. In this experiment it was accounted for potential asymmetric information between landowners and the conservation agency, which can limit the effectiveness of PES programs according to Ferraro (2008). The author explains that procurement auctions among suppliers of environmental services can reduce their incentives to inflate the contract prices through bidding rules and market competition in the presence of adverse selection (Ferraro, 2008, p. 813). Furthermore, the problem of moral hazard, in which landowners have an incentive not to fulfill the contractual responsibilities (Ferraro, 2008), can also be addressed through an auction mechanism that allows for the selection of the landowners with low compliance costs, which are less likely to cheat (Latacz-Lohmann and Schilizzi, 2005).Therefore, after being randomly assigned to either action or outcome-based tree planting contracts, the landowners participated in an auction. Those who offered the lowest bids (until the budget was exhausted and/or until 60 landowners were contracted for each treatment) were offered a contract for a period of six months.

The paper is structured as follows: In section 2 we provide an analytical framework based on literature and empirical research. Section 3 presents the methodology we use to address the main objective of this study, namely the comparison between outcome-based and action-based payments in terms of cost-effectiveness. The fourth section presents the results of the analysis, which leads us to draw conclusions, in section 5.

2. Analytical framework for the cost-effectiveness analysis

To determine and compare the cost-effectiveness between action-based and outcome-based PES, we primarily use the analytical framework proposed by Matzdorf and Lorenz (2010). The authors emphasize in their study the importance of identifying elements of both, static and dynamic aspects of cost-effectiveness. The static aspect of cost-effectiveness refers to the achievement of a specific environmental benefit at the least possible costs or, equivalently, to the maximum environmental benefit achievable for a given budget (Matzdorf and Lorenz, 2010). The dynamic aspect of cost-effectiveness on the other hand, refers to the incentives given to farmers to be innovative and motivated to meet a specific

environmental goal by using information advantages and by increasing their own management efficiency (Matzdorf and Lorenz, 2010).

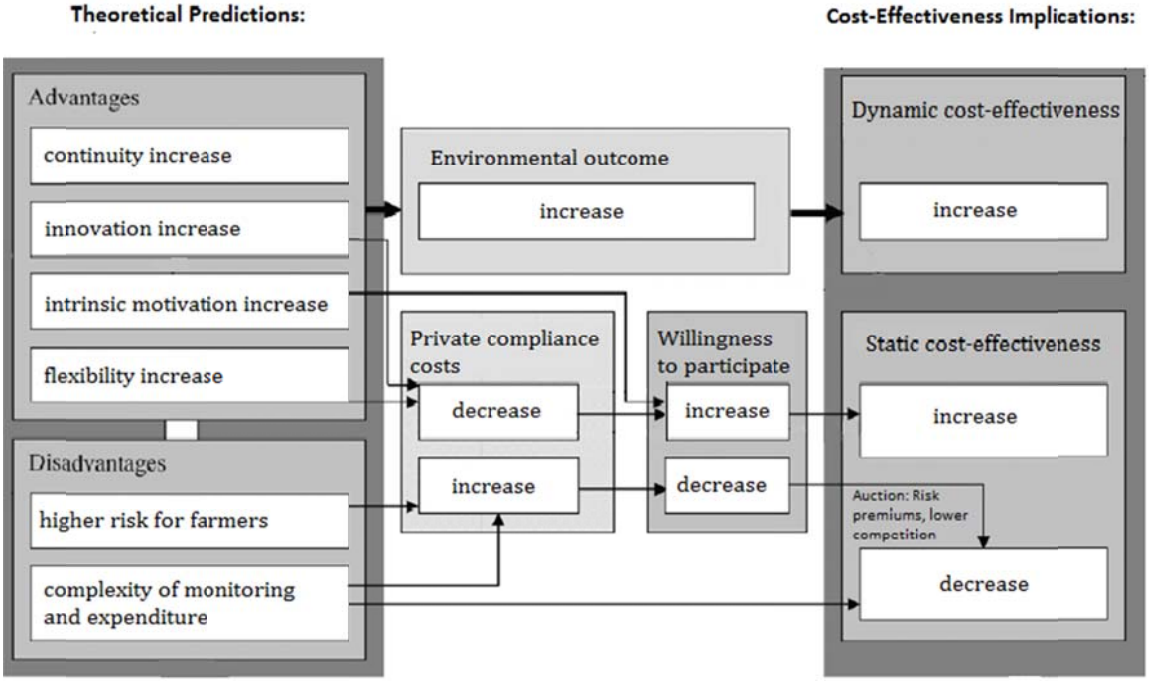
We adjusted the framework to a situation where the outcome-based conservation contracts are allocated through an auction mechanism. This illustrates the advantages and disadvantages of result-oriented approaches and their relationships to the environmental outcome[2], the private compliance costs[3], and the willingness to participate, which is in our case the willingness to accept (WTA) a contract, i.e. the cost of the contract resulting from the submitted bid.

As figure 1 shows, outcome-based PES are expected to increase the ecological performance and thus the dynamic aspect of cost-effectiveness. However, the nature of the contract makes the value of the private compliance costs unpredictable, which directly influences the farmers' willingness to accept and thus the cost-efficiency of the program. Independently of whether payments are based on the outcome or on actions, monitoring is expected to directly and indirectly decrease the static cost-effectiveness through the increase of the private compliance costs and consequently of the contract costs. In order to make a conclusion on the overall cost-effectiveness of a conservation auction for outcome-based contracts, it has to be accounted for all the aspects mentioned above. The cost-effectiveness of the action-based contracts can be determined analogously.

[2] Synonyms for environmental outcome are ecological or environmental performance.

[3] Private compliance costs compose in our framework of implementation (including production), opportunity and transaction costs.

Figure 1 Analytical framework for the cost-effectiveness analysis



Source: Adapted from Matzdorf and Lorenz (2010)

2.1. Continuity, innovation, intrinsic motivation and flexibility

Matzdorf and Lorenz (2010) identify the advantages of an increase in innovation, motivation, flexibility of farmers and continuity of participation, and take also into consideration arguments concerning transaction costs and the risk for participating landholders. They argue that outcome-oriented approaches give farmers more flexibility about how to achieve the specified environmental goal, and more incentives to develop innovative approaches by using their knowledge about local environmental conditions more effectively.

To address the aspect of motivation, the authors use the conceptualization of Aarts and van Woerkum (2000), who distinguish between *coercion* and *voluntariness* as key guiding principles. In this context, according to Hugo-Becker and Becker (1997), voluntary conduct consists of *extrinsic* and *intrinsic* motivation, where extrinsic motivation includes all material and non-material incentives, and intrinsic motivation refers to the inner urge of

commitment. Matzdorf and Lorenz (2010) suggest that outcome-oriented remuneration addresses both, extrinsic and intrinsic motivation due to the high flexibility it offers.

2.2. Risk

Matzdorf and Lorenz (2010) discuss the risk affecting landholders' participation. In particular, the ecological performance does not depend only on the effort obtained, but also on the environmental productivity, and environmental events that are out of landholders' control such as diseases, drought, or insects (Zabel and Roe, 2009).

The layers of uncertainty that lie with outcome-based contracts may decrease the willingness of risk-averse landholders to sign the contract, or (like in the case of a conservation auction) induce them to demand a high risk premium in return. This would reduce the cost-effectiveness of the payments (Latacz-Lohmann and Schilizzi, 2005). A possible solution to this problem is provided by the contract theory, which suggests that the risk neutral principal (i.e. conservation organization) and the risk-averse agent (i.e. farmer) share the risk (Latacz-Lohmann and Schilizzi 2005). This can be done by splitting the total payment between a guaranteed base payment for participation and a payment for provision of desired environmental services (Schwarz et al. 2008). Up to date most of the outcome-based PES schemes are still at the very early stage (Schwarz et al., 2008) and the current PES literature still lacks more in-depth evidence on the particular trade-offs between action-based and outcome-based PES schemes (Zabel and Roe, 2009).

3. Methodology

A study based on payments for environmental services was conducted with landholders along the Kapingazi River at the Eastern slope of Mount Kenya, an area with severe soil erosion and river sedimentation problems resulting from agricultural activities at the riparian area. The Tana River is Kenya´s largest river, flowing 800 km from Central Kenya to the Indian Ocean. The providers of the ES are in the Upper Tana area, which is the source of most of the water of the Tana River due to higher rainfalls. The lower Tana basin, which is much drier and completely dependent on the river´s water is the area of service demanders.

The PES concept gave an incentive to the farmers in the upper catchment to choose more environment friendly land-use practices (reduction of agricultural practices along the river banks, more trees) and thus enhance the provision of the watershed services which benefits the population and industry downstream. The Research area, The Kapingazi Catchment is 61 square kilometers.

The study's aim is to compare the cost-effectiveness of two different types of contracts, both of them implying tree planting activities and conservation during 6 months. One contract relied on *action-based* payments and the other one on *outcome-based* ones. In the action-based contract the actions that are expected to deliver environmental services were precisely defined, whereas in the outcome-based contract the payments were directly linked to the desired environmental outcome, independent of the landholder's land management actions (Zabel and Roe, 2009).

3.1. Program implementation in Kenya

Landowners interested in the program were randomly assigned to one of the two contract types, so that they could participate in an auction, through which the contracts were allocated. In contrast to fixed payments, auctions induce landholders to reveal their opportunity costs and potentially increase cost-effectiveness through bidding rules and market competition (Ferraro, 2008). A discriminative price rule was used, meaning that landholders got a payment equal to their bid if they were contracted. Therefore, they were required to submit bids indicating the payment they were willing to accept for the respective conservation contract. Only those landowners with the lowest bids were offered a contract, subject to a target constraint of 60 contracts and a budget constraint of approximately 1,770,000 KES (21,000 USD) for both auctions. Out of 117 participants in each of the two auctions, 60 were selected for the action-based and 60 for the outcome-based contract. However, only 45 action-based contracts and 54 outcome-based contracts were signed due to drop-outs.

