The Cost-Effectiveness of Combining Reforestation Auctions with Performance Based Payments – A Field Trial in Rural Kenya

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Abstract

The increased interest in, and application of payments for ecosystem services calls for mechanisms that are highly cost-effective. In participatory field trials with communities in Western Kenya, we combined procurement auctions for reforestation contracts with payments based on contractor performance, measured as number of survived seedlings. We compared the cost-effectiveness of this approach to a baseline approach that is currently applied by the Kenyan Forest Services. We found our approach to return a considerably higher cost-effectiveness. The increase in cost-effectiveness is partly due to lower contracting costs as a result of competitive bidding, but even more so to improved seedling survival as a result of the incentives of outcome oriented payments. The latter led to a monitoring intensity which significantly reduced seedling destruction through cattle grazing, one of the major causes of seedling loss. Seedling care, however, also appeared to have been motivated by factors other than performance based payments including i. monitoring costs, ii. community benefits from the reforested areas, and iii. the size of the investment. With respect to equity, participation of poor community members was disproportionately high. We acknowledge the limitation of this study in lacking statistical evidence but find our results to indicate clear trends.

Key words: PES, auction, tender, Kenya, reforestation, procurement

1 Introduction

Interest in payments for ecosystem services (PES) or PES-like schemes has grown considerably in recent years (Pattanayak et al., 2010; Gómez-Baggethun et al., 2010). PES constitutes a clear market transaction in which the different interests of two market agents (supplier and buyer of ecosystem services) are recognized and openly dealt with through agreements on supply and remuneration (Wunder et al., 2008). As Ferrarro and Simpson (2002) point out, direct payments can be more cost effective in achieving conservation goals than indirect strategies such as the promotion of commercial enterprises intended to generate local incentives for conservation. Cost effectiveness is defined here as the ratio of environmental benefits to program costs.

A major challenge to PES schemes is the information asymmetry over the cost of service provision. Service providers know more about costs of contractual compliance than service buyers which usually puts the latter in a disadvantaged bargaining position (Ferraro, 2008). This may entail high surpluses for service providers both in individual negotiations and where schemes use fixed payments that are made independent of individual provision costs (Wünscher et al., 2008). Procurement auctions for conservation contracts are one viable way to overcome or at least mitigate the problem of informational rent (Jack et al. 2009). Conservation auctions are multi-item procurement auctions in which governments (or private actors) purchase (instead of sell) multiple units (rather than one unit) of the conservation good (Latacz-Lohmann and Schilizzi, 2005). Competitive bidding under certain conditions can reduce overcompensation and increase cost-effectiveness by revealing the 'real' opportunity cost of service provision (Engel and Palmer, 2008). Auctions thus constitute an interesting instrument to circumvent the issue of informational rent (Latacz-Lohmann and Schilizzi, 2007). While the interest in procurement auctions for conservation and natural resource management has grown in recent times (e.g. Tisdell, 2007; Lowell et al., 2007; Espinola-Arredondo, 2008; Raffensperger, 2011; Reeson et al., 2011), there have been great deviations in gains, which made a robust assessment of the cost effectiveness of conservation auctions difficult (Hailu and Schilizzi, 2004).

In order to ensure that desired services are delivered and to further increase cost effectiveness, the use of performance based PES approaches has been suggested (Ferraro, 2007). Other than action-based approaches which pay for the implementation of defined conservation actions, performance payments are made on a strictly outcome oriented basis. In other words, the concrete amount paid, depends on the level of services produced. The actions involved in achieving the conservation outcome are not relevant (Zabel and Holm-Müller, 2008). Hence, performance based payments give maximum flexibility and room for innovations for the scheme participants regarding the choice of methods to achieve the desired environmental outcome (Zabel and Roe, 2009).

Up to date there is little empirical evidence for conservation auctions and performance based payments and most of them stem from high income countries. The objective of this study is therefore to test the general functioning and cost-effectiveness of auctions and performance based payments in a developing country, more precisely for the specific case of Western Kenya. The innovative methodological element of our study is the combination of procurement auctions with performance based payments. In addition, we contribute to fill the empirical gap regarding the implementation of such approaches in low income countries where weak institutional settings often present obstacles to the use and enforcement of PES.

In our approach, we auction reforestation contracts to members of forest adjacent communities in Western Kenya. The payments are made conditional on survived seedlings, although, following Ferraro (2007), a 'base payment' is made immediately after planting. Base payments may further increase the cost effectiveness because they attract risk-averse service providers into the program who are otherwise deterred by the uncertainty associated with performance based payments in which the eventual pay-off can depend on factors outside the providers control, for example due to unexpected weather events. The outcomes are compared to fixed payment reforestation activities led by the Kenyan Forest Service in the same area.

The paper continues as follows. In section 2 we describe the applied methodologies including a description of the study area. This is followed by the results which are presented in section 3. In section 4 we discuss the results and conclude in section 5.

