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RESEARCH REPORT

No. 2009-RR10

Designing A Procurement Auction For Reducing Sedimentation: A Field Experiment In Indonesia

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The setting of this EEPSEA study is a watershed area in Lampung, Indonesia where soil erosion has broad implications for both on-site and off-site environmental damage. The strategy to engage farmers in environmental protection initiative is through the Payment for Environmental Services (PES) scheme.

A key condition of PES is transparency regarding the conditions under which incentives or rewards can be granted. Balanced information and the power of transaction are the basis for any environmental service (ES). A contract procurement auction is an alternative mechanism for extracting information from ES providers on levels of payments or incentives that will cover their costs when joining a conservation program. This study tested the application of a procurement auction method to reveal hidden information on the opportunity costs of supplying environmental services.

The results show that a seal-bid, multiple round second–price Vickrey auction with a uniform price can be applied where most of the auction participants have a low education level, low asset endowment, small plot size and where market-based competitiveness is not common. It reveals too that farmers' bids to be involved in conservation contracts is more dependent on their learning process during the auction than observable factors such as their socioeconomic background, their awareness of conservation and their social capital state. Finally, it shows that introducing procurement auction as a market-based approach to rural communities does not harm their social relationships and is an applicable method in a rural setting.

Published by the Economy and Environment Program for Southeast Asia (EEPSEA)
22 Cross St, #02-55 South Bridge Court, Singapore 048421(www.eepsea.org)
Tel: +65-6438 7877, fax: +65-6438 4844, email: eepsea@idrc.org.sg

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ISBN: **978-981-08-5440-9**

Designing a Procurement Auction for Reducing Sedimentation: a field experiment in Indonesia

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August 2009

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EEPSEA is supported by the International Development Research Centre (IDRC); the Swedish International Development Cooperation Agency (Sida); and the Canadian International Development Agency (CIDA).

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ACKNOWLEDGEMENTS

The resources and collaborative efforts of this study have been provided primarily by the Environment and Economics Program of Southeast Asia (EEPSEA) and partly by the RUPES Program and BASIS USAID. We would like to acknowledge the following people.

Dr. Herminia Francisco and Dr. David Glover for all their support – without their facilitation the study would not have been completed. Dr. Victor Adamowicz, Dr. Paul Ferraro, and Dr. Nancy Olewiler for their insightful comments and ideas to improve the paper. Dr. Dolf de Groot, Dr Meine van Noordwijk, Dr Bustanul Arifin, Mr. Suseno Budidarsono, and ICRAF scientists for their support and input. Ms. Catherine Ndiaye and Ms. Ang Cheng Hiang from EEPSEA, and the ICRAF Finance and Administration staff: Jati Martopranoto, Yuni Agus, Yosi Tapjani, and the team for their patience conducting the administration, accounting and financial reports for this project. The enumerators and field facilitators; Yana Buana, Iron Maria Edi, Eva, Mulus, and Edwin Jonson, Bapak Rasna from the Forestry Service, Pratiknyo Purnomo Sidhi, Rudy Widodo and Susanto for their services; and Farid Affendi and Desita Andini for their assistance in analyzing the statistical data.

Finally, the authors would like to thank all the farmers and communities in Sumberjaya watershed for their active participation and collaboration.

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ABSTRACT

The setting of this study is a watershed area in Lampung, Indonesia, where soil erosion has broad implications for both on-site and off-site environmental damage.