Tree seedlings were provided to all field trial participants for free. Both contracts required landholders to plant 30 tree seedlings on a river bank following contract guidelines. Each farmer received a payment equal to 10% of their bid in order to help them cover costs of

initial inputs. After the six months period, there was no obligation for farmers to keep the trees standing or to take care of them.

Whether the whole or reduced contract price was paid after the period of six months was conditional on criteria specified for each type of contract. Action-based contracts required keeping the soil around the trees moist, and the payments were conditional on monitoring results of this tree-watering requirement. Outcome-based contracts did not prescribe any actions to the landholders, and the payments were conditional on the tree survival rates after six months.

3.2. Data

The data used for the purpose of this study relies on information gained out of surveys, auction mechanisms and monitoring results. A baseline survey with 411 eligible households was designed to capture their characteristics and to introduce the study. Consequently 234 household representatives participated in the auctions - that is 56.9 % of the invited population.

To avoid self selection biases in the results, landowners were stratified and randomly assigned to either the outcome-based or the action-based contract, based on their income level and gender. This allowed for two homogeneous groups in terms of their covariates

117 landowners participated in an auction at the same time for each contract type. The auction setting was equal for both contract types – a one-shot, target constrained, sealed bid, discriminative-price auction. According to the bids offered and a total budget sealing of approximately 1,770,000 KES (21,000 USD) 60 participants were selected in each auction, which resulted in ceiling prices of 25,000 and 27,000 KES for the action-based and outcome-based contracts, respectively. Because of the target constraint of 60 contracts one out of three participants had to be selected by lottery for the outcome-based contract with a bid equal to 27,000 KES. Selected participants were notified by cell phone whereas ten of them could not be reached (five per treatment). Additionally, twelve out of those notified participants - all except of one were offered action-based contracts - directly rejected or did not appear for contract signing. Moreover, one of the farmers that signed the action-based

contract did not plant the trees. Therefore, out of 120 contracts offered, only 44 action-based and 54 outcome-based contracts were signed and accomplished (see table 1).

Table 1 Auction participation, bid selection and contract allocation

	Action-based treatment	Outcome-based treatment	Both treatments
Eligible households	-	-	411
Number of participants (stratified random sampling)	117	117	234
Number of selected bids	60	60	120
Total value of selected bids in KES (in USD)	781,723 (9,306)	987,380 (11,755)	1,769,103 (21,061)
Contract drop-outs prior/post	10+1	1	12
Number of participants not reached for contract signing	5	5	10
Number of PES contracts signed	44	54	98
Total value of contracted bids in KES	661,223 (7,872)	897,380 (10,683)	1,558,603 (18,555)

Notes: Figures in KES, 1 USD=84 KES (, 8.11.2013).

The research team conducted the monitoring on conservation contract compliance in collaboration with the Kenya Forest Service and in presence of the contracted farmers. In February 2012 all contracted farmers were monitored on general contract compliance – i.e. whether they have planted 30 trees at their riparian area according to the contract requirements. Only one farmer – with an action-based contract – did not plant the trees, which was considered as a contract drop-out (see table 1).

For research purposes tree survival rates were recorded during this monitoring on general contract compliance, although this had no consequences on payments. Simultaneously, landholders with action-based contracts were monitored on compliance with the tree-watering requirement (whether soil around the tree was kept moist), followed by a second monitoring towards the end of the dry season in March 2012. The compliance of outcome-based contracted farmers – the tree survival rate - was monitored at the end of the contract

period in July 2012. At the same time, tree survival rates of action-based contracts were recorded for research purposes only (see Table 2).

Table 2 Conducted monitoring

Type of monitoring	Tree planting (30 trees planted)	Watering (Soil kept moist around trees)		Tree survival rates		
	February 2012	February 2012	March 2012	February 2012	July 2012	August 2013
Action-based contracts						
On contract compliance	□	□	□	□	□	□
For research purpose only	□	□	□	□	□	□
Outcome-based contracts						
On contract compliance	□	□	□	□	□	□
For research purpose only	□	□	□	□	□	□

The conservation payments were adjusted for each farmer at the end of the contract period according to their monitoring results and the particular contract conditions. Regardless of the monitoring results and the contract type all farmers were guaranteed 10% of their bids as a base payment. The latter was meant to cover part of the implementation cost such as watering cans and was paid to all contracted farmers at the beginning of the contract period. The remaining conservation payments, considering the corresponding sanctions, were made to the contracted farmers after the end of the contract period.

Action-based contracted farmers were told that they might be monitored several times whereas the exact frequency and time were kept unknown. This measure was intended to prevent farmers from deliberately watering the trees only on the days of monitoring and from stopping watering after the last announced monitoring. Whenever action-based contracted farmers were monitored, their payment was reduced by 1% for each tree that was not kept moist. Thus, three monitoring rounds could have reduced the payment by a maximum of 90% if none of the trees were found to be sufficiently watered.

In the case of the outcome-based contracts, up to four dead trees were tolerated without sanctions. The reasoning behind this was to avoid sanctioning farmers for a natural phenomenon, which they cannot influence, since according to the baseline survey - out of

30 trees planted in December at the riparian area - on average three trees would die even if good care were taken. However, the payment was reduced by 4% for every additional not surviving tree during the contract period of six months.

Farmers with both contract types were required to report incidents like flooding and human conflicts to the research representatives, who then recorded the damaged and missing trees. For the latter no sanctions were imposed. Whenever trees evidently suffered from such incidents and outcome-based contracted farmers did not report them, only half of them was considered for sanctions.

At the time where the contract ended and farmers received the payment, a project evaluation survey was conducted to acquire information on the conservation effort, innovation, contract risk perception and intrinsic motivation of the contracted landholders.

4. Results

The main objective of this study is to test the theoretical predictions of cost-effectiveness of tendering outcome-based conservation contracts, following the analytical framework as described above (see Fig 1).

Thus, in our study we prove following hypothesis:

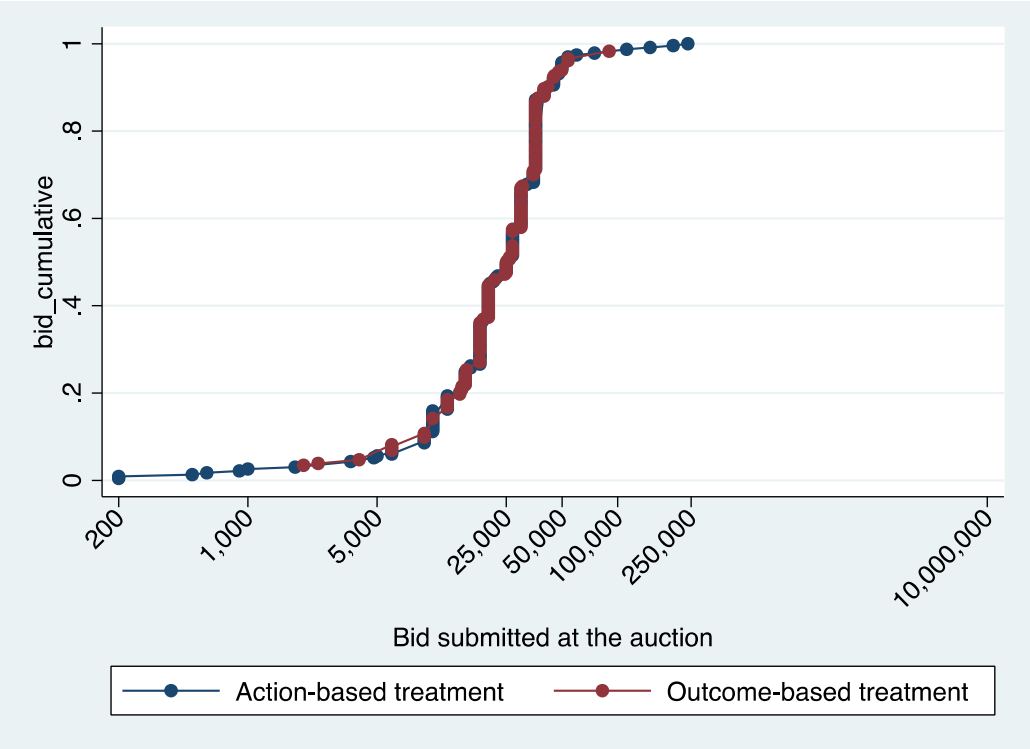
1. Bid levels are higher under auction for outcome-based contracts due to predominance of risk (over the other effects that are expected to decrease the bid levels/WTA such as increased intrinsic motivation, flexibility and innovation – more on that in the discussion part).
2. Environmental outcome is clearly better under outcome-based contracts.

First, we prove the expectation of higher contract costs of the outcome-based auction as result of risk premiums. Second, the expected higher ecological performance of outcome-based contracts is tested. Finally, we assess the cost-effectiveness of the outcome-based conservation auction, measured as average cost of a surviving tree.

4.1. Conservation auctions willingness to accept

While the cumulative distribution functions of individual bids seem to be similar (see figure 2), both positively skewed (10.65 and 1.07), the action-based treatment is characterized by the occurrence of very low and very high-level bidders.

Figure 2 Individual bids (in KES) by auction treatment (in log scale)



This is reflected in an extremely higher mean, notably lower bid values up to the 25th percentile, slightly lower median, and notably higher bid values from the 90th percentile by the action-based treatment (see table 3).

Table 3 Summary of submitted bids by auction treatment

	Action-based treatment (N=117)	**Outcome-based treatment (N=117)**
Mean	114,625	26,126.32
Std. Dev.	(32,499.01)	(12,729.78)
Median	25,000	26,000
Min	200	2000

Max	10,000,000	90,000
1%	200	2,400
5%	1,000	6,000
10%	6,000	12,000
25%	12,000	18,000
75%	36,000	36,000
90%	50,000	40,000
95%	75,000	45,500
99%	240,000	54,000

Notes: Figures in KES, 1 USD=84 KES (www.oanda.com, 8.11.2013).

We used two different linear regressions of submitted bids on auction treatment, with the action-based treatment as the benchmark, to prove the effect of tendering outcome-based contracts. First, we applied ordinary least squares (OLS) with robust standard errors to correct for heterogeneous variance of residuals in the data (Breusch-Pagan/Cook-Weisberg test for the heteroskedasticity, p=0.00). Second, we used robust regression in order to reweight the impact of leverage and outlierness on the regression results (see table 7).

