

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

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25

26

Abstract

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The increased interest in, and application of payments for ecosystem services calls for

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mechanisms that are highly cost-effective. In participatory field trials with communities in

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Western Kenya, we combined procurement auctions for reforestation contracts with payments

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based on contractor performance, measured as number of survived seedlings. We compared

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the cost-effectiveness of this approach to a baseline approach that is currently applied by the

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Kenyan Forest Services. We found our approach to return a considerably higher cost-

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effectiveness. The increase in cost-effectiveness is partly due to lower contracting costs as a

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result of competitive bidding, but even more so to improved seedling survival as a result of

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the incentives of outcome oriented payments. The latter led to a monitoring intensity which

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significantly reduced seedling destruction through cattle grazing, one of the major causes of

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seedling loss. Seedling care, however, also appeared to have been motivated by factors other

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than performance based payments including i. monitoring costs, ii. community benefits from

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the reforested areas, and iii. the size of the investment. With respect to equity, participation of

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poor community members was disproportionately high. We acknowledge the limitation of this

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study in lacking statistical evidence but find our results to indicate clear trends.

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

44

45 **1 Introduction**

46 Interest in payments for ecosystem services (PES) or PES-like schemes has grown
47 considerably in recent years (Pattanayak et al., 2010; Gómez-Baggethun et al., 2010). PES
48 constitutes a clear market transaction in which the different interests of two market agents
49 (supplier and buyer of ecosystem services) are recognized and openly dealt with through
50 agreements on supply and remuneration (Wunder et al., 2008). As Ferraro and Simpson
51 (2002) point out, direct payments can be more cost effective in achieving conservation goals
52 than indirect strategies such as the promotion of commercial enterprises intended to generate
53 local incentives for conservation. Cost effectiveness is defined here as the ratio of
54 environmental benefits to program costs.

55 A major challenge to PES schemes is the information asymmetry over the cost of service
56 provision. Service providers know more about costs of contractual compliance than service
57 buyers which usually puts the latter in a disadvantaged bargaining position (Ferraro, 2008).
58 This may entail high surpluses for service providers both in individual negotiations and where
59 schemes use fixed payments that are made independent of individual provision costs
60 (Wünscher et al., 2008). Procurement auctions for conservation contracts are one viable way
61 to overcome or at least mitigate the problem of informational rent (Jack et al. 2009).
62 Conservation auctions are multi-item procurement auctions in which governments (or private
63 actors) purchase (instead of sell) multiple units (rather than one unit) of the conservation good
64 (Latacz-Lohmann and Schilizzi, 2005). Competitive bidding under certain conditions can
65 reduce overcompensation and increase cost-effectiveness by revealing the 'real' opportunity
66 cost of service provision (Engel and Palmer, 2008). Auctions thus constitute an interesting
67 instrument to circumvent the issue of informational rent (Latacz-Lohmann and Schilizzi,
68 2007). While the interest in procurement auctions for conservation and natural resource

69 management has grown in recent times (e.g. Tisdell, 2007; Lowell et al., 2007; Espinola-
70 Arredondo, 2008; Raffensperger, 2011; Reeson et al., 2011), there have been great deviations
71 in gains, which made a robust assessment of the cost effectiveness of conservation auctions
72 difficult (Hailu and Schilizzi, 2004).

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

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

90 In our approach, we auction reforestation contracts to members of forest adjacent
91 communities in Western Kenya. The payments are made conditional on survived seedlings,
92 although, following Ferraro (2007), a 'base payment' is made immediately after planting.
93 Base payments may further increase the cost effectiveness because they attract risk-averse

94 service providers into the program who are otherwise deterred by the uncertainty associated
95 with performance based payments in which the eventual pay-off can depend on factors
96 outside the providers control, for example due to unexpected weather events. The outcomes
97 are compared to fixed payment reforestation activities led by the Kenyan Forest Service in the
98 same area.