2 Methodology

2.1 Study area

The trials were conducted in communities adjacent to Kakamega forest in Western Kenya. Kakamega forest is the last remaining rainforest in Kenya and home to a large number of endemic species (Müller and Mburu, 2008). Its rich biodiversity makes Kakamega Forest a high priority area for conservation both nationally and globally. Within Kenya it was ranked the third highest priority for conservation in 1995 (Guthiga et al., 2008). Globally, Kakamega forest is significant also as a carbon sink (Glenday, 2006). Like in many other parts of the world the forest is subject to deforestation and forest degradation. While the forest underwent farmland conversion in the pre-colonial era, and gold mining and large scale logging in the colonial period (Mitchell, 2004), today's degradation is mainly attributed to the extraction of forest products such as firewood and livestock feed by the people who live in and around the forest in one of the most densely populated areas in Africa (Guthiga, 2007). At present, the forest covers an area of about 240 km^2 with 10% being forest plantation and the rest being natural forest (Glenday, 2006). Lung and Schaab (2004) estimated that approximately 20% of the forest cover was lost in the last three decades. Complementary to activities aimed at halting further forest loss the Kenyan Forest Service (KFS), which is responsible for the management of the largest part of Kakamega Forest, finances reforestation in and around the forest with mixed indigenous species. In Kakamega alone 2134 hectares are designated for reforestation (Khalumba, personal communication in 2011). Our study is an attempt to find ways to increase the cost-effectiveness of these reforestation activities, and thus amplify the impact of limited reforestation budgets. Since the passing of the new Forest Act in 2005, KFS depends more heavily on own fund generation. For this reason KFS has recently started to sell timber to saw mills via auctions in order to obtain higher prices than the previously government-determined sale prices. With the same motivation the auctioning of reforestation contracts constitutes a potential instrument to cut spending. Our field trials are therefore of high interest for KFS with whom we closely cooperated.

The field trial on reforestation auctions which we present here is an offshoot of another field trial in which forest user rights were auctioned to community members (unpublished). For a better understanding of the overall context we briefly describe the forest user right auctions here. The latter were motivated by the Forest Act 2005, which, in an attempt to reduce destructive extraction of forest materials, provided the basis for community based forest management (CBFM) . Yet, CBFM is not without risks. If the community does not regulate forest access the 'tragedy of the commons' may prevail (Hardin, 1968). To address the issue the allocation of individual property rights is commonly suggested (e.g. Hardin, 1968)[2]. One way of allocating these rights is to auction them off. In the auction, property rights go to the highest bidders, i.e. those who put the highest monetary value on them. This allows the community to obtain the highest price for the forest resources, maximizing the financial income the community can gain from selling property rights to its own community members.

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[2] CBFM can, however, work under certain conditions (e.g. Larson and Bromley 1990). Ostrom et al. (1999) note on the issue: "Scholarly consensus is emerging regarding the conditions most likely to stimulate successful self-organized processes for local and regional common pool resources.

These financial resources in turn can be used to give compensation to those members of the community who were not able to obtain forest property rights. For example, the community can utilize the communal income to finance development programs which benefit the whole community. A defined percentage of the income, however, was set aside for reforestation activities in Kakamega Forest. These reforestation funds, administered by the community, constitute a kind of reimbursement to KFS for the granted right to communally manage the forest area (yet flow back to community members because only they were eligible to participate in the auction), and form the financial basis for the auctioned reforestation contracts that are the subject of this paper. While the contract payments were made by the community, the organization of the trials was funded by our research project funds.

With the assistance of KFS, three communities for the user right auction, and consequently for the reforestation auction, were selected from a list of 57 villages all bordering the forest. To minimize disturbance effects, some of the communities were excluded from the selection such as those with a high record of forest offences and conflicts with neighbouring communities . The selected villages are namely Isecheno and Cheroban, bordering Kakamega forest station in Kakamega South District, and Kamlembe bordering Kibiri forest station in Hamisi District. With approximately 900 households Kamlembe was the biggest community, followed by Cheroban and Isecheno with 475 and 470 households, respectively.

2.2 Timing

In December 2008, after consultations with the community leaders and the Kenyan Forest Service, the reforestation auctions were announced in one of the monthly community meetings in each village that were held as part of the user-right auction monitoring process. A few months later, in February 2009, a planning workshop was organized in which the sites were chosen, auction design and payment modalities were agreed upon, and planting standards and the monitoring approach was presented. The auctions were held in April 2009. The actual planting was also scheduled for April following the onset of the rainy season. Survival rates for tree seedlings were assessed five months after planting, in August 2009.

2.3 Selection of reforestation sites

In February 2009 the reforestation sites for the communities were selected by the local KFS forester and community representatives that had been elected in the 'user right auctions' to fulfil the functions of chairman, secretary and treasurer, . All community members, however, had the possibility to join and influence the selection process by attending the meeting in which the selection was made.