The OLS coefficient´s sign changes from negative (-88,498.66 KES) to positive (2,088.89 KES) if using robust regression weights. However, both regression results fail to reject the null hypothesis of equal performance (see table 7).

Table 47 Linear regressions of submitted bids on auction treatment

5.	OLS		Robust regression	
Submitted bids	-88,498.66	(85,279.36)	2,088.89	(1,777.283)
Constant	114,625	(85,271.24)	23,401.39***	(1,256.729)
R-sq	0.0046		-	

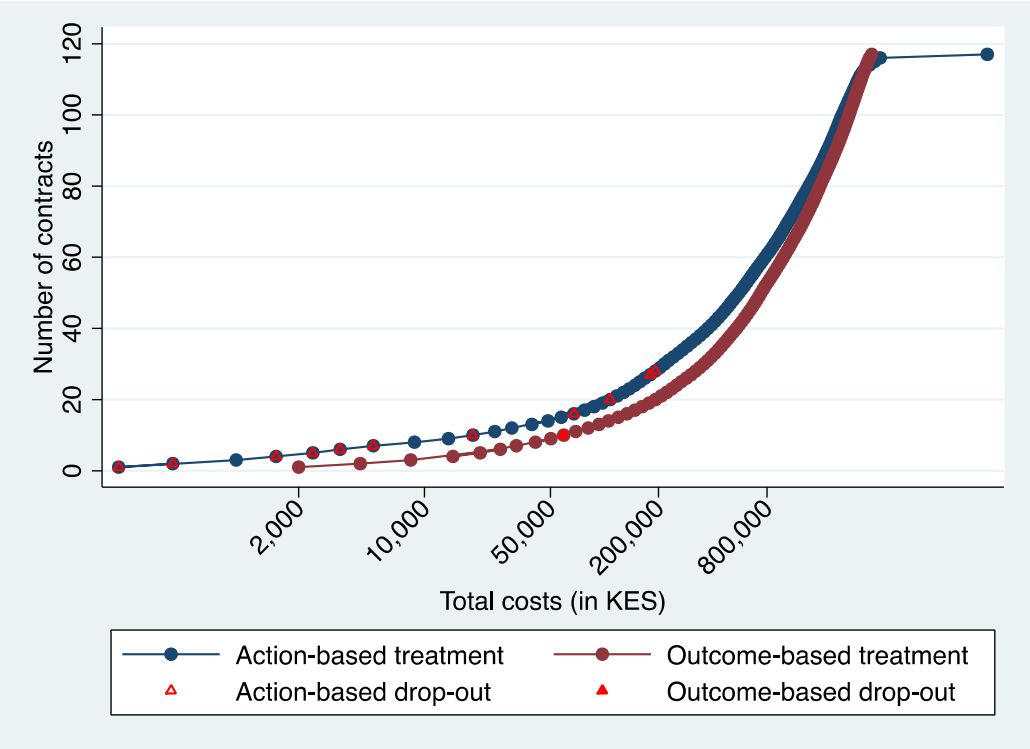
Notes: Figures in KES, 1 USD=84 KES (www.oanda.com, 8.11.2013).
* p<0.10, ** p<0.05, *** p<0.001. The action-based treatment as the benchmark.
Robust standard errors (of OLS) and standard errors (of robust regression) in parentheses.

Following, considering all submitted bids we cannot support the hypothesis of higher bid levels for outcome-based contracts. As next we focus on the contract allocations and discuss the potential explanations of bidding behavior further below.

4.2. Contracts allocations

Figure 3 shows the difference in total costs of purchasing a particular number of conservation contracts, each for planting 30 trees at the riparian area, under action-based and outcome-based treatments.

Figure 3 Total costs by auction treatment (in log scale)



The target-constrained conservation auctions (i.e. we aimed at signing 60 contracts of each contract type) resulted in clearing prices of 25,000 KES for the action-based treatment and 27,000 KES for the outcome-based treatment (where only one bid out of three with value of 27,000 KES was chosen by a lottery in order to reach the targeted number of contracts), and means of approximately 13,028 and 16,456 KES, respectively (see table 9).

Table 5~~8~~ Summary of selected and contracted bids and drop-outs by auction treatment

	Obs.	Mean	Std. Dev.	Median	Min	Max
Selected bids						
Action-based contract	60	13,028.72	6,923.35	12,000	200	25,000

Outcome-based contract	60	16,456.33	6,077.74	18,000	2,000	27,000
Contracted bids						
Action-based contract	44	15,027.8	5,915.35	17,000	500	25,000
Outcome-based contract	54	16,618.15	5,900.53	18,000	2,000	26,000
Drop-outs						
Action-based contract	11	4,881.81	5,062.96	1,800	200	12,000
Outcome-based contract	1	9,000	-	-	-	-

Given the notably lower bid levels for action-based contracts in the first quartile and the reverse discriminative-price auction selection rule (of accepting bids from the lowest one until the target is achieved or the budget exhausted), the total cost of 60 selected outcome-based contracts was by 205,657 KES (26.30%) higher compared with the purchase of 60 action-based contracts. Accordingly, the magnitude of the risk premium effect as well as the significance level are decreasing with increase in the conservation target (i.e. the number of contracts), and vice versa (see table 9).

Table 6~~9~~ Linear regressions of selected and contracted bids on auction treatment

6.		**OLS**
Selected bids (N=120)	3,427.617**	(1,189.341)
Constant	13,028.72***	(893.8014)
R-sq	0.0658	
Selected bids – Hypothetical (N=80)	4,152.5***	(1,175.9)
Constant	9,400***	(852.109)
R-sq	0.1378	
Selected bids – Hypothetical (N=160)	2,579.462*	(1,361.726)
Constant	17114.04***	(1,052.154)
R-sq	0.0222	
Contracted bids out of 120 selected bids	1,590.353	(1,199.736)
Constant	15,027.8***	(890.7172)
R-sq	0.0180	

Notes: Figures in KES, 1 USD=84 KES (www.oanda.com, 8.11.2013).
* p<0.10, ** p<0.05, *** p<0.001. The action-based treatment as the benchmark.
Robust standard errors in parentheses.

Surprisingly, the field trial results show a high drop-out rate by farmers offered action-based contracts. Out of 60 selected action-based bidders ten did not sign the contract and one did not plant the trees as opposed to only one outcome-based contract rejection

Further scrutiny of the drop-out data reveals that the action-based conservation contracts were predominantly rejected by low-cost bidders (see figure 3), with mean of 4,882 KES and median of 1,800 KES (see table 9). This implies that the total cost saving effect of the selected action-based bids (as compared to the outcome-based treatment) was eroded by a high drop-out rate.

The drop-out data do not include bidders who we were not able to inform about their bid selection (five for each treatment with means of 13,360 and 16,200 KES for action-based and outcome-based auction, respectively).

Possible factors that influenced drop outs are part of the discussion below.

Environmental performance

The theory predicts higher environmental performance of outcome-based PES schemes as result of intrinsic motivation, flexibility, and innovation (Matzdorf and Lorenz, 2010). In our study, the ecological performance is measured as the number of surviving trees, out of 30, after the six-month contract period (including one dry and one rainy season). The hypothesis tested is whether farmers with outcome-based contracts had a higher tree survival than those with the action-based contract.

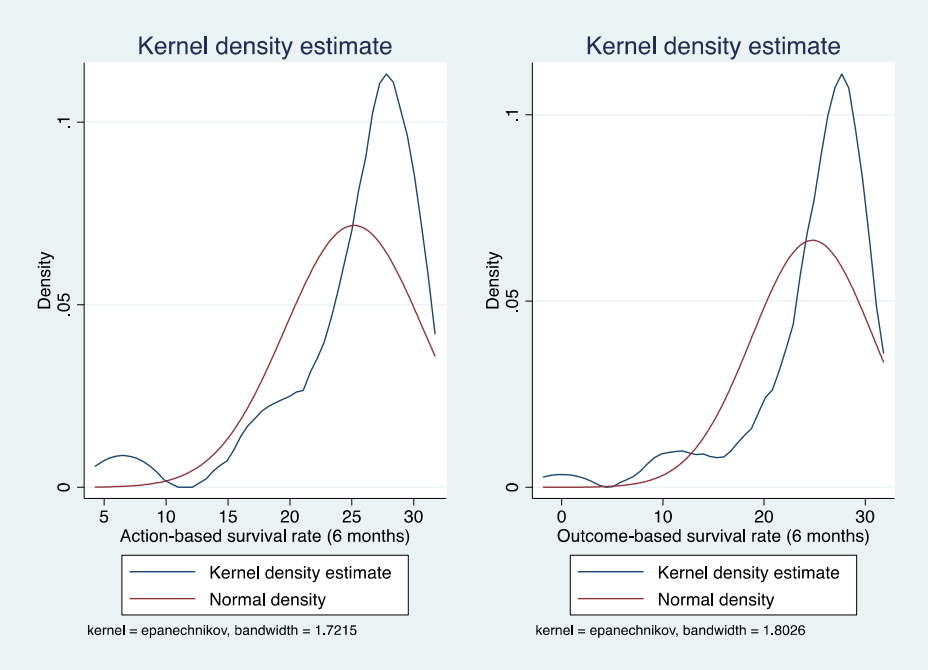
Tree survival rates with skewness of -1.89 and -2.08, means of 25.18 (83.93%) and 24.79 (82.63%), and equal medians of 27 for action-based and outcome-based contracts, respectively, show little difference in ecological performance between the two treatments (see table 10). Neither the two-sample t-test for equal means ($p = 0.744$), nor the Kolmogorov-Smirnov test for equality of distribution show significant difference between the two treatments ($p = 0.927$).