Payment for environmental services (PES) is a conditional and voluntary policy option that, in this study, provides incentives for maintaining watershed functions. A key condition of PES is transparency regarding the conditions under which incentives or rewards can be granted. Balanced information and the power of transaction are the basis for any environmental service (ES). A contract procurement auction is an alternative mechanism for extracting information from ES providers on levels of payments or incentives that will cover their costs when joining a conservation program. In this paper we focus on designing a procurement auction method to reveal hidden information on the opportunity costs of supplying environmental services. This is an initial application of a procurement auction method in a rural setting in a developing country. Our study resulted in a set of auction rules for determining how limited watershed rehabilitation funds could be allocated. We examined the applicability of such an auction design in an Indonesian rural setting by testing: (1) auction design factors, such as: participants‘ understanding of auction rules, the ease-of-use of these rules, the appropriateness of the participants‘ bid offered during the auction, and the fairness of the auction process; (2) social factors, such as: impact on relationship between contracted and non-contracted farmers, general interpersonal relationships between communities, and information exchange amongst farmers; (3) environmental factors, such as: awareness of soil and water conservation and the rate of contract completion. Our results show that a sealed-bid, multiple round, second-price Vickrey auction with a uniform price can be applied where most of the auction participants have a low education level, low asset endowment, small plot size, and where market-based competitiveness is not common. Our finding is that farmers‘ bids to be involved in conservation contracts is more dependent on their learning process during the auction than observable factors such as their socioeconomic background, their awareness of conservation, and their social capital state. It was also found that introducing procurement auction as a market-based approach to rural communities does not harm their social relationships and is an applicable method in a rural setting. Nevertheless, this learning process does not guarantee the successful accomplishment of a conservation contract. The rate of contract accomplishment was moderate and this may be influenced by many other factors such as the farmer groups‘ leadership and their institutional arrangements for conducting conservation activities. The implication of these findings is that designing a proper conservation auction method and estimating the ‗right‘ value for contracts form only minimal requirements for the success of any conservation contract.

1 INTRODUCTION

1.1 Research Problems

A payment for environmental services (PES) is one example of a conservation approach that provides incentives for maintaining the functions of a watershed. The central principles of this approach are that those who provide environmental services (ES) or the ES providers should be rewarded for doing so, and that those who receive the services should pay for their provision based on the performance in enhancing ES (Ferraro 2001; Ferraro and Kiss, 2002; Pagiola and Platais, 2002). Compared to previous conservation approaches, the approach's main innovation is the conditionality or the transparency of conditions wherein incentives or rewards can be granted (van Noordwijk et al., 2008) (Wunder, 2005; van Noordwijk et al 2008). As a consequence of this conditionality, PES requires voluntary contractual relationships between ES providers or farmers as land managers[1] and ES buyers.

The conditionality of the PES requires transparent information and a balanced power of transaction as the basis of any ES contracts to ensure fairness and effectiveness. Information asymmetry exists when one actor has more or better information than the other on their benefits in being involved in the PES scheme. Two important information asymmetries in the design of PES contracts are *hidden information* or lack of information while negotiating a contract and *hidden action* or lack of information about the performance of the agreed contract or lack of ability to retaliate for a breach of an agreement (Ferraro, 2004; Latacz-Lohmann and Schilizzi, 2005).

Hidden information (adverse selection) that often occurs in designing and negotiating a PES scheme is the lack of information on the opportunity costs of supplying environmental services (Ferraro 2008). The amount of incentive required by farmers to change their behaviors to enhance environmental services is private information. If the incentive is too low, it will not motivate ES providers to improve their land-use practices and provision of ES. If the incentive is too high, the PES will fail to provide environmental services effectively from a given budget.

A PES contract procurement auction is an alternative policy mechanism to extract from ES providers the information on level of payments or incentives that at least cover all their costs in joining a conservation program (Ferraro, 2004; Latacz-Lohmann and Schilizzi, 2005). It is defined as ―a process through which a buyer of environmental services invites bids (tenders) from suppliers of environmental services for a specified contract and then buys the contracts with the lowest bids" (Ferraro 2008).

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[1] In our context, we denote farmers as environmental service suppliers since they have a role in maintaining the environmental benefits from the watershed. Their decisions on land use practices influence the provision of environmental services (ES) from this landscape, including clean water, high biodiversity and the beauty of the landscape.

Procurement auctions on conservation contracts have been successfully implemented in the United States, Australia and Europe (Stoneham et al., 2003). The award of contracts on the basis of competitive bidding is a method frequently used in procuring commodities for which there are no well-established markets (Latacz-Lohmann and van der Hamsvoort, 1997; Ferraro, 2008), such as in markets for environmental services.

In this paper, we focus on designing a procurement auction method to reveal hidden information on the opportunity costs of supplying environmental services. This is the first application of procurement auction method in a rural setting of a developing country, where most of the auction participants have a low education level (less than seven years of education), low asset endowment, small plot size (most owned land of less than 0.5 hectares) and where market-based competitiveness is not so common. Our study resulted in a set of auction rules for determining how a limited budget from the watershed rehabilitation fund could be allocated. We observed if the socioeconomic backgrounds of the participants influenced the submission of the final bids and analyzed the validity of applying this auction design in a rural setting in Indonesia by testing some other factors. These factors were (1) auction design factors, such as: participants‘ understanding of auction rules, the ease-of-use of these rules, the appropriateness of the participants‘ bid offered during the auction, and the fairness of the auction process; (2) social factors, such as: impact on the relationship between contracted and non-contracted farmers, general interpersonal relationships between communities, and information exchange amongst farmers; (3) environmental factors, such as: awareness of soil and water conservation and the rate of contract completion.