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

102

103 **2 Methodology**

104 **2.1 Study area**

105 The trials were conducted in communities adjacent to Kakamega forest in Western Kenya.
106 Kakamega forest is the last remaining rainforest in Kenya and home to a large number of
107 endemic species (Müller and Mburu, 2008). Its rich biodiversity makes Kakamega Forest a
108 high priority area for conservation both nationally and globally. Within Kenya it was ranked
109 the third highest priority for conservation in 1995 (Guthiga et al., 2008). Globally, Kakamega
110 forest is significant also as a carbon sink (Glenday, 2006). Like in many other parts of the
111 world the forest is subject to deforestation and forest degradation. While the forest underwent
112 farmland conversion in the pre-colonial era, and gold mining and large scale logging in the
113 colonial period (Mitchell, 2004), today's degradation is mainly attributed to the extraction of
114 forest products such as firewood and livestock feed by the people who live in and around the
115 forest in one of the most densely populated areas in Africa (Guthiga, 2007). At present, the
116 forest covers an area of about 240 km² with 10% being forest plantation and the rest being
117 natural forest (Glenday, 2006). Lung and Schaab (2004) estimated that approximately 20% of

118 the forest cover was lost in the last three decades. Complementary to activities aimed at
119 halting further forest loss the Kenyan Forest Service (KFS), which is responsible for the
120 management of the largest part of Kakamega Forest, finances reforestation in and around the
121 forest with mixed indigenous species. In Kakamega alone 2134 hectares are designated for
122 reforestation (Khalumba, personal communication in 2011). Our study is an attempt to find
123 ways to increase the cost-effectiveness of these reforestation activities, and thus amplify the
124 impact of limited reforestation budgets. Since the passing of the new Forest Act in 2005, KFS
125 depends more heavily on own fund generation. For this reason KFS has recently started to sell
126 timber to saw mills via auctions in order to obtain higher prices than the previously
127 government-determined sale prices. With the same motivation the auctioning of reforestation
128 contracts constitutes a potential instrument to cut spending. Our field trials are therefore of
129 high interest for KFS with whom we closely cooperated.

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

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.

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

152

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

161

162 **2.2 Timing**

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

171

172 **2.3 Selection of reforestation sites**

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

178 The identification of reforestation sites centred on the areas outlined in the KFS planting plan,
179 which is developed on an annual basis and that indicates areas for reforestation. The
180 suggestions that were made by the forester were readily accepted by Kamlembe and Isecheno,
181 whilst Cheroban complained about the distance to their suggested site. An alternative closer
182 site was invaded by Guava trees, however. Soil preparation would have been very labour
183 intensive and in light of this disadvantage Cheroban hand-voted with a majority for the distant
184 site (votes were not counted). The Kamlembe site of one hectare was close to the community.
185 Reforestation on that site was beneficial to the community as it could help protect a river

186 bank. Isecheno and Cheroban shared a site (3.5 ha) in the Tisain forest block, which was
187 relatively far away from both communities, eleven and six kilometres, respectively. The site
188 was situated in an open area of the natural forest that had been prone to forest fires. The plots
189 close to the entrance of this forest site were given to Isecheno and the plots located deeper
190 inside the site were assigned to the Cheroban community.

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

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

210 **[Insert about here Table 1 (Reforestation plots)]**

211 **2.4 Auction Design**

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

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

236 (3.33 US\$) without food. On average, the reforestation of one hectare requires KFS to pay for
237 23 man days (Table 2) or the equivalent of 5520 Kenyan Shillings. Accordingly, the reserve
238 price for the 0.5 ha and 0.25 ha plots were 2760 KSH and 1380 KSH, respectively.

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

240

241 **2.5 Payment Modalities**

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

252

253 **2.6 Planting Standards**

254 The February workshop also set the required planting standards. For example, 400 seedlings
255 were to be planted per hectare. Planting rows were to be five meters apart. Using diagrams, it
256 was explained how the sites were to be cleared and how the plants were to be planted. It was
257 stressed to keep animals out of the reforestation area to avoid seedling damage. This was also
258 emphasised by putting up signs saying 'BIOTA EA Forest Conservation Project. Animals are

259 not allowed on the site'. People were informed that they would have to get in touch with the
260 forester after the beginning of the rain to obtain the seedlings (the Kenyan Forest Service
261 provided the seedlings for the reforestation for free).

262

263 **2.7 Monitoring and Performance Score**

264 Monitoring after five months had the purpose to evaluate the seedling survival rate, seedling
265 damage, site preparation and planting quality. The information was used to calculate the
266 performance score of each plot. On the treatment sites the monitoring followed a monitoring
267 design, which captured 50% of all planted seedlings and was based on a selection of random
268 control units of ten seedlings each. The specific time of monitoring – five months after
269 planting – was chosen mainly due to time constraints for the implementation of the field trial.
270 From a forestry perspective we would have preferred to monitor after a longer time period.
271 While seedling survival after five months is not a sufficient indicator for long term survival,
272 the five month period is long enough to detect differences in tree survival and thus justify
273 payment differentiation. Seedling survival was measured as a percentage with 100%
274 corresponding to a score of five, meaning that all seedlings on a plot had survived. Less than
275 50% seedling survival meant a score of zero. Seedling damage refers to damage by grazing.
276 The seedlings that were destroyed by insects or other pests were counted as surviving. The
277 rationale for this is that destruction of seedlings by pests was outside the control of the bid
278 winners and was therefore not penalized. Each single plant within the control units was
279 examined and given a score from which a mean was calculated to determine the overall score
280 of the plot for this criterion. Seedling damage was evaluated on a scale from zero to five
281 points. Zero points meant that the plant had been completely uprooted by an animal while five
282 points indicated no loss of vegetation due to grazing. The criteria, 'site preparation' and
283 'planting quality' were combined to create a composite score. Although the criteria remind of