Table 7~~10~~ Summary of tree survival rates by contract type

	Obs	Total (surviving trees)	Mean	Std. Dev.	Median	Min	Max
Survival rates – 2 months							
Action-based contract	44	1,285	29.20	1.30	30	25	30
Outcome-based contract	54	1,550	28.70	2.08	29.5	18	30
Survival rates – 6 months							
Action-based contract	44	1,108	25.18	5.56	27	6	30
Outcome-based contract	54	1,339	24.79	6.01	27	0	30

Fifteen landholders out of 98 (15.30%) achieved the maximum survival rate of 30 trees, seven out of 44 action-based contracted (15.90%) and eight out of 54 (14.81%) outcome-based contracted farmers. For both treatments tree survival rates are skewed to the left with most values concentrated to the right of the mean and extreme values to the left (see figure 4).

Figure 4 Kernel density estimates for tree survival rates by contract type



Based on the regression results of the number of surviving trees on the contract type we can reject the zero hypothesis of difference in average tree survival rates by treatment. The ordinary least squares linear regression shows 0.38 more trees surviving for action-based contracts (p=0.745). This finding stays valid if using a censored binomial regression (tobit), which accounts for count data type, with the upper limit of 30 surviving trees (see table 11).

Table 8~~11~~ Regressions of tree survival rates on contract type

	OLS	**Tobit**
Tree survival rates – 2 months	-0.50 (-1.21; 0.21)	-1.15 (-2.69; 0.37)
Tree survival rates – 6 months	-0.38 (-2.73; 1.95)	-0.44 (-3.12; 2.23)

Notes: Ordinary least squares (OLS) and censored binomial regression with an upper limit at 30 (tobit) of tree survival rates on auction treatment, with the action-based treatment as the benchmark. 95% confidence intervals in parentheses. * p<0.10, ** p<0.05, *** p<0.001.

Possible explanation for equal ecological performance across the two treatments might be a strong correlation of watering the trees and their survival. Correlation coefficients of 0.51 and 0.60 of the number of surviving trees and the number of trees with soil kept moist in the first (after two months) and second (after three months) monitoring, respectively, of farmers with action-based contracts, show that the action prescription in the action-based contracts was the most necessary action for tree survival.

Thus, based on the survival rates alone – given the short period of six months – we cannot confirm the hypothesis that farmers with the outcome-based contract have higher ecological performance as result of the incentive effect. The incentive effect, however, resulted in an ecological performance that was as good as in the case of the prescribed conservation action, which actually desired a great effort in watering the trees.

Cost-effectiveness

As the table 12 shows there was no significant difference in the average costs of a surviving tree between the two contracts. The average costs were calculated by dividing the received conservation payments through the corresponding tree survival rates.

Table 9~~12~~ Cost-effectiveness by contract type

	Obs	Mean	Std. Dev.	Median	Min	Max	OLS
Marginal cost of a tree							
Action-based contract	44	578.42	246.84	631.77	11.66	1086.95	57.21 (-38.10; 152.53)
Outcome-based contract	54	635.63	225.52	666.66	68.96	1008	

Notes: Ordinary least squares (OLS) of average cost of a tree on auction treatment, with the action-based treatment as the benchmark. 95% confidence intervals in parentheses. * p<0.10, ** p<0.05, *** p<0.001.

7. Discussion

In this section we discuss the impact of risk, flexibility, innovation and intrinsic motivation on the willingness to accept (i.e. the bid levels) and the environmental performance. In addition, continuity is examined and other relevant effects observed during the project described.

Risk

Risk and whether it is in the responsibility of the conservation agency (principal) or the landholder (agent) is affecting landholders´ willingness to accept. As a possible solution for enhancing the project´s cost-effectiveness the contract theory suggests sharing the risk between the risk-neutral principal and the risk-averse agent (Latacz-Lohmann and Schilizzi 2005).

In our field trial, all participants were paid an advance payment of 10% of their contract price. This was guaranteed regardless of the farmers' compliance and was supposed to partly cover for farmers´ expenses on inputs and labor. Participants confirmed in the evaluation survey[4] the importance of the advance payment, indicating that one of their challenges was to cover the initial cost (e.g. water cans or insecticides) and that they would prefer the guaranteed payment to be even higher.

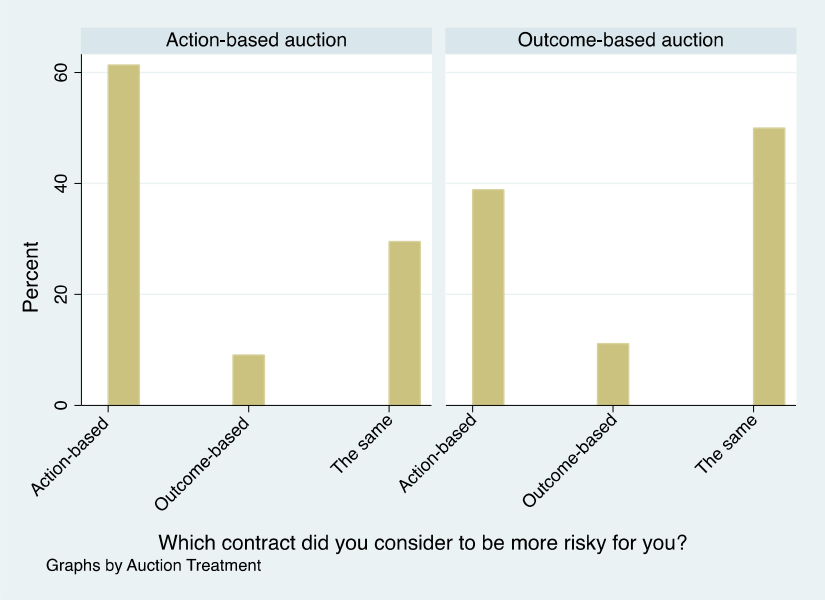
[4] Evaluation survey was conducted at the project end (after the six months contract period) with the 98 contracted landholders.

Further, using the evaluation survey we assessed farmers´ risk perceptions given the two different contract types. Contrary to the theoretical prediction on uncertainty inherent to the outcome-based approach inflating participants´ willingness to accept, 48.97% of the participants perceived the action-based contract as more risky, and only 10.20% of the farmers stated that the outcome-based scheme implies more risk. The remaining 40.81% perceive the same risk regardless of the contract type. This surprising finding holds also if disaggregating the risk perceptions by contract type (see figure 6).

The participants explained that according to them the prescription on the soil around the trees kept moist required a higher frequency of watering and thus labor (i.e. cost) if compared to the outcome-based scheme (when farmers could decide on the watering intensity). At the same time, farmers considered themselves at risk of being monitored and possibly sanctioned at any time.

Seven out of the ten farmers who then perceived the outcome-based contract as more risky indicated that they might forget to water the trees if not monitored closely, thus risking ending up being responsible (i.e. penalized) for dry trees. The actual risk for them thus was not the events beyond their control but the own responsibility for the tree survival. This implies that some participants, though a small number, actually preferred the coercion of the action prescription.

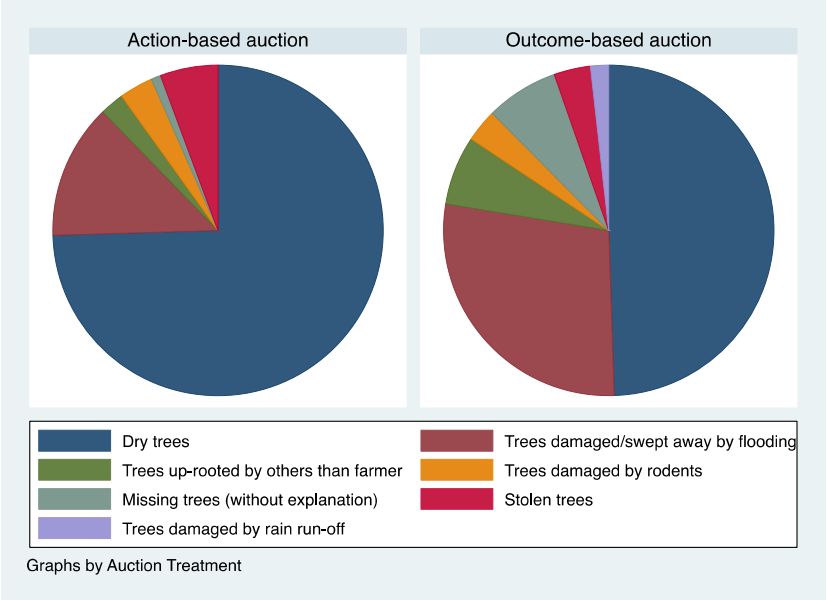
Figure 5 Perceived risk by contract type (N=98)



In addition to the participants´ risk perceptions we estimated the effective risk farmers faced during the six months project period. In the case of the outcome-based PES scheme, effective risk is represented by events beyond the participants´ control. Farmers with the action-based contracts are then exposed to risk of sanctions for trees not kept moist at the day of monitoring, though the trees might be in a very good condition.

Drought was the main cause of tree mortality counting for 74.52% and 49.46% of not surviving trees by action-based and outcome-based contracts, respectively, followed by flood damage with 13.20% of action-based and 28.11% of outcome-based contracted trees affected. Human conflicts represented then the third main cause of tree mortality, affecting 8.01% of action-based and 10.32% of outcome-based contracted trees, when trees where either up-rooted or stolen. Trees were further destroyed by rodents, water run-off in the rainy season, or missing as result of a neglected care (see figure 12).

Figure 6 Causes of tree mortality by contract type



From this follows that out of three main tree mortality causes two were out of participants´ control – namely flooding and human conflicts. In particular the risk of the riparian area to be flooded was enormous and farmers participating at the workshops, where the conservation auction project was presented, were expressing their concerns. For this reason we adopted in the contracts an exception from the sanctions for trees damaged by a flooding, when farmers were guaranteed the whole payment, condition to a prompt reporting of the project team. Herewith we significantly reduced the effective risk of farmers with outcome-based contracts since we as the implementation agency were bearing the extra cost of a flood.