The setting of this study was a watershed area in Lampung, Indonesia, where soil erosion has broad implications for on-site and off-site damage. The most direct on-site effect is the loss of topsoil from the coffee farmlands that dominate the watershed, resulting in low agricultural productivity in the long term. Off-site effects include siltation, water flow irregularities, a reduction in irrigation, water pollution and agrochemical run-off. The soil sediment can reduce the capacity of a reservoir located downstream of the watershed, adversely affecting irrigated agriculture and hydro-electricity generation (Sihite, 2001; Ananda and Herath, 2003).

1.2 Financing and Enhancing Environmental Services

A wide range of innovative mechanisms has been developed for financing conservation in recent years. These have attempted both to access new sources of revenue for conservation and to develop new mechanisms for utilizing any available funds. Receiving considerable attention as a new way of approaching conservation is the payments for environmental services (PES) approach. This initiative has been applied globally, especially for the conservation of biodiversity, with regard to the conservation and maintenance of watershed functions, for carbon sequestration, and in order to protect the beauty of the landscape.

At the beginning of its concept development, the PES was defined as a voluntary transaction where a well-defined ES (or a land-use likely to secure that service) was being bought by a (minimum of one) ES buyer from a (minimum of one) ES provider, if and only if the ES provider secures ES provision (conditionality) (Wunder 2005). In principle, those who provide environmental services should be compensated for doing so and those who receive the services should pay for their provision (Pagiola and Platais 2002). In other words, a payment by the ES beneficiaries can help make the conservation more attractive for land users. To change their behavior, the payment must obviously be more than the additional benefit which land users can gain from alternative land use and less than the value of the benefit which the downstream populations are willing to pay. Additional sources of income for poor land users that could augment their livelihood were assumed to be advantages of this scheme.

1.3 Experimental Auction

Experimental auction methods are becoming more commonplace in non-market valuation because of their perceived benefits relative to previously used contingent valuation survey methods. The reason is that participants have more incentives to reveal their true value for a product compared to a hypothetical survey setting. In this case, real products and real money are exchanged in an experimental setting (Lusk et al., 2004). The mechanism is particularly useful in low-income countries where markets are imperfect and households can behave in ways very different from profit maximization (Ferraro, 2004).

Four auctions are commonly used in the literature that can theoretically reveal any private information asked for (or *incentive compatible*): the English auctions, second price (Vickrey auction), Becker-DeGroot-&-Marschak (BDM) and random n-th price auctions. The structure of each mechanism is outlined in Table 1 (Lusk et al., 2004). The most widely recognized and straightforward method is the English auction. In an English auction, the experimenter opens the auction at a relatively high price and begins running down in fixed increments. Depending upon the setup of the auction, participants either offer descending bids or signal their willingness to stay in the auction as prices are decreased over time. The auction ends when only one participant is willing to accept the current price. This participant wins the contract, and s/he is paid.

The other three types of auctions, namely: second price, BDM and random n-th price auctions basically modify the one-shot, sealed offer auction wherein each participant independently fills out and submits an offer-submission card that specifies the per-hectare price proposed to join the program. In a second price auction, the individual with the lowest bid wins the auction and is paid the second lowest bid amount for joining the program. The BDM mechanism induces individuals to truthfully reveal certainty equivalents for lotteries. In the BDM elicitation procedures, a random number or price is drawn from a pre-specified distribution. Individuals with bids lesser than the randomly drawn price ‗win' the auction and are given the contracts at the randomly drawn price. The random n-th price auction introduced by Shogren et al. (2001) combines elements of two classic demand-revealing mechanisms – the second price and the BDM mechanism. The random-n-th-price auction works as follows: each bidder submits a bid, each bid is rank-ordered from highest to lowest. A random number uniformly-distributed between 2 and k (k bidders) is selected. Each of the (n-1) lowest bidders wins the contract at the n-th price.