The identification of reforestation sites centred on the areas outlined in the KFS planting plan, which is developed on an annual basis and that indicates areas for reforestation. The suggestions that were made by the forester were readily accepted by Kamlembe and Isecheno, whilst Cheroban complained about the distance to their suggested site. An alternative closer site was invaded by Guava trees, however. Soil preparation would have been very labour intensive and in light of this disadvantage Cheroban hand-voted with a majority for the distant site (votes were not counted). The Kamlembe site of one hectare was close to the community. Reforestation on that site was beneficial to the community as it could help protect a river bank. Isecheno and Cheroban shared a site (3.5 ha) in the Tisain forest block, which was relatively far away from both communities, eleven and six kilometres, respectively. The site was situated in an open area of the natural forest that had been prone to forest fires. The plots close to the entrance of this forest site were given to Isecheno and the plots located deeper inside the site were assigned to the Cheroban community.

After the two sites had been selected, one for Kamlembe and one for Isecheno and Cheroban together, they were split up into plots, which was the unit in which they were put on auction. The 3.5 ha site of the Isecheno and Cheroban community was divided into three plots of one hectare for Isecheno, and two plots of 0.25 hectares for Cheroban. The one hectare site in Kamlembe was split up into two plots of 0.5 hectares. The sizes of the plots and total reforestation area followed the available funding which came from the 'forest user right auctions'.

The outcomes of the 'treatment' sites were compared to 'baseline' sites. On these baseline sites the Kenyan Forest Service reforested simultaneously to the activities on the treatment sites, using a conventional contracting method in which day labourers were hired for site preparation and tree planting. We attempted to minimize our influence on how things were done on the baseline sites to enable a direct comparison of treatment sites to the business as usual practice. The baseline sites, KFS Kakamega (21ha) and KFS Kibiri (2ha), were right next to the treatment sites and had similar biophysical conditions, for example with respect to vegetation cover, soils and climate. On treatment and baseline sites the same mix of indigenous tree species was used, the same planting standards were applied, and planting was done in the same week For monitoring purposes three plots of one hectare each and one plot of half a hectare were randomly selected at KFS Kakamega and one plot of one hectare was randomly selected at KFS Kibiri (Table 1).

[Insert about here Table 1 (Reforestation plots)]

2.4 Auction Design

The modalities that were discussed and determined in the February planning workshop included the design of the auction. Due to the previously conducted user-right auctions community members were already familiar with the overall auction idea and the suggestion of a reverse auction for reforestation contracts (in which the lowest bid wins) did not provoke significant disorientation. We presented two auction alternatives: (i) a closed single bid auction in which each bidder can only submit one bid in a sealed envelope and (ii) an open auction with multiple rounds in which bids are published (anonymously) after each round and bidders can revise their offers downwards (descending auction) for the next round. Both auctions were presented to make discriminatory payments (that is pay the amount asked for in the bid). The great majority (100 or 85%) of the eligible community members who attended the meeting voted for auction type (ii) while only seven (6%) voted for auction type (i) and ten (9%) abstained from voting. In the meeting, participants also determined that the number of rounds should be seven. The specific number emerged as a compromise between participants, some of whom preferred more and some less rounds. Participants further determined that for the first three rounds bidders would be allowed to bid for a maximum of two specific plots, whilst after the third round they were restricted to one of the two plots only. This setup had the purpose to increase the competition in the first rounds but at the same time to prevent one bidder from wining more than one plot . Participation in the auction was open to every household in the community. For the auction itself the households were asked to send their head to bid in the auction. The planting and caretaking of the plots could, however, be undertaken by the entire family.

We established a reserve price of Kshs 5520 per hectare, on the basis of estimated average planting costs by KFS. The auction participants were not informed about the reserve price, in order to avoid a drive up of the bids. The KFS paid a daily wage of 240 Kenyan Shillings

(3.33 US$) without food. On average, the reforestation of one hectare requires KFS to pay for 23 man days (Table 2) or the equivalent of 5520 Kenyan Shillings. Accordingly, the reserve price for the 0.5 ha and 0.25 ha plots were 2760 KSH and 1380 KSH, respectively.

[Insert about here: Table 2 (Reserve price per hectare)]

2.5 Payment Modalities

Next, people were briefed on the payment modalities. 60% of the bid would be paid right after planting but the remaining 40% were dependent on the performance after five months. Performance was measured as a score, calculated from a number of criteria about which the bidders were fully informed. People were also informed that any performance below 80% survival rate would be penalized with the bid winners having to re-plant all the failed seedlings, with the second rainy season beginning in August (the new seedlings would however still be provided by KFS). Theoretically, our base payment is therefore somewhat conditional on a relatively good performance (above 80%) as part of it becomes eroded by opportunity costs of time in case of replanting. Practically, there were problems in enforcing replanting, so that the replanting rule merely served as an additional psychological incentive.

2.6 Planting Standards

The February workshop also set the required planting standards. For example, 400 seedlings were to be planted per hectare. Planting rows were to be five meters apart. Using diagrams, it was explained how the sites were to be cleared and how the plants were to be planted. It was stressed to keep animals out of the reforestation area to avoid seedling damage. This was also emphasised by putting up signs saying ‘BIOTA EA Forest Conservation Project. Animals are not allowed on the site'. People were informed that they would have to get in touch with the forester after the beginning of the rain to obtain the seedlings (the Kenyan Forest Service provided the seedlings for the reforestation for free).