The reasoning behind our decision to fully cover for the risk related to floods was that these were beyond the farmers' control and it was our aim not to harm the participants, in particular considering the conditions of a developing country. However, it is possible that this might be an important factor responsible for the surprisingly low risk perceptions towards the outcome-based contract, though the very high effective risk of unexpected events. In particular, the average sanctions of participants with the outcome-based contracts would almost double if we decided to impose the cost of flooding on them, when deducting payments for the flood damaged trees (see table 13).

Table 10 Sanctions, cost of flooding and final payments

	Obs	Mean	Std. Dev.	Total
Action-based contract				
1st & 2nd sanctions on watering	44	605.95	1,376.07	26,662
Hypothetical sanctions on tree survival	44	660.36	1,505.93	29,056
Final payment	44	14,421.84	6,534.71	634,561
Outcome-based contract				
Sanctions on tree survival	54	698.87	1,478.45	37,739
Cost of flooding (not sanctioned)	54	639.44	2,130.28	34,530
Final payment	54	15,919.27	6,105.55	859,641

Notes: Figures in KES, 1 USD=84 KES (www.oanda.com, 8.11.2013).

Farmers with the action-based contracts faced then a different kind of risk, namely risk of being sanctioned for trees not kept moist at the monitoring days, regardless of the potentially high tree survival rates. In order to prove this we compared the average sanctions imposed on the participants, as result of their non-compliance with the tree watering requirement, to sanctions that would hypothetically apply if evaluating their performance using the outcome-based criteria on tree survival. Though, most participants perceived the action-based contracts as more risky due to the higher monitoring frequency, the comparison did not reveal any significant difference in the average sanctions using the two different evaluation rules (see table 13).

Thus in both cases - for the action-based and the outcome-based contract type – it was confirmed that the perceived risk can significantly differ from the effective risk. Accordingly, the decision on risk sharing is of particular importance, yet, it is the perceived risk that too much extent determines the willingness to accept and thus the conservation auction cost-effectiveness.

Flexibility

The theory predicts the result-oriented conservation approach to increase participants´ flexibility as opposed to a scheme with payments tied to prescribed actions when participants are expected to exclusively follow the contract requirements. In our analytical

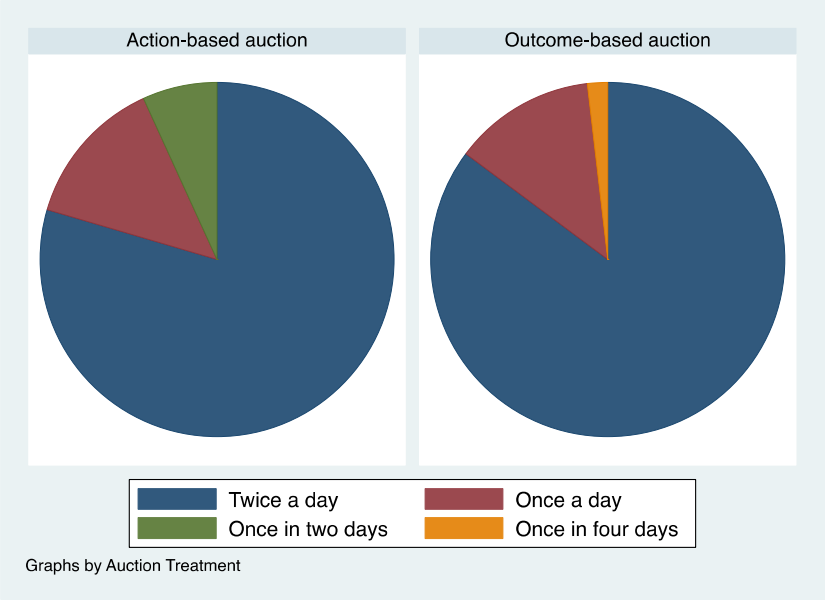
framework, flexibility is assessed as the difference between the two contract types in the tree watering intensity, the average time spent on tree-care and the perceived labor intensity together with the effort on reporting of unexpected events.

If comparing the overall work related to the two tree planting contracts, then 67.34% of farmers claimed the action-based contract to be more work demanding, 24.48% consider both contracts to demand the same work, and only 8.16% would consider the outcome-based contract to be more labor intensive. The perceived high labor intensity of the action-based treatment does not change if disaggregating the statements across the two contract types (see figure 7).

Figure 7 Perceived labor intensity by contract type (N=98)

However, if considering the dry season only, then the watering intensity was almost the same across the two treatments, with 79.54% and 85.18% of farmers with the action-based and outcome-based contracts, respectively, watering the trees twice a day, followed by a daily watering (see figure 8).

Figure 8 Watering intensity by contract type



Also, most of the participants with the action-based contract (63.63%) would water the trees with the same intensity if being contracted for the outcome. The remaining participants would either increase (18.18%) or decrease (15.15%) the watering intensity, thus only small part of them hypothetically using the flexibility offered by the outcome-based contracts.

Similarly, the overall time spent on the tree care in the dry season differs only slightly, with 2.4 hours a week less for farmers with the outcome-based contracts (see table 14). Therefore, it seems that the increased flexibility farmers were given in the outcome-based contracts did not give them much advantage in the dry season, since the action prescription in the action-based contracts has shown as the most necessary action for tree survival.

Table 11 Tree care by contract type

Tree care in dry season (hours/week)						
Action-based contract	44	19.25	10.31	14	3	45
Outcome-based contract	54	16.82	8.89	14	6	42
Tree care in rainy season (hours/week)						
Action-based contract	44	6.35	5.60	4	0	24
Outcome-based contract	54	6.01	5.55	4	0.5	28

As expected, without the tree watering exercise, the weekly hours that the outcome-based contracted farmers spent on the tree care in the rainy season, then, dropped from 16.82 hours to 6.01 hours only. Surprising is, however, the conservation behavior of the action-based contracted farmers who, though not required to conduct any additional action to tree watering, still spent about six hours a week on tree care in the rainy season, thus achieving the same labor intensity as the outcome-based contracted farmers (see table 14).

Thus, it seems that farmers with the action-based contracts went in their conservation activities much beyond the prescribed requirement on keeping the soil around the trees moist. This is further confirmed by the statement that most of the farmers (68.18%) would have conducted the same conservation activities as they did if their payments were condition to the tree survival (and not to the soil around the trees kept moist).

At the same time, participants with the action-based contracts also made use of their limited flexibility. As mentioned above, all participants were obliged to immediately report any damage caused by flooding or human conflicts in order to avoid sanctions for non-compliance with their contract. However, while six out of eight flood affected farmers (and in addition one farmer affected by a human conflict) with the outcome-based contracts reported on the unexpected events, none of the six flood affected participants with the action-based contracts did report to the project team. Obviously, the action-based contracted farmers were aware that their payments are condition to the watering requirement only, thus not being affected by any damage to the trees (as long as the trees were kept moist), and opted for avoiding the extra effort of reporting.

All this together, the majority of participants perceived the action-based contract as more labor intensive, which shows on less flexibility. However, if comparing the watering intensity – both real and hypothetical - and the working time spent on tree care we did not find any significant difference. Similar to the risk discussed above, the perceptions on flexibility might have a significant impact on the (perceived) compliance cost and thus the willingness to accept, though not necessarily corresponding with the real situation. Finally, the action-based contracted farmers used their limited flexibility and did not report on

unusual events; while at the same time have conducted conservation activities far beyond their assignment.

Innovation

In our analytical framework, all additional conservation actions to watering are considered as an innovation since those actions were not required by any of the two contracts. Innovation, similar to flexibility, is predicted to increase with the use of the result-oriented conservation approach.

The project evaluation survey revealed that both the outcome-based and the action-based contracted farmers showed a wide range of innovations during the six months contract period. In total thirteen innovations could be classified and on average 4.22 and 4.35 innovations were implemented by farmers with action-based and outcome-based contracts, respectively.

The three most common conservation practices (in addition to watering) were fertilizing and guarding trees from people and animals, followed by the use of insecticides and/or pesticides, flood prevention and tree fencing. Farmers were also protecting trees from sun, rainwater run-off and erosion, weeding, mulching and trapping moles. One farmer applied ash in order to protect trees from termites (see table 15).

Table 12 Innovations by contract type

INNOVATION	Action-based treatment (N=44)	Outcome-based treatment (N=54)
Fertilizing	34 (77.27%)	45 (83.33%)
Guarding from people	27 (61.36%)	37 (68.51%)
Guarding from animals	11 (25%)	29 (53.70%)**
Use of insecticides/pesticides	14 (31.81%)	24 (44.44%)
Flood prevention	16 (36.36%)	12 (22.22%)
Tree fencing	8 (18.18%)	16 (29.62%)
Shading trees from sun	5 (11.36%)	2 (3.70%)
Rain water run-off protection	6 (13.63%)	2 (3.70%)*
Erosion prevention	5 (11.36%)	6 (11.11%)
Trapping moles	8 (18.18%)	4 (7.40%)

Weeding	7 (15.90%)	3 (5.55%)
Mulching	2 (4.54%)	1 (1.85%)
Applying ash to fight termites	0 (0%)	1 (1.85%)

Notes: Regression of innovations on contract type (*p<0.10, ** p<0.05, *** p<0.001).

Though, overall farmers with the outcome-based contracts outperformed in implementation of most of the innovative practices, the theoretical prediction of higher innovation with outcome-based approaches could be proved only to a limited extent. Guarding from animals was the only conservation action with a significantly higher conduct by the result-oriented farmers, and the extent to which the action-based contracted farmers have been conducting additional activities to watering is surprising.

In this regard, intrinsic motivation among the project participants and its possible effect on the increased innovation across the two treatments is examined.

Intrinsic motivation

Using the baseline survey we analyzed the general intrinsic motivation for conservation of the targeted landholders and in addition the environmental awareness and the experience with conservation practices (conservation attitudes), which might positively influence the motivation. Further, using the evaluation survey we proved the field trial participants´ intrinsic motivation related to tree planting and whether the outcome-based scheme increases the motivation to deliver the environmental goals as suggested by the theoretical framework. Finally, the possible effects of the contract allocation mechanism and PES scheme design as well as the farmers´ perceptions of tree benefits on the intrinsic motivation are examined.