284 an action-based approach we decided to integrate them into the performance score because
285 they serve as a proxy for performance beyond the five-month monitoring period. Again, each
286 single seedling within the control units was examined and categorized according to the
287 following indicators: 1. clear area around the seedling, 2. staking is well done, 3. planting hole
288 is approximately 45cm in diameter, 4. spacing done as per forester's directions, 5. seedlings
289 are planted upright. If all five of these indicators were met, the seedling would get a score of
290 five, if only four of the indicators were fulfilled a score of four was given, and so forth.
291 Eventually, the mean score of all seedlings per plot was calculated.

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

296

297 **2.8 Surveys**

298 We undertook two surveys to capture the socio economic characteristics of the three
299 communities. One general questionnaire with 286 randomly selected inhabitants of the three
300 villages, and one smaller survey with the 114 participants of the auction only. The main
301 survey was conducted in March 2009 before the implementation of the auction. The second
302 smaller survey was held in August 2009, five month after the auctions had taken place. The
303 main questionnaire inquired general socio economic characteristics of the three communities,
304 such as the gender of the household head, his/her occupation, forest product utilization. The
305 smaller questionnaire, posing similar questions, had the purpose to assess the socio-economic
306 situation of the participants in contrast to their communities as a whole. In addition, it also

307 contained more specific questions related to the auctions, as for instance the distance to the
308 planting plot and the number of days people went to guard their site.

309

310 **3. Results**

311 **3.1 Socio-economic characteristics of the communities**

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

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

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

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

331

332 **3.2 Participation**

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

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

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

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

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

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

349

350 **3.3 Auction outcomes**

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

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

360

361 **3.4 Guarding/protection of seedlings by bid winners**

362 After planting, it was in the interest of the auction winners to ensure a high seedling survival
363 rate as 40% of the payment depended on the performance score achieved. In undertaking this
364 task of guarding and protecting the planted seedlings, the three communities had to face fairly
365 different circumstances. The distance from Isecheno to the forest plot was 11km. The
366 remoteness of their plot attracted the participation of grass cutters who passed by the
367 reforestation sites every day on their way to grass cutting areas and would have done so
368 without our reforestation trial. Due to their occupation as grass cutters they had bicycles at
369 their disposal which made it relatively easy for them to cover the distance. Travel time per
370 visit was 70 minutes. All bid winners in Isecheno were grass cutters and they recorded to have
371 controlled their plots 26 days per month. In addition, the surroundings of the Isecheno forest
372 plots were accessed predominantly by Isecheno community members. The familiarity with the
373 people enabled the auction winners to influence the people's behaviour towards protecting the

374 reforested plot, for example by keeping their cattle out of the trial area. More approximate
375 to the forest plot (6 km), the Cheroban community members had no activities which would
376 have taken them close to the reforestation sites. They did not have bicycles at their disposal
377 and needed to walk the distance, which took an average of 60 minutes. Consequently, they
378 only came two days a month to monitor their plots. In addition, they expressed concern with
379 the fact that they were planting in an area which they did not belong to and where they did not
380 know the people. Yet, considering that Cheroban shared its site with the Isecheno people, it
381 also benefited from the latter's frequent visits and monitoring. The two winners from
382 Kamlembe only had 0.15 km or nine minutes to walk to reach their forest plots. They
383 controlled the development of their plots every single day of the month as they were so close
384 that they could just quickly pass by during the day. It seems that the guarding intensity is
385 strongly linked to the distance and the ease with which the bid winners could reach their plots.
386 The KFS Kakamega and KFS Kibiri sites were guarded by the KFS forest rangers together
387 with other duties. Although we have no data available to quantify the ranger's guarding
388 intensity, we know that due to the unfavourable ratio of rangers to forest size and tasks, the
389 guarding intensity is generally low.