2.7 Monitoring and Performance Score

Monitoring after five months had the purpose to evaluate the seedling survival rate, seedling damage, site preparation and planting quality. The information was used to calculate the performance score of each plot. On the treatment sites the monitoring followed a monitoring design, which captured 50% of all planted seedlings and was based on a selection of random control units of ten seedlings each. The specific time of monitoring – five months after planting – was chosen mainly due to time constraints for the implementation of the field trial. From a forestry perspective we would have preferred to monitor after a longer time period. While seedling survival after five months is not a sufficient indicator for long term survival, the five month period is long enough to detect differences in tree survival and thus justify payment differentiation. Seedling survival was measured as a percentage with 100% corresponding to a score of five, meaning that all seedlings on a plot had survived. Less than 50% seedling survival meant a score of zero. Seedling damage refers to damage by grazing. The seedlings that were destroyed by insects or other pests were counted as surviving. The rationale for this is that destruction of seedlings by pests was outside the control of the bid winners and was therefore not penalized. Each single plant within the control units was examined and given a score from which a mean was calculated to determine the overall score of the plot for this criterion. Seedling damage was evaluated on a scale from zero to five points. Zero points meant that the plant had been completely uprooted by an animal while five points indicated no loss of vegetation due to grazing. The criteria, 'site preparation' and 'planting quality' were combined to create a composite score. Although the criteria remind of an action-based approach we decided to integrate them into the performance score because they serve as a proxy for performance beyond the five-month monitoring period. Again, each single seedling within the control units was examined and categorized according to the following indicators: 1. clear area around the seedling, 2. staking is well done, 3. planting hole is approximately 45cm in diameter, 4. spacing done as per forester's directions, 5. seedlings are planted upright. If all five of these indicators were met, the seedling would get a score of five, if only four of the indicators were fulfilled a score of four was given, and so forth. Eventually, the mean score of all seedlings per plot was calculated.

Using the scores for all three criteria the overall performance score for each plot i was derived by computing the sum (s_i) of the three criteria. The maximum achievable score was 15 (s_{max}). The performance based payment (P), that is 40% of the total bid b for i, was calculated as follows: $P = S_i/S_{max}\ (0.4b_i)$

2.8 Surveys

We undertook two surveys to capture the socio economic characteristics of the three communities. One general questionnaire with 286 randomly selected inhabitants of the three villages, and one smaller survey with the 114 participants of the auction only. The main survey was conducted in March 2009 before the implementation of the auction. The second smaller survey was held in August 2009, five month after the auctions had taken place. The main questionnaire inquired general socio economic characteristics of the three communities, such as the gender of the household head, his/her occupation, forest product utilization. The smaller questionnaire, posing similar questions, had the purpose to assess the socio-economic situation of the participants in contrast to their communities as a whole. In addition, it also contained more specific questions related to the auctions, as for instance the distance to the planting plot and the number of days people went to guard their site.

3. Results

3.1 Socio-economic characteristics of the communities

As expected the great majority of household heads are male (82%). Only 37% of Cheroban's household heads stated farming to be their main occupation. With this Cheroban differs from Isecheno and even more so from Kamlembe where 52% and 81% of household heads work mainly on-farm. The subsistence level is high with 80% of the interviewees indicating to grow crops mainly for household consumption. We used house types as an indicator of the economic faring of a household. A mud house with a grass roof was categorized as a poor household, a mud house with a tin roof indicated a middle income household, and a stone house with tin roof was an indicator for a high income family. Using these determinants our general survey showed that all of the three communities are relatively poor, with 88% of the respondents owning mud houses and 49% having grass roofs (Table 3). 78% of all respondents regularly grazed cattle in the forest indicating the forest's importance in the lives of most community members.

[Insert about here: Table 3 Household characteristics I ('main survey'), in percentages]

Educational levels differ between the villages. Time spent in education is slightly lower in Cheroban (five years) than in the other two communities with six and seven years. With an average of 0.64 hectares the sampled households can be classified as small-scale farmers. The average household in Cheroban, however, owns only 0.20 hectares, compared to 0.89 ha in Isecheno and 0.52 in Kamlembe.

[Insert about here: Table 4 Household Characteristics II (main survey)]

3.2 Participation

Altogether 114 households participated in the auctions (Kamlembe 37, Cheroban 33, Isecheno 44). With respect to income 79%, 80%, and 74% of all the households that participated in the auction in Cheroban, Isecheno and Kamlembe, respectively, fall into the category of poor households (Table 5). Thus the participation rate of poor households is far above their share in the three communities (49%). This finding refutes fears that the poor are excluded from competitive mechanisms.

[Insert about here: Table 5 Income categories of participants ('small survey'), percentages in brackets]

The bidders initially asked for high remuneration for the reforestation service. With each round, however, the amount of money for which the service was offered became reduced until it fell slightly below the reserve price, as shown for the example of Cheroban (Figure 1).

[Insert about here: Figure 1 Bids in auction rounds in Cheroban]

The amount of time bidders took between the rounds varied (Table 6). The initial time taken was around seven minutes and became successively reduced to a mean of 3.6 minutes. Before the final bid, however, preparation time went up again to a mean of 4.7 minutes.