The surveyed farmers with a land along the Kapingazi River (n=411) showed very high awareness of conservation problems in their area, while at the same time a limited acknowledgment of their own responsibility. Landholders stated that water quality (71.53%) and quantity (78.34%) are major problems and that more trees lead to a better water quality (91.97%) and increased water quantity (95.37%), whereas almost everybody (99.27%) indicated the willingness to protect water. Further, 77.85% of farmers agreed that farming activities at the riparian banks affect the water quality, and 78.34% of them

believed that the water they get is affected by the activities of people living upstream. However, a relatively smaller proportion of landholders (58.39 %) admitted that there is a relationship between their individual farming and the water quality in their area. Similarly, almost all farmers (98.54%) stated that conservation plays an important role in the society and they (94.64%) feel obliged to conserve the environment. Relatively less landholders (69.82%) then believed that people in their area are in general concerned with conservation.

Further, we found evidence of an extensive experience with conservation practices of the project-targeted landholders (see table 16). The conduct of tree planting at the farm were then proven to have a high magnitude impact on the willingness to accept the tree planting contract, decreasing the bid on average by 9,790.91 (p=0.047). If disaggregating the bid levels by contract types, then only farmers tendering for the action-based contracts submitted significantly higher bids (increase of 19,822.31 KES, p=0.031) if having not previously planted trees at their farm.

Table 13 Conduct of conservation practices by targeted landholders

CONSERVATION PRACTICE	**Farmers with land along the river (N=411)**
Napier grass planting	383 (%)
Tree planting	369**(%)
Mixed cropping	366 (%)
Terracing	271 (%)
Use of drought resistant crops	269 (%)
Crop rotation	245 (%)
Roof water harvest	217 (%)
Cover cropping	163 (%)
Grass strips	157 (%)
Contour ploughing	153 (%)

Notes: Two-sample t-test with equal variances of bid by whether previous conduct of tree planting (*p<0.10, ** p<0.05, *** p<0.001).

Using the evaluation survey, we tested the intrinsic motivation of the contracted landholders towards tree planting in general at the end of the field trial. First, emotions related to a planted tree dying were analyzed. 52% and 50% of landholders, with action-based and outcome-based contracts respectively, stated feeling sad about a tree dying because they want the tree to survive. The remaining participants, 48% and 50% for each of

the two contract types, stated feeling disappointed due to time spent on caring for the tree. None of the participants stated any feeling about a tree dying. Thus, regardless of the contract type, farmers showed high intrinsic motivation for survival of a planted tree, half of it originating in the opportunity cost of the tree care.

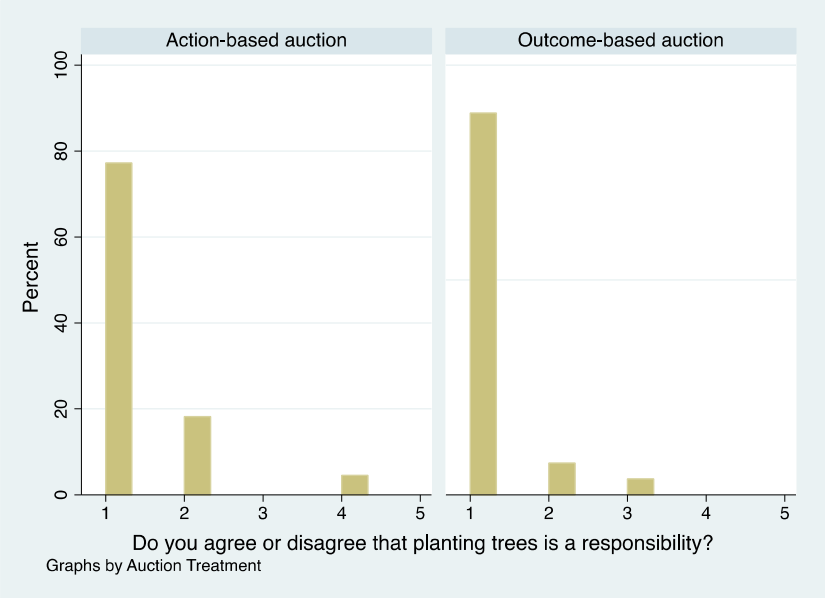
Participants were also asked about their opinion towards concepts of (i) a good farmer taking care of plants on his/her farm, (ii) the obligation of planting a tree once receiving a seedling as well as (iii) the obligation of taking good care for trees once planted, and finally (iv) the concept of tree planting being a responsibility of landholders.[5]

84.09% and 87.03% of action-based and outcome-based contracted farmers, respectively, very much agreed with the statements that a good farmer cares for plants on his farm. Further, 86.36% of landholders with an action-based contract as opposed to 90.74% of those with an outcome-based contract agreed very much that they feel obliged to plant a tree once receiving a seedling. Similarly, 88.63% and 92.59% of action-based and outcome-based contracted participants, respectively, very much agree that they feel obliged to take good care of a tree once planted. Finally, 77.27% participants with the action-based contract as compared to 88.88% of those with the outcome-based contract agreed very much with the statement that planting trees is a responsibility (see figure 9).

Though, we could reveal moderately higher motivation on tree planting and tree care of farmers with the outcome-based contracts (in four out of the five questions), we cannot conclude on an increase of the motivation as result of the participation in a result-oriented scheme since the differences were not statistically significant.

[5] The questions used scale from 1 to 5, where 1 corresponds to “I agree very much” and 5 to “I very much disagree”.

Figure 9 Whether tree planting is a responsibility



Note: Scale from 1 to 5, where 1 corresponds to “I agree very much” and 5 to “I very much disagree”.

Analysis of the participants´ compliance motivation during the tree planting field trial revealed that only one farmer with the action-based contract was solely aiming at keeping the soil around the trees moist. All remaining action-based contracted landholders were aiming either at the tree survival (59.09%) or both (38.63%), keeping the soil moist and the tree survival (see figure 10). Also, the action-based contracted participants stated either the tree survival only (56.81%) or the tree survival together with the expected payment (40.90%) as their motivation for tree watering, and none was motivated solely by the expected payment (while one farmer did not provide any answer). Thus, against the theoretical predictions and in accordance with the above findings on flexibility and innovation, the motivation on the tree planting of landholders with the action-based contracts went far beyond their contract requirements.

The outcome-based contracted farmers were then aiming at the tree survival (48.14%) as expected, though for most of them (51.85%) tree survival was linked to the conduct of tree watering (see figure 10). This again confirms the above finding regarding the flexibility that the outcome-based contracted farmers recognized the action-based contracts´ requirement on tree watering as a crucial measure for their aim at tree survival. Overall, we can

conclude that participants of both treatments were driven by almost identical motivation towards tree survival, which to most of them to a great extent depended on the conduct of tree watering.

Figure 10 Main goals of the contracted landholders by contract type

Further, we could reveal a great positive effect of the auction allocation mechanism and the contract signing procedure on increase of the project participants´ motivation towards tree planting. In particular, 79.54% and 68.51% of landholders with action-based and outcome-based contracts, respectively, very much agreed that being among the farmers selected in a tender increased the importance of tree planting as compared to a situation without a tender when everybody could participate. Similarly, 65.90% of action-based and 70.37% of outcome-based contracted participants very much agreed that the act of signing a contract increased the importance of tree planting as compared to a situation without a contract.[6]

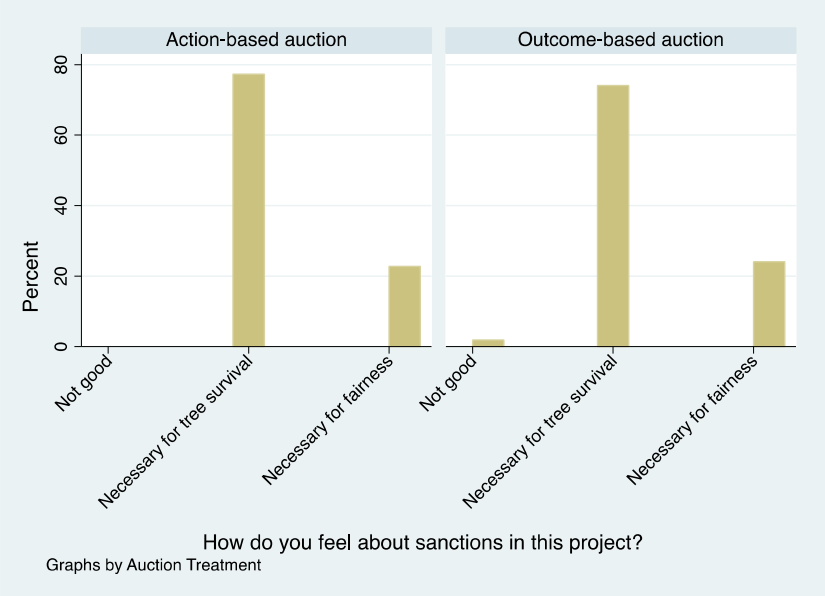
This is very similar to the finding of an experiment in Malawi (Jack, 2010), which showed higher tree survival rates under contracts that were allocated trough an auction as opposed

[6] The questions used a scale from 1 to 5, where 1 corresponds to “I agree very much” and 5 to “I very much disagree”.

to a posted offer treatment. While the Malawian study concludes that the auction allowed for a better selection of high compliance landholders, given the participants´ answers we assume that the selection through an auction by itself increases the landholders´ motivation towards a high environmental performance. This overall increase of the motivation given the auction selection process might be then one of the main reasons for the small differences in tree survival rates we found between the two treatments.

Furthermore, all field trial participants except of one considered the contract compliance sanctions as necessary, either in order to assure the tree survival or equal conditions for all participants, given the two contract types (see figure 11). Farmers were also largely (93.87%) satisfied with the tree species they received. Further, most of the landholders (74.48%) appreciated the participation in the field trial due to gain of knowledge and skills on tree benefits, planting and management. Also, every sixth farmer (15.30%) valued that the project participation promoted a sense for responsibility, commitment and time planning.[7] The satisfaction with these different aspects of the project design might also be an important source of the observed high intrinsic motivation towards the tree survival.