390

391 **3.5 Survival rates**

392 Five months after planting the Kamlembe site showed the highest number of seedling survival
393 with 87% survival rate (Table 8). Isecheno noted a survival rate of 75%, whilst Cheroban
394 accounted for the lowest rate with only 52%. Apart from distance, other factors might also
395 have influenced the differences in survival rates. The Isecheno and Cheroban community did,
396 for instance, complain about the bad quality of the seedlings they had received from the KFS
397 forester. They argued that the forester had planted his own areas first and had given the
398 'leftovers' to the auction planting. We could not confirm this complaint, as we were informed

399 of the grievance only after the planting had taken place and the accuracy of the charge could
400 not be proven any more. At the same time Kamlembe was advantaged as the seedlings they
401 were given came from tree nurseries on their own compounds. Due to this fact the seedlings
402 were used to the soil conditions of that area, did not need to be transported over longer
403 distances, and consequently were in a better state when planted. Another issue that seems to
404 be of relevance is the varying sensitivity of different tree species. In all sites five different tree
405 species had been planted, the mix was, however, determined by the KFS forester and differed
406 from site to site. It appeared that Prunus africana was more sensitive relative to the other tree
407 species and died more frequently. Observations indicated that the least number of seedlings of
408 Prunus Africana were planted in Kamlembe, although this was not confirmed quantitatively.
409 Lastly, the Kamlembe community turned out more innovative than the other villages. They
410 brought, inter alia, organic fertiliser to improve the seedlings' growth. Organic fertiliser is,
411 however, not entirely uncritical as it can contain insects, such as cut worms and termites, that
412 could also contribute to the seedling destruction. Whether this was the case in our study is
413 difficult to prove, as we did not analyse the fertilizer, yet the high ratio of seedling destruction
414 through pests in Kamlembe may indicate that organic fertiliser and pests are closely related.

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

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

419 **3.6 Cost effectiveness**

420 In terms of cost effectiveness, that is cost per survived tree seedling, the auction outperformed
421 the baseline approach in all communities. The unit cost of surviving seedling of Kshs 5 (US\$
422 0.07) in Kamlembe, Kshs 8 (US\$ 0.11) in Isecheno, and 14 (US\$ 0.19) in Cheroban, was

423 considerably lower than that of the KFS baseline approach with Kshs 26 (US\$ 0.36) per
424 surviving tree seedling.

425

426

427 **3.7 Mode of destruction**

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

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

446 Lastly, the chewing of seedlings by animals/cattle accounted for a mean of 24.5% with large
447 differences between sites. While the Kamlembe site saw cattle chew to have caused zero

448 percent of the total seedling destruction, it was the highest factor of destruction at the KFS
449 sites with 72%. The other auctioned sites (Cheroban and Isecheno) also stayed well below the
450 KFS occurrence with 16% and 33%, respectively. The high rate of seedling destruction
451 through grazing cattle at the KFS sites may be explained by the small number of forest
452 rangers to guard Kakamega forest. Thus, the likelihood of a ranger being around the KFS
453 plots when cattle were grazing on them was rather small.

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

463

464 **4. Discussion**

465 In our study, the performance based auction approach showed considerably lower contract
466 costs and substantially higher survival rates compared to the baseline approach. The findings
467 concur with Latacz-Lohmann and van der Hamsvoort (1997 and 1998), and Latacz-Lohmann
468 and Schilizzi (2005), who reported that competitive bidding performs better than fixed rate
469 payment by significantly increasing the cost effectiveness. The findings are also in line with
470 Ferraro (2007), and Zabel and Roe (2009), who state that performance based payments give
471 an incentive to ensure the proper provision of the service, which consequently improves cost

472 effectiveness, too. In practical terms and with regard to our study the incentive encouraged
473 increased monitoring of the seedlings by the planters and therefore visibly reduced the
474 predominant factor of seedling destruction that was identified on the ‘non-guarded’ KFS sites:
475 the grazing of cattle.

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

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

495 Cheroban also put very few funds on the table for reforestation investment (the user right
496 auctions had only generated a small overall amount). With little money invested costs of

497 failure are low, hence reducing community interest and sense of ownership. The far distance
498 and cost of transport also drove up monitoring costs in Cheroban reducing monitoring
499 intensity and performance levels. In Kamlembe, it was possible to guard the plots throughout
500 the day, as they were in range of sight.