[Insert about here: Table 6 Mean time in minutes between auction rounds]

3.3 Auction outcomes

In Isecheno, where the land had been divided into three plots of 1 ha each, final bids resulted to be 4.500, 3.650, and 3.900 Kenyan Shillings (Kshs) for each one of the three 1 ha plots. Thus, in comparison to the fixed price established by the KFS (5.500 Kenyan Shillings), the payment had been reduced on average by 1.483 Kenyan Shillings per hectare. In Kamlembe, the auction on the two plots of 0.5 hectares went to bidders with final offers of Kshs 1.320 and 1.450. Here the average savings per hectare were Kshs 2.730. In Cheroban, the two 0.25 hectare plots went for the price of Kshs 794 and 690 saving an average of Kshs 2532 per hectare (Table 7).

[Insert about here: Table 7 Procurement Auction, winning bids (in Kenyan Shillings)]

3.4 Guarding/protection of seedlings by bid winners

After planting, it was in the interest of the auction winners to ensure a high seedling survival rate as 40% of the payment depended on the performance score achieved. In undertaking this task of guarding and protecting the planted seedlings, the three communities had to face fairly different circumstances. The distance from Isecheno to the forest plot was 11km. The remoteness of their plot attracted the participation of grass cutters who passed by the reforestation sites every day on their way to grass cutting areas and would have done so without our reforestation trial. Due to their occupation as grass cutters they had bicycles at their disposal which made it relatively easy for them to cover the distance. Travel time per visit was 70 minutes. All bid winners in Isecheno were grass cutters and they recorded to have controlled their plots 26 days per month. In addition, the surroundings of the Isecheno forest plots were accessed predominantly by Isecheno community members. The familiarity with the people enabled the auction winners to influence the people’s behaviour towards protecting the reforested plot, for example by keeping their cattle out of the trial area. More approximate to the forest plot (6 km), the Cheroban community members had no activities which would have taken them close to the reforestation sites. They did not have bicycles at their disposal and needed to walk the distance, which took an average of 60 minutes. Consequently, they only came two days a month to monitor their plots. In addition, they expressed concern with the fact that they were planting in an area which they did not belong to and where they did not know the people. Yet, considering that Cheroban shared its site with the Isecheno people, it also benefited from the latter's frequent visits and monitoring. The two winners from Kamlembe only had 0.15 km or nine minutes to walk to reach their forest plots. They controlled the development of their plots every single day of the month as they were so close that they could just quickly pass by during the day. It seems that the guarding intensity is strongly linked to the distance and the ease with which the bid winners could reach their plots. The KFS Kakamega and KFS Kibiri sites were guarded by the KFS forest rangers together with other duties. Although we have no data available to quantify the ranger's guarding intensity, we know that due to the unfavourable ratio of rangers to forest size and tasks, the guarding intensity is generally low.

3.5 Survival rates

Five months after planting the Kamlembe site showed the highest number of seedling survival with 87% survival rate (Table 8). Isecheno noted a survival rate of 75%, whilst Cheroban accounted for the lowest rate with only 52%. Apart from distance, other factors might also have influenced the differences in survival rates. The Isecheno and Cheroban community did, for instance, complain about the bad quality of the seedlings they had received from the KFS forester. They argued that the forester had planted his own areas first and had given the 'leftovers' to the auction planting. We could not confirm this complaint, as we were informed of the grievance only after the planting had taken place and the accuracy of the charge could not be proven any more. At the same time Kamlembe was advantaged as the seedlings they were given came from tree nurseries on their own compounds. Due to this fact the seedlings were used to the soil conditions of that area, did not need to be transported over longer distances, and consequently were in a better state when planted. Another issue that seems to be of relevance is the varying sensitivity of different tree species. In all sites five different tree species had been planted, the mix was, however, determined by the KFS forester and differed from site to site. It appeared that Prunus africana was more sensitive relative to the other tree species and died more frequently. Observations indicated that the least number of seedlings of Prunus Africana were planted in Kamlembe, although this was not confirmed quantitatively. Lastly, the Kamlembe community turned out more innovative than the other villages. They brought, inter alia, organic fertiliser to improve the seedlings' growth. Organic fertiliser is, however, not entirely uncritical as it can contain insects, such as cut worms and termites, that could also contribute to the seedling destruction. Whether this was the case in our study is difficult to prove, as we did not analyse the fertilizer, yet the high ratio of seedling destruction through pests in Kamlembe may indicate that organic fertiliser and pests are closely related.

The survival rate for the baseline KFS sites was notably lower. The KFS scheme in Kibiri noted a survival rate of 57.8% and the site in Kakamega had the lowest rate with 48.4%.

[Insert about here: Table 8 Mean number of seedlings per control unit after 5 months (SD in brackets)]

3.6 Cost effectiveness

In terms of cost effectiveness, that is cost per survived tree seedling, the auction outperformed the baseline approach in all communities. The unit cost of surviving seedling of Kshs 5 (US$ 0.07) in Kamlembe, Kshs 8 (US$ 0.11) in Isecheno, and 14 (US$ 0.19) in Cheroban, was considerably lower than that of the KFS baseline approach with Kshs 26 (US$ 0.36) per surviving tree seedling.