Figure 11 Landholders´ opinions on sanctions by contract type



[7] The question was opened asking „What lessons did you learn from the project?“

Moreover, participants of the action-based and outcome-based treatments estimated the average net benefits from the planted trees to achieve in five years 36,267 and 70,225 KES (p=0.311), respectively. In ten years the landholders expect almost identical net benefits amounting approximately 89,000 KES (p=0.994). If considering the median, which is a more appropriate measure of the central tendency in case of such a high variation, then the action-based contracted farmers expected almost a triple amount of the net benefit in five years and a double amount in ten years (see table 17). Overall, landholders across both treatments expected the benefits to predominantly outweigh the conservation cost.

Table 14 Expected net benefits from planted trees by contract type

	Obs.	Mean	Std. Dev.	Median	Min	Max
Action-based contract						
Expected total gain in 5 years	44	76,024.98	89,772.77	35,000	0	300,400
Expected total cost in 5 years	44	39,757.30	77,146.09	13,975	3,000	432,000
Expected net benefit in 5 years	44	36,267.68	113,552.90	14,500	-362,000	287,825
Outcome-based contract						
Expected total gain in 5 years	54	92,916.48	196,128.90	20,000	0	1,151,200
Expected total cost in 5 years	53	24,425.11	25,257.21	17,650	0	120,000
Expected net benefit in 5 years	53	70,225.64	195,424.20	5,750	-106,000	1,116,650
Action-based contract						
Expected total gain in 10 years	44	144,404.50	168,463.40	62,500	10,000	800,000
Expected total cost in 10 years	42	59,198.33	98,598.85	21,500	4,860	500,000
Expected net benefit in 10 years	42	89,035.00	189,821.30	32,325	-383,000	725,000
Outcome-based contract						
Expected total gain in 10 years	54	144,373.90	337,798.90	50,000	0	2,292,000
Expected total cost in 10 years	52	58,468.92	123,312.20	27,400	0	864,000
Expected net benefit in 10 years	52	89,534.73	370,948.60	16,000	-857,000	2,252,950

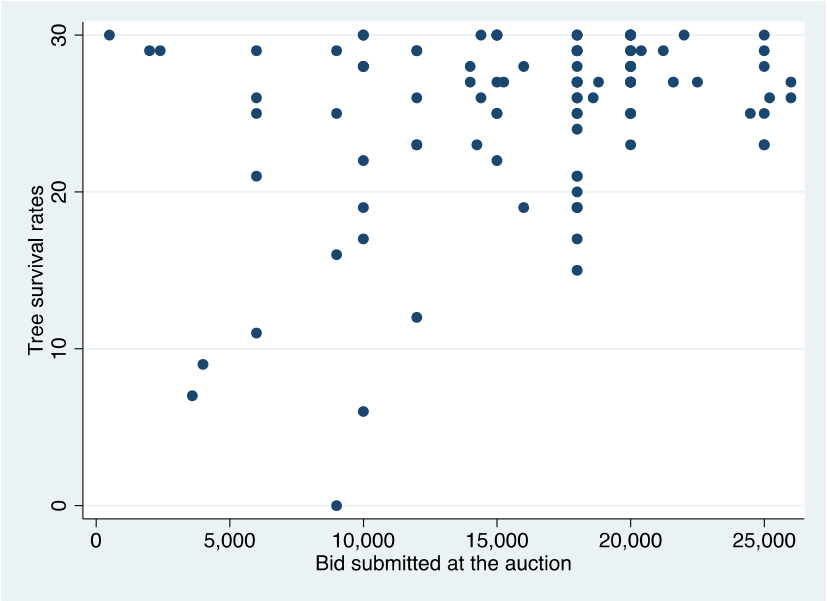
Notes: Figures in KES, 1 USD=84 KES (www.oanda.com, 8.11.2013).

Furthermore, regardless of the contract type, farmers expected a wide range of additional benefits such as firewood, fodder for animals or leaves for mulching. 61.36% and 74.07% of the action-based and outcome-based contracted farmers, respectively, stated that these benefits are more important than the payment. The remaining landholders perceived then the benefits and the conservation payment equally important. None stated the payment to be more important than the additional benefits. Finally, all landholders believed that their children would benefit from the conducted tree planting.

Consequently, considering all the above landholders` statements we can conclude on high intrinsic motivation towards conservation and the tree planting project. In this regard, the question arises whether there was any additionality of the conservation payments or whether the intrinsic motivation alone would be sufficient to promote a high environmental performance.

First, we examined a possible relationship between the environmental performances and the submitted bids and revealed that the tree survival rates drop with decrease in the submitted bid amounts (see figure 12). In particular, a bid increase of 1,000 KES results in 0.3 more surviving trees (p=0.002). Moreover, the tree survival rate increases by 4.56 trees (i.e. 15.20% of max. 30 trees) if the bid submitted exceeds the average opportunity cost (p=0.001)[8].

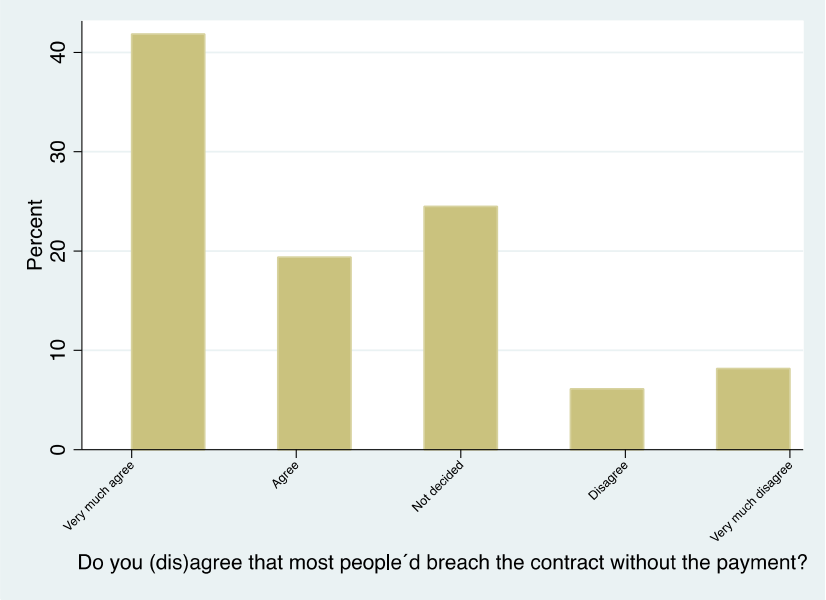
Figure 12 Tree survival rates versus submitted bids



8 The average opportunity cost was estimated to 10,658 KES, using the question „What was the tree planting cost considering all expenses – i.e. time, productive land loss due to tree planting, input and travel costs, etc.?“

Following, the results show that the expected payment amounts greatly impacted the observed tree survival rates and even more importantly, that the participants´ opportunity costs have to be covered in order to achieve good environmental performances. In addition, the participants confirmed the conservation payments´ additionality when 61.22% of them believe that without the payment most farmers would breach the tree planting contract, i.e. would fail to comply with the contract requirements (see figure 13).

Figure 13 Contract compliance and conservation payments



As next the impact of risk, flexibility, innovation, and intrinsic motivation on the private compliance cost and the willingness to accept (as suggested by the analytical framework) are considered.

Private compliance cost and willingness to accept the other contract type

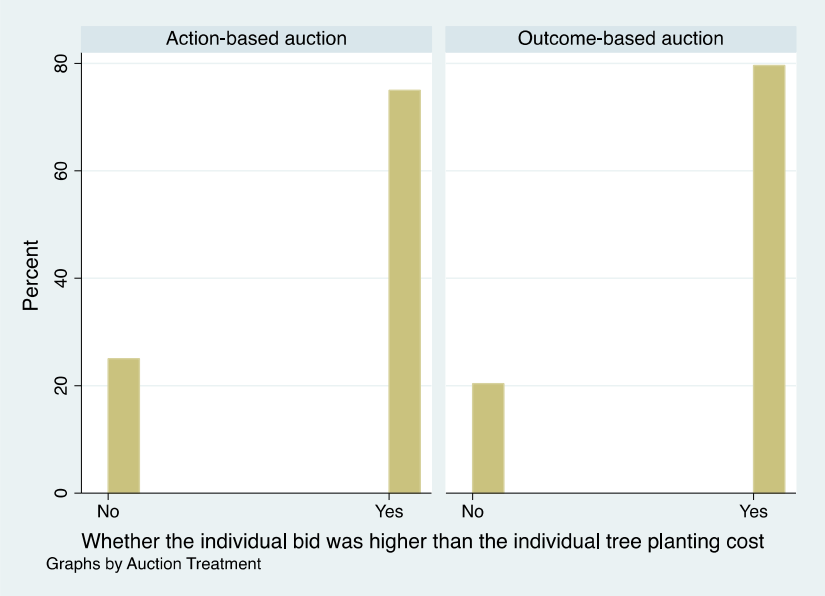
The risk associated with the result-oriented approaches is expected to increase the private compliance cost while at the same time the enhanced flexibility and innovation are supposed to decrease the cost. Decreased compliance cost, together with intrinsic motivation, should then result in higher willingness to accept (i.e. lower bids), and vice versa (Matzdorf and Lorenz, 2010). Thus, in contrary to the explicit prediction on higher environmental outcome of the result-oriented approaches, the theory does not allow for

conclusion on the compliance cost and the willingness to accept of outcome-based conservation contracts. The empirical evidence of the field trial should then shed more light on which of these above mentioned effects prevail.

Using an evaluation survey, we requested the contracted farmers to indicate the whole cost incurred during the tree planting project including time, land loss, and inputs. Further, in order to reveal whether the different contract types might lead to different bidding strategies (i.e. willingness to accept), the contracted participants were in addition asked on possible changes of their bid amount if participating at the other auction[9].

The average field trial compliance cost as displayed by the farmers was almost identical for both treatments - 10562.64 and 10736.19 KES for the action-based and outcome-based contracts, respectively (p=0.927). Neither we could prove any significant difference in the compliance cost estimation prior the field trial start, with % and % of farmers with the action-based and outcome-based contracts, respectively, who underestimated their bids (see figure 11).