The three auctions above give participants incentives to tell the truth because each auction separates what they say from what they are paid. Sincere bidding is the weakly dominant strategy. In examining the effects of varying numbers of bidders, more aggressive bidding happens in first price auction, while this treatment has essentially no impact on bidding in second-price auction and results in lower bids in third-price auctions (Kagel, 1995). Shogren et al. (2001) concluded that second-price auction does a reasonable job on aggregate but falls short at the individual level. Comparison of the random n-th price auction to the second-price auction showed that the second-price auction works better on-margin, and the random n-th price auction works better off-margin.

Lusk et al. (2004) investigated the effect of several procedural issues on valuation estimates from experimental auctions. They conducted multiple bidding rounds for the second-price and the random n-th price auctions because market prices are endogenously determined and subjects could incorporate market feedback into their valuations. On the other hand, in the BDM mechanism, market prices are exogenously determined, and as such, subjects receive no meaningful feedback from additional rounds. They found that the choice of auction institution significantly (both statistically and economically) influenced bids. Results indicated that the second price auction generated higher valuations than English, BDM, and random n-th price auctions, especially in latter bidding rounds, and that the random n-th price auction yielded lower valuations than the English and BDM auctions.

Table 1. Incentive Compatible Auction[2]

	Auction Institution			
	English	***Second Price***	***BDM***	***Random n-th Price***
Participant procedure	Sequentially offer ascending bids	Simultaneously submit sealed bids	Simultaneously submit sealed bids	Simultaneously submit sealed bids
Winning bidder	Participant who offers the last bid	Participant with highest (or lowest) bid	All participants with bid greater (or lesser) than a randomly drawn price	All participants with bid greater (or lesser) than a randomly (n-th) bid
Number of winners	1	1	0 to all participants	n-1
Market feedback?	Yes, with multiple rounds	Yes, with multiple rounds	Yes	No
Market price	Last bid offered	Second highest (or lowest) bid	Randomly drawn price	n-th highest (or lowest) bid

1.4 Designing a PES Procurement Auction in Developing Countries: Some Considerations

A sealed-bid auction maintains anonymity. In a developing country where village leaders and elders have significant roles and dominance in decision-making, a sealed-bid auction is considered more appropriate compared to an English or Dutch auction (Ferraro, 2004). A second price auction is also relatively easily to explain and to be understood by participants, making the bidding process more transparent.

In procurement auctions, the reserve price is the maximum acceptable bid[3]. The announcement of a reserve price can influence the bidding decision and hide the bidders' true value. However, the

[2] Modified from Lusk et al. (2004)

[3] Shor, Mikhael, ―Reserve Price" Dictionary of Game Theory Terms, Game Theory .net, <*http://www.gametheory.net/dictionary/ url_of_entry.html*> Web accessed: June 06, 2008

bidders also can implicitly interpret the information revealed by winning bids as reserve prices in multiple round auctions (Latacz-Lohmann and Schilizzi, 2005).

Two pricing mechanisms in auctions are uniform pricing and discriminatory pricing. When more than one product is available in an auction, the auction may have multiple winners with different winning bid values. With uniform pricing at a procurement auction, all winners are paid the price offered by the winner with the lowest winning bid. For discriminatory pricing, all the winners are paid their exact bid amounts.

Alix-Garcia et al. (2003) showed that uniform pricing may be more equitable while discriminatory pricing is more cost-effective. A complete list of possible implications for each pricing rule is listed in Table 2. Latacz-Lohmann and Schilizzi (2005) showed that under uniform pricing a bidder's bid only determines the chance of winning but not the payment received. It was assumed that the bidders' dominant strategy thus is to bid their true opportunity costs.

Table 2. Comparison between Two Pricing Rules: uniform and discriminative

Element	***Uniform***	***Discriminative***	***Description***
Bidding strategy	+	-	Under discriminatory pricing, ES seller's bid determines both chance of winning and price to be received for selected activities Under uniform pricing, ES sellers' bid only determines chance of winning, so it reveals WTA more accurately
Transaction cost	+	-	Uniform pricing requires relatively more simple administration when dealing with many ES sellers
Fairness	+	-	ES sellers in discriminative pricing earn no profits if they submit offers equal to their opportunity costs
Political interest	-	+	High opportunity cost farmers can be disappointed when uniform pricing is applied
Efficiency of ES buyer	-	+	ES buyers might achieve environmental objective at least cost (McKee and Berrens 2001; Cason and Gangadharan 2005) For ES sellers, since conservation payment is a non-stochastic income, it would lower their income uncertainty (Riley and Samuelson 1981)
Effect of risk aversion	+ (not exist)	- (exist)	Risk-averse participants inflate their bids under discriminative pricing
Effect of over-bidding	+ (not exist)	- (exist)	Over bidding will increase expenditure under discriminative bidding