3.7 Mode of destruction

The main factor leading to the destruction of the seedlings in the auctioned plots was the drying up of the intact seedlings with an overall mean of 53% (46% in Isecheno, 59% in Kamlembe, and 54% in Cheroban). In the KFS sites drying up accounted for considerably less seedling mortality than in the auctioned sites with a mean of 13.5%. Drying up was caused by poor planting leaving the soil around the seedling's roots either too loose or too compact. Although we observed adequate rainfall during the five months after planting, poor planting would not allow the roots to absorb sufficient amounts of moisture. Regarding the low seedling destruction through drying up in the KFS sites, it is possible that the people contracted by KFS had better planting skills. This might be explained by the fact that they were preferably chosen from forest user groups and thus were already familiar with different planting methods.

The second most frequent cause of seedling mortality was the attack of seedlings by defoliators such as insects, cut worms and termites which accounted for 30.6% of seedling mortality. Although the destruction of seedlings by pests were not factored into the calculation of the performance score, it is, nevertheless, interesting to see that pest attacks accounted for considerably less seedling mortality on the KFS sites (14.5%) than on the auctioned sites (30.6%). Unfortunately, we have no explanation for what may have brought this about.

Lastly, the chewing of seedlings by animals/cattle accounted for a mean of 24.5% with large differences between sites. While the Kamlembe site saw cattle chew to have caused zero percent of the total seedling destruction, it was the highest factor of destruction at the KFS sites with 72%. The other auctioned sites (Cheroban and Isecheno) also stayed well below the KFS occurrence with 16% and 33%, respectively. The high rate of seedling destruction through grazing cattle at the KFS sites may be explained by the small number of forest rangers to guard Kakamega forest. Thus, the likelihood of a ranger being around the KFS plots when cattle were grazing on them was rather small.

There seems to be a strong relation between frequent guarding of the plots and the prevention of seedling destruction through grazing animals/cattle. Cheroban appears to be an exception (little guarding, little cattle damage). But given that the Cheroban and Isecheno sites were in the same location, Cheroban benefitted from the high monitoring intensity by the Isecheno bid winners and had the additional advantage to have been located at rear end of the forest site. Thus, cattle first entered the Isecheno plots before reaching the Cheroban plots. Overall, while cattle damage was the predominant source of seedling loss in the KFS sites, drying up was responsible for most losses in the auctioned sites. This invokes the question how to guarantee better planting, having controlled for the prevention of chewing already.

4. Discussion

In our study, the performance based auction approach showed considerably lower contract costs and substantially higher survival rates compared to the baseline approach. The findings concur with Latacz-Lohmann and van der Hamsvoort (1997 and 1998), and Latacz-Lohmann and Schilizzi (2005), who reported that competitive bidding performs better than fixed rate payment by significantly increasing the cost effectiveness. The findings are also in line with Ferraro (2007), and Zabel and Roe (2009), who state that performance based payments give an incentive to ensure the proper provision of the service, which consequently improves cost effectiveness, too. In practical terms and with regard to our study the incentive encouraged increased monitoring of the seedlings by the planters and therefore visibly reduced the predominant factor of seedling destruction that was identified on the ‘non-guarded’ KFS sites: the grazing of cattle.

It has to be noted though that due to the limited scope of our study the findings do not provide statistically relevant evidence. This makes it difficult to isolate the effects of the auction and performance based payments from other influential factors. Nevertheless, with all the care that is necessary for the interpretation of results under these conditions, the results appear to show clear trends. Apart from the positive impact of auctions and performance based payments on the cost-effectiveness, other factors seem to play a crucial role. These include ‘sense of ownership’ and ‘monitoring costs’ and may explain the relatively low performance levels in Cheroban.

While we witnessed Kamlembe and Isecheno develop some kind of pride and ownership, this was not evident in Cheroban. Based on our observations, the degree to which a sense of ownership is developed may be linked to two factors: i. the benefit the community obtains from the reforested area, ii. the amount that the communities themselves pay for the reforestation. Given the distance and the lack of transport facilities (and thus the difficulty or cost to incorporate the caretaking of seedlings into daily routines which made Cheroban participants offer bids that included few caretaking visits) as well as the small size of the reforested area, Cheroban clearly benefited least. For Kamlembe, on the other hand, it was easy to identify the reforestation to benefit the entire community as it was located right next to the village. The sense of ownership that was observed in Kamlembe is probably the driver for extra efforts that were made by bringing organic fertiliser to the plots.

Cheroban also put very few funds on the table for reforestation investment (the user right auctions had only generated a small overall amount). With little money invested costs of failure are low, hence reducing community interest and sense of ownership. The far distance and cost of transport also drove up monitoring costs in Cheroban reducing monitoring intensity and performance levels. In Kamlembe, it was possible to guard the plots throughout the day, as they were in range of sight.

A third aspect to be considered is the fact that the Cheroban community was least engaged in farming. Average land size was 0.2 hectares and only 37% of the population specified their principal occupation to be farming. This may have had some implications for the community's low performance in the sense that land working skills were low, though this evidence is, admittedly, only associative.