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

506 General questions concerning the social desirability of procurement auctions may also arise.
507 One may ask why it is necessary to bargain down Kenyan wages that are already low relative
508 to wages in industrialized countries. In general, higher payments vs. differentiated lower
509 payments imply trade-offs between larger payments for fewer people (and less reforested
510 area) and smaller payments for more people (and more reforested area). From a distributional
511 point of view, it is not clear which is more desirable (Ferraro, 2008). Trade-offs between
512 social and environmental goals have been confirmed in case studies on implemented PES
513 programs (Kosoy et al., 2007). From a conservation perspective, smaller payments are clearly
514 the more desirable option. The choice of instrument therefore primarily depends on the
515 principal goals of a reforestation program. It should be noted that the average auction bid was
516 still above the legally determined minimum wage of 127.75 KShs for unskilled labour in the
517 agricultural industry in 2009 (Kenya Subsidiary Legislation, 2009). Average per-hectare bids
518 in our auctions were 3360 KShs (S.D. 632, Min 2640, Max 4500). If we assume the planting
519 of one hectare to take 23 working days (based on the average number of days paid by KFS,
520 Table 2), the theoretically derived average daily payment equals 146 KShs (S.D. 27, Min 115,
521 Max 196). As can be seen the minimum bid falls below the minimum wage. It is likely that

522 the number of actual working days, however, was less than 23 (henceforth increasing the
523 daily payments) since the bid winners are not paid by time and have an incentive to work fast.
524 Unfortunately, we did not collect data on time investments to support this expectation. It is
525 also possible that scarcity of income generating activities induced some auction participants to
526 make bids below the official minimum wage (Jack 2010).

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

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

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

552 **5. Conclusion**

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

571 larger sample sizes. Taken together, the findings represent rather good news for innovative
572 approaches of ecosystem restoration in developing countries.

573

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578

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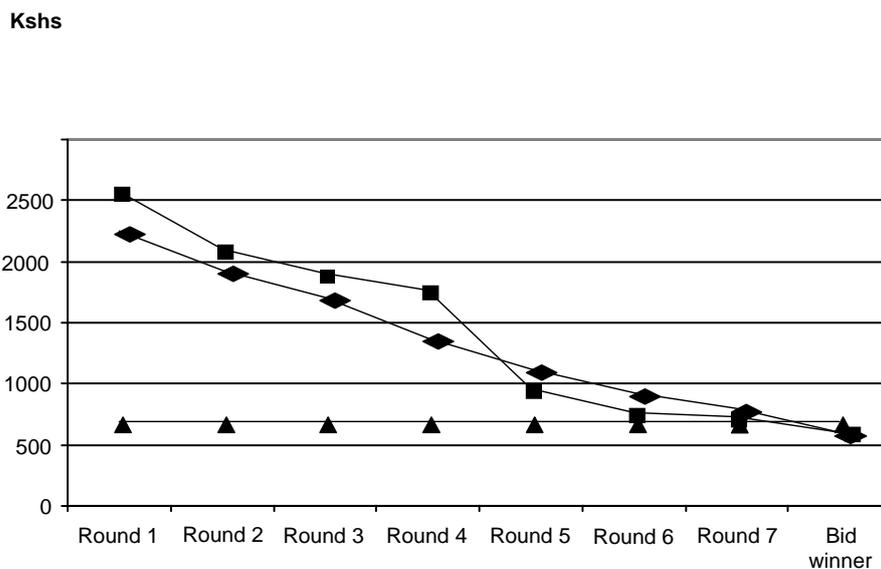
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665 **Figure 1 Bids in auction rounds in Cheroban (in Kenyan Shillings, Kshs)**



666

667 **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

668

669 **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)

670 US\$ in brackets

671 **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

672

673 **Table 4 Household characteristics II (main survey)**

Variable	Characteristics of the households							
	Overall		Isecheno		Kamlembe		Cheroban	
	N=268		n=86		n=96		n=86	
	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

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675

676 **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)

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678

679 **Table 6 Mean time in minutes between auction rounds**

Village	Mean time in minutes between conservation auction rounds						
	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

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682 **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	16 th April 2009	Assorted indigenous	5520	3650
3	Isecheno	1	400	16 th April 2009	Assorted indigenous	5520	3900
4	Kamlembe	0.5	200	8 th April 2009	<i>Croton megalocarpus</i>	2760	1320
5	Kamlembe	0.5	200	8 th April 2009	<i>Croton megalocarpus</i>	2760	1450
6	Cheroban	0.25	100	16 th April 2009	Assorted indigenous	1380	794
7	Cheroban	0.25	100	16 th 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

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684

685 **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)

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^aNumber of seedlings per control unit at time of planting was ten

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