2 METHODOLOGY

2.1 Setting of Study Site

Sumberjaya (which means ‗source of wealth') is a sub-district of the mountain range of Bukit Barisan in Lampung Province, Indonesia. It covers 55,000 ha and shares a boundary with the Way Besai River's upper watershed, which sits at between 720 and 1,900 m above sea level. This area had a population of about 82,453 people in 2003, giving a population density of about 150 persons/km^2. About 40 percent of the sub district is classified as protected forest and about 10 percent as National Park. Nevertheless, about 70 percent of the area is now covered by coffee gardens.

The majority of the communities in the Way Besai upper watershed make their living by planting coffee in the hilly regions (44.61 percent of the area) and planting paddy rice along the valley bottoms (5.13 percent of the area). Two types of coffee-cultivation – coffee-monoculture and coffee-multistrata (or coffee agroforestry) – cover 20.12 percent and 24.49 percent of the watershed area, respectively.

The communities in the upper sub-watersheds and in the riparian zone of the river are the ones that decide land use, and they can affect the quality and quantity of hydrological services of the sub-watershed. The preliminary results of the Alternative to Slash and Burn (ASB) studies done by the International Centre for Research in Agroforestry (ICRAF) over the past six years suggest that coffee-agroforestry can be as effective as the original forest cover in protecting watershed functions related to water yield and water quality (van Noordwijk *et al.*, 2000). Research findings have consistently shown that planting fodder grass under intensive annual upland crops and other conservation measures effectively reduces erosion (Agus, 2005). In coffee plantations, soil loss was very high on plots that did not employ any conservation efforts, especially in the first two years after coffee planting. During this period conservation practices such as using bench terraces and hedgerows effectively reduced erosion.

Many farmers using coffee-monoculture systems do not apply soil conservation techniques, and this may cause high soil erosion. Some research has confirmed that the land covered with young coffee trees (less than three years old) and the early stages of paddy fields along the riverbank are prone to high erosion. Potential conflicts over water resources can happen in such situations. During the dry season the supply of water is often not sufficient to satisfy demand and in some areas of the sub-watershed the sediment load in the water seems unacceptably high to some downstream users, especially the hydropower company located downstream in the watershed. The other potential problem is the decreasing quality of water, caused by domestic waste and chemical fertilizers.

Observations on river discharge and sediment load (erosion hot-spots) in the Way Besai and its main sub-catchments are ongoing[4]. ICRAF research selected the 11 largest sub-catchments and nine

[4] A field report. The Second Observation: Assessment of Discharge and Sediment Load in the Way Besai and its Main Subcatchments, Bruno Verbist, Susanto, Pratiknyo Purnomo Sidhi, Endri Subagyo, Dede.

measuring points along the Way Besai. The sampling points were located on bridges on roads along the river. A water-quality monitoring group of 21 people was formed to collect data daily.

Collective actions, classified as societal-based, and formal collective actions already exist in Sumberjaya (Arifin, 2004). The existing societal-based collective actions are: *gotong-royong* (labor sharing on common property); *arisan* (periodical capital sharing on a regular basis), and *kelompok tani* (farmer groups sharing information to obtain land tenure). A formal watershed community forum was established in January 2004 and has been endorsed by local government as a collective method of conserving natural resources.

Since 2002, the Way Besai Hydroelectric Power Plant (HEP) has implemented programs of land rehabilitation and reforestation by empowering local people. During the first year, the focus was on establishing HEP's jurisdiction for land rehabilitation. The power plant provided tree seedlings and lumber and polybags for this purpose. The HEP has claimed that it has contributed as much as Rp 80 million in four years to the land rehabilitation program and to the enhancement of the livelihoods of the people living around the power plant. These livelihood enhancements have included scholarships for students, contributions to charities on religious occasions, and the rehabilitation of mosques and schools.