General questions concerning the social desirability of procurement auctions may also arise. One may ask why it is necessary to bargain down Kenyan wages that are already low relative to wages in industrialized countries. In general, higher payments vs. differentiated lower payments imply trade-offs between larger payments for fewer people (and less reforested area) and smaller payments for more people (and more reforested area). From a distributional point of view, it is not clear which is more desirable (Ferraro, 2008). Trade-offs between social and environmental goals have been confirmed in case studies on implemented PES programs (Kosoy et al., 2007). From a conservation perspective, smaller payments are clearly the more desirable option. The choice of instrument therefore primarily depends on the principal goals of a reforestation program. It should be noted that the average auction bid was still above the legally determined minimum wage of 127.75 KShs for unskilled labour in the agricultural industry in 2009 (Kenya Subsidiary Legislation, 2009). Average per-hectare bids in our auctions were 3360 KShs (S.D. 632, Min 2640, Max 4500). If we assume the planting of one hectare to take 23 working days (based on the average number of days paid by KFS, Table 2), the theoretically derived average daily payment equals 146 KShs (S.D. 27, Min 115, Max 196). As can be seen the minimum bid falls below the minimum wage. It is likely that the number of actual working days, however, was less than 23 (henceforth increasing the daily payments) since the bid winners are not paid by time and have an incentive to work fast. Unfortunately, we did not collect data on time investments to support this expectation. It is also possible that scarcity of income generating activities induced some auction participants to make bids below the official minimum wage (Jack 2010).

The scale of the auctions in our study was restricted to the community level. This raises the question to what extent the presented approach could be successfully applied at a larger scale. For our study we can confirm that the auction and the mediation of all related processes went smoothly and without any considerable problems. Much of this may have had to do with the participatory approach that was chosen to implement the schemes. Schemes that are rolled out on a larger scale, however, may not be able to maintain such a participatory undertaking. Roll out on a larger scale means potentially increasing heterogeneity of the participants with associated differences in culture, norms and hierarchies. On the one hand, this calls for well established rules, clear structures, and enforcement mechanisms. At the same time, an auction scheme with an extensive scope that is not adjusted to the particularities of the community members may invoke the issue of legitimacy or community acceptance. It is therefore important to consider community acceptance and the potentially increasing heterogeneity of the participants with a more extensive auction scheme.

It should also be noted that reforestation in our study was implemented on KFS managed public land, hiring workers to do the job as opposed to paying private land stewards, i.e. the study does not resemble the typical set up of a PES scheme. This may somewhat limit the transferability of our results to a typical PES scheme. Also, we used average KFS planting costs as a benchmark for comparison with the auction results. If KFS had planted on the auctioned plots, actual planting costs may have somewhat differed adding a certain degree of uncertainty to our findings.

The set up of the auctions and the mediation of all processes from the first meeting over the planting period until the final payment is relatively complex and is thus likely to impose higher transaction costs than an action based payment scheme with fixed rates. The question that remains to be answered and was not addressed by us is whether the effectiveness gains offset the higher associated transactions costs.

5. Conclusion

Using data from field trials in Western Kenya we found the combination of procurement auctions for reforestation contracts with performance based payments to return a considerably higher cost-effectiveness than the baseline approach that is currently applied by the Kenyan Forest Services. The increase in cost-effectiveness is partly due to lower contracting costs as a result of competitive bidding, but even more so to improved seedling survival as a result of the incentives given by the use of outcome-oriented payments. This led to improved seedling protection by bid winners, which significantly reduced seedling damage through cattle grazing, one of the major causes of seedling loss. Seedling care, however, also appeared to have been motivated by factors other than performance based payments including i. the degree to which the caretaking of seedlings could be incorporated into daily routines, ii. the extent to which the community foresaw the reforested areas to provide them with direct benefits such as firewood, and iii. the level of reforestation investment that was made by the community. With respect to equity considerations we found that auctions can be designed in such ways that poor households have equal opportunities in participating in PES schemes as service providers. Poor community members were represented disproportionately high in the auctions which can probably be credited to the participatory approach to auction design. We acknowledge the limitation of this study in lacking statistical evidence but find our results to indicate clear trends. Confirmation of our findings remains to be provided in studies with larger sample sizes. Taken together, the findings represent rather good news for innovative approaches of ecosystem restoration in developing countries.