Figure 14 Private compliance cost estimation by contract type (N=98)



[9] Telephone interview with the 98 contracted participants after the project end

Yet, about % farmers (i.e. other than the same) would decide for a different bidding strategy if having participate at the other auction treatment. % of farmers with the outcome-based contracts indicated that they would increase their bid if participating at the action-based auction. Accordingly, …% of farmers with action-based contracts, then, would decrease their bids if tendering for outcome-based bids (see figure 12).

Figure 15 Change in bids if other treatment (N=98)

Since it is the compliance cost (and in addition the intrinsic motivation) that according to our analytical framework determines the willingness to accept, it is a question why would be the field trial participants adjusting their bids to the particular contract if the actual compliance cost of both treatments was the same?

The hypothetical increase in bids if tendering for the action-based contract (and vice versa decrease if tendering for the outcome-based contract) thus very possibly relates to the higher risk perception and the lower flexibility related to action-based contracts, regardless of the actually incurred compliance cost. This is too much extent confirmed by the farmers´ reasoning behind their decisions on changes of the bidding strategies.

Similarly to the question on risk perceptions, those 23 (out of 54) farmers with outcome-based contracts, who would increase their bids if participating at the action-based auction,

mostly indicated the higher labor intensity and thus more time spent and higher cost due to labor hiring as the main reason for the hypothetical change in their bidding behavior. Accordingly, most of the number action-based contracted farmers (out of 44), who would decrease their bids if bidding for an outcome-based contract, indicated that for them the outcome-based contract was not so labor intensive.

26 and 35 farmers with the action-based and outcome-based contracts, respectively, would then not change their bid if participating in the other treatment. The most common reasoning were that they were actually satisfied with the payment received (and), the labor was the same (and), they were interested in the trees as such (), and were not willing to risk loosing the contract if bidding too high (1 - contract).

Only three farmers with an action-based contract would then increase their bid if tendering for an outcome-based contract, also reasoning by higher labor cost. Only one farmer with outcome-based contract would then decrease her bid if bidding for an action-based contract, due to a short distance from the watering point to the planted trees.

Following, the participants of the tree planting field trial did obviously distinguish the different kind of risk and the accordingly different compliance cost depending on whether they were paid for the outcome or the conduct of the action prescription. Though we cannot infer for all the auction participants, the answers of the contracted farmers indicate that the landholders were indeed adjusting their bidding strategies to the perceived risk and correspondingly requesting for risk premiums.

In particular, in our field trial setting the contracted landholders perceived the action-based contract as more labor intensive (i.e. less flexible and more costly) and more risky (of not performing well at the monitoring days), while most farmers would increase their bid if aiming at the action-based contract. On the other hand, the farmers did not have an obvious preference for one of the two contract types, with most landholders having preference for the one contract type they were awarded. Thus, it seems that farmers of both treatments were satisfied with their contract conditions. Combination of these factors does not allow us to conclude on who was requesting the risk premiums – the action-based contracted farmers

due to the perceived higher risk of monitoring and labor intensity or the landholders with the outcome-based contracts due to the risk of being responsible for the tree survival.

However, it is very probable that the landholders aiming at action-based contracts would request lower bids if perceiving the action-prescription as less work demanding. Therefore, the contract design matters a lot when the interaction of the action prescriptions, the monitoring intensity and the requested outcome have a significant influence on participants´ risk and flexibility perceptions and thus on the PES scheme cost-effectiveness.

Monitoring cost

There was the same monitoring cost for both contracts types. All project participants were monitored at the start of the project on whether trees were planted according to the contracts, while at the same time the farms with the action-based contracts were monitored on the tree watering requirement. Further two monitoring were conducted during the project, one more on the tree watering of the action-based contracted trees and one on the survival of the outcome-based contracted trees. The monitoring cost does not include the one additional monitoring on survival rates of farmers with the action-based since that was conducted for the research purpose only (and would be skipped in the real situation). Thus, while keeping the project monitoring rounds equal for both PES schemes, there was no significant impact of the monitoring cost on their cost-effectiveness.

8. Conclusion

Based on a theoretical framework proposed by Matzdorf and Lorenz (2010), a tree-planting field trial was carried out in Kenya to explore the budgetary cost-effectiveness and ecological outcome of action-based and outcome-based conservation auctions, as well as their implications in terms of risk, flexibility, innovation and intrinsic motivation.

The experimental results do not confirm the expectation that tendering outcome-based contracts lead to higher bids. Neither the theoretical prediction of higher ecological performance of outcome-based contracts could be confirmed as high tree survival rates prevailed independent of the contract type. As result, the field trial study did not reveal any

significant difference in the cost-effectiveness - calculated as an average cost of a tree – depending on whether the payment is linked to the outcome or prescribed actions.

A closer look at the factors influencing bidding behavior and ecological performance reveal even more unexpected effects. First, the farmers did not necessarily perceive the outcome-based contracts as more risky since they also perceived the monitoring on the action compliance as risk. Second, farmers with action-based contracts did not limit their conservation effort to watering prescription only, but performed a number of additional conservation activities. Guarding trees from animals was then the only conservation activity predominantly performed by farmers with payments linked to outcome. Finally, high intrinsic motivation on tree survival was observed independently of the contract type.

Overall, the study revealed that outcome-based payments do not necessarily lead to gains in environmental outcome. In our study this was prevented by a high intrinsic motivation of action-based participants to care for trees as well as strong positive correlation of the prescribed conservation action and the tree survival. Finally, conservation auction cost-effectiveness is highly dependent on participants risk perceptions towards the offered contract types.

ACKNOWLEDGMENTS

We thank the German Federal Ministry of Education and Research for funding within the BIOTA and Small Grant projects. We are also grateful for the support from the World Agroforestry Centre (ICRAF), Kenya Forest Service (KFS), the community members and the field assistants. We would like to express our gratitude to Dr. Delia Catacutan (ICRAF), Dr. B. Kelsey Jack (Tufts University) and Prof. Dr. Joachim von Braun (ZEF) for the valuable guidance and advice.

LITERATURE

Aarts, N. and van Woerkum, C. (2000): Communication in nature management policy making, Rientjes, S. (Ed.), Communicating Nature Conservation. ECNC, The Netherlands, 27–47.

Assessment, M. E. (2003). Millennium ecosystem assessment, Ecosystems.

Engel, S., Pagiola, S., Wunder, S. (2008). Designing payments for environmental services in theory and practise: An overview of the issues. *Ecological Economics* 65: 663 - 674.

Ferraro, P. J. (2008). Asymmetric information and contract design for payments for environmental services. *Ecological Economics*, no. 65, p. 810-821.

Ferraro, P.J. and Pattanayak, S.K. (2006): Money for Nothing? A call for Empirical Evaluation of Biodiversity Conservation Investments, PLoS Biology 4 (4): e105, 482-488.

Ferraro, P. J., Simpson, R.D. (2002). The Cost-Effectiveness of Conservation Payments. *Land Economics*, no. 78(3), p. 339-353.

Hugo-Becker, A. and Becker, H. (1997) Motivation–Neue Wege zum Erfolg, Beck, Wirtschaftsberater. Verlag C.H. Beck, München.

Jack, B. K. (2010). Allocation in environmental markets: A field experiment with tree planting contracts.

Jack, B. K., Leimona, B. and Ferraro, P. (2009): A revealed preference approach to estimating supply curves for ecosystem services: use of auctions to set payments for soil erosion control in Indonesia, *Conservation Biology* 23.2 : 359-367.

Latacz-Lohmann, U., Van der Hamsvoort, C. (1997). Auctioning Conservation Contracts: A Theoretical Analysis and an Application. *American Journal of Agricultural Economics*, vol. 79, p. 407-418.

Latacz-Lohmann, U., and Schilizzi, S. (2005): Auctions for conservation contracts: a review of the theoretical and empirical literature, *Scottish Executive Environment and Rural Affairs Department* 101.

Matzdorf, B. and Lorenz, J. (2010): How cost-effective are result-oriented agri-environmental measures? An empirical analysis in Germany. *Land Use Policy* 27: 535–544.

OECD (2010): Paying for biodiversity. Enhancing the cost-effectiveness of payments for ecosystem services.

Pagiola, S., Arcenas A. and Platais G. (2005): Can payments for environmental services help reduce poverty? An exploration of the issues and the evidence to date from Latin America, World development 33.2: 237-253.

Pattanayak, S. K., Wunder, S. and Ferraro, P.J. (2010): Show me the money: Do payments supply environmental services in developing countries?, Review of Environmental Economics and Policy 4.2 (2010): 254-274.

Schilizzi, S., Breustedt, G. and Latacz-Lohmann, U. (2011). Does tendering conservation contracts with performance payments generate additional benefits? *Working Paper 1102*, School of Agricultural and Resource Economics, University of Western Australia, Crawley, Australia.

Schwarz, G., Moxey, A., McCracken, D., Huband, S. and Cummins R. (2008). An analysis of the potential effectiveness of a Payment-by-Results approach to the delivery of environmental public goods and services supplied by Agri-Environment Schemes. *Report to the Land Use Policy Group*, UK, 108pp.

Swallow, B. M., Kallesoe, M.F., Iftikhar, U. A., van Noordwijk, M., Bracer, C., Scherr, S.J., Raju, K.V., Poats, S.V., Duraiappah, A.K., Ochieng, B.O., Mallee, H., Rumley, R. (2009): Compensation and Rewards for Environmental Services in the Developing World: Framing Pan-Tropical Analysis and Comparison, *Ecology and Society* 14 (2): 26.

Whitten et. al. (2008)

Wunder, S. (2005): Payments for environmental services: some nuts and bolts, CIFOR, Ocassional Paper No. 42.

Wunder, S., Engel, S., and Pagiola S. (2008): Taking stock: A comparative analysis of payments for environmental services programs in developed and developing countries, Ecological economics 65.4 (2008): 834-852.

Zabel, A., Roe, B. (2009). Optimal design of pro-conservation incentives. *Ecological Economics* 69: 126–134