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Figure 1 Bids in auction rounds in Cheroban (in Kenyan Shillings, Kshs)

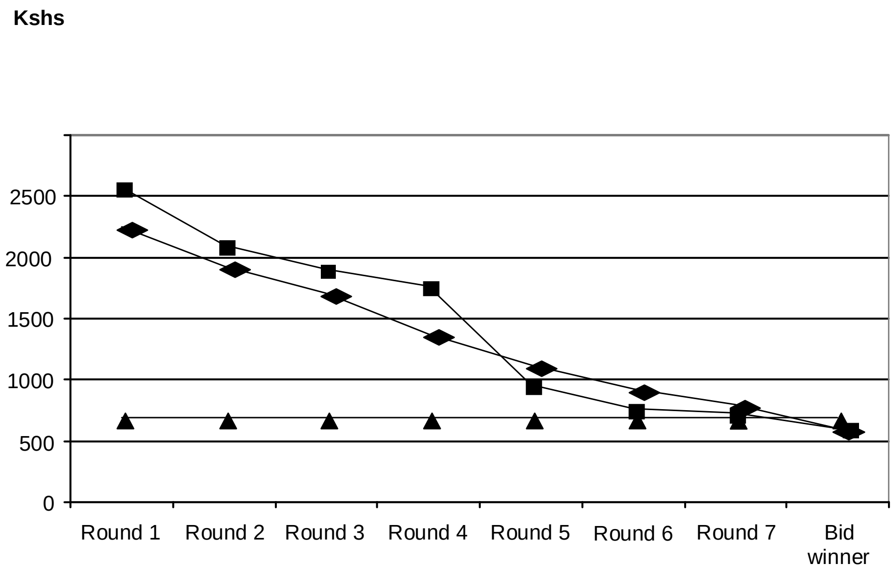

Table 1 Reforestation plots

Village	No of plots	Area per plot(ha)	Total area (ha)
Isecheno	3	1	3.0
Cheroban	2	0.25	0.5
Kamlembe	2	0.5	1.0
KFS Kakamega	3	1	3
KFS Kakamega	1	0.5	0.5
KFS Kibiri	1	1	1

Table 2 Reserve price per hectare

	Man days	Enrichment planting N= 400
Clearing	10	2400 (33.3)
Staking	3	720 (10)
Digging holes	6	1440 (20)
Planting	4	960 (13.3)
TOTAL	23	5520 (76.7)

US$ in brackets

Table 3 Household characteristics I ('main survey'), in percentages

Variable	Isecheno	Kamlembe	Cheroban	Overall
Household head is male	90	75	79	82
Farming is main occupation of household head	52	81	37	58
Farmer grows crops mainly for subsistence	79	73	88	80
Household's house made of mud	86	91	87	88
Household's roof made of grass	70	18	62	49
Household grazes cattle in the forest	82	68	85	78

Table 4 Household characteristics II (main survey)

	Characteristics of the households							
	Overall		Isecheno		Kamlembe		Cheroban	
	N=268		n=86		n=96		n=86	
Variable	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
No of cattle owned by HH	2.1	2.2	2.3	2.8	1.5	1.4	2.5	2.1
Age of household head in years	43.0	12.9	42.4	12.4	46.9	13.8	39.2	11.3
Years of formal education	6.1	4.0	6.9	4.6	6.0	3.4	5.3	4.0
Total land area in hectare	0.64	1.38	0.89	2.67	0.52	0.48	0.20	0.56
Average family size	5.7	2.3	5.7	2.5	5.9	2.4	5.6	2.2

Table 5 Income categories of participants ('small survey'), percentages in brackets

Income category	Cheroban	Isecheno	Kamlembe	TOTAL
Low	26 (79)	35 (80)	27 (74)	88 (77)
Middle	7 (21)	9 (20)	5 (13)	21 (18)
High	0 (0)	0 (0)	5 (13)	5 (4)
TOTAL	33 (100)	44 (100)	37 (100)	114 (100)

Table 6 Mean time in minutes between auction rounds

	Mean time in minutes between conservation auction rounds						
Village	**Round 1**	**Round 2**	**Round 3**	**Round 4**	**Round 5**	**Round 6**	**Round 7**
Isecheno	6.6	6	5.4	4.9	3.8	2.9	4.2
Cheroban	7	7	6	5	5	4	5
Kamlembe	7	6	5	4	4	4	5

Table 7 Procurement Auction, winning bids (in Kenyan Shillings)

ID	Site	Plot	No of	Planting date	Tree species	Reserve	Cost
1	Isecheno	1	400	April 16, 2009	Assorted indigenous	5520	4500
2	Isecheno	1	400	16th April 2009	Assorted indigenous	5520	3650
3	Isecheno	1	400	16th April 2009	Assorted indigenous	5520	3900
4	Kamlembe	0.5	200	8th April 2009	*Croton megalocarpus*	2760	1320
5	Kamlembe	0.5	200	8th April 2009	*Croton megalocarpus*	2760	1450
6	Cheroban	0.25	100	16th April 2009	Assorted indigenous	1380	794
7	Cheroban	0.25	100	16th April 2009	Assorted indigenous	1380	690
8	Kakamega KFS	1	400		Assorted indigenous	n.a.	5520
9	Kibiri KFS	1	400		Assorted indigenous	n.a.	5520

Table 8 Mean number of seedlings per control unit after 5 months (SD in brackets)

	Isecheno	Kamlembe	Cheroban	Kakamega (KFS)	Kibiri (KFS)	Total
n (no of control units)	60	31	30	90	31	242
No of seedlings[a]	7.5 (1.5)	8.7 (0.45)	5.2 (1.4)	5.8 (2.0)	4.8 (1.4)	6.4 (2.0)

[a]Number of seedlings per control unit at time of planting was ten