The legal basis of this scheme was the letter of the Ministry of State-owned Company Affairs about the Corporate Social Responsibility Partnership Program, number KEP-236/MBU/2003. This letter cites that 1 percent of the net-benefit of state-owned companies should be allocated for developing environmental programs with communities. This scheme involving government public investment is a potential mechanism for reward transfers in the near future.

2.2 Research methods

The research consisted of several preparatory steps before the procurement auction was conducted (Figure 1). Firstly, we identified the sample population and potential auction participants at the sub-watershed level. Secondly, we designed the conservation contract that would be offered in the auction. In designing the contract, some basic information was needed such as: What problems would be solved by the conservation project? Do local farmers have any knowledge that can help to solve watershed problems? What are these conservation techniques? What are the farmers' preferences for terms of payment? When should the contract begin? Thirdly, we tested and selected some elements of the auctions through two types of experiments: a laboratory auction experiment with students and field framed experiments with farmers[5]. The final step of the research was to conduct a natural field

[5] This taxonomy of field experiments proposed by Harrison and List (2004) differentiated between field experiments from conventional lab experiments:

experiment and to monitor the success and completion rate of the contract by farmers who won the auction for one year.

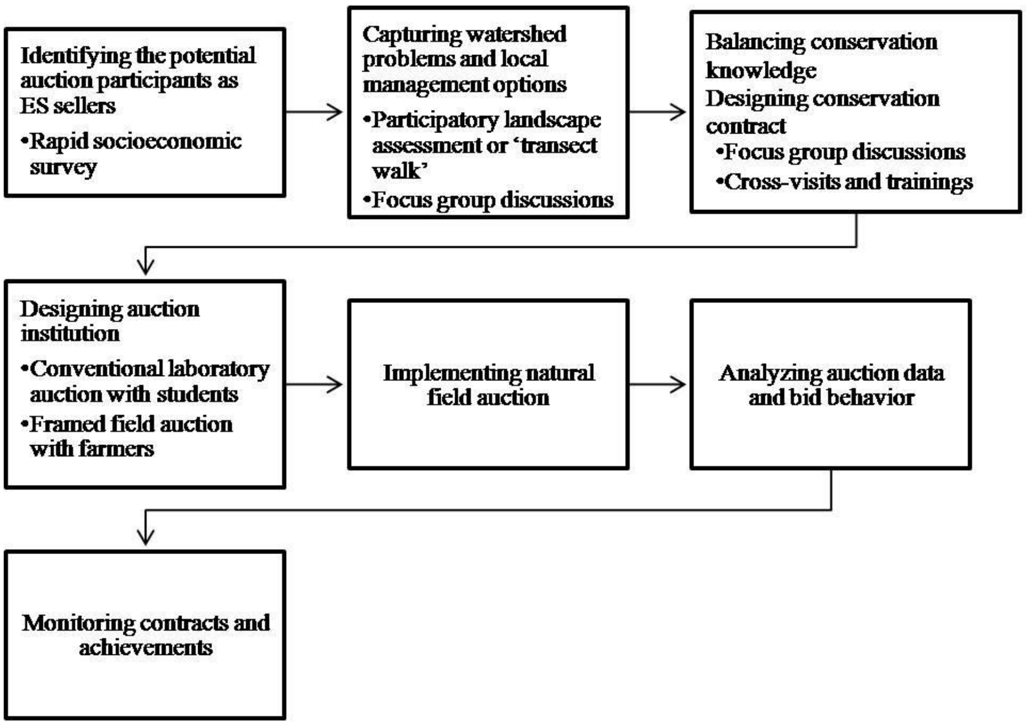

Figure 1. Flow of the Research Steps

2.2.1 Identifying Potential ES Providers and Auction Participants

The research team conducted a series of rapid surveys of the socioeconomic profiles of potential auction participants. These surveys took place at five hamlets in three sub-watersheds of Sumberjaya – Way Lirikan, Way Ringkih and Air Hitam – all of which have high erosion rates. The key informant interviews resulted in 13 variables. Variables included the name of the farmer, ethnicity, age, main occupation, house location, status of land management (self-owned and managed; self-owned but

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A *conventional lab experiment* is "one that employs a standard subject pool of students, an abstract framing, and an imposed set of rules";

A *framed field experiment* is an experiment that "employs a nonstandard subject pool with field context in either the commodity, task, or information set that the subjects can use";

A *natural field experiment* is "the same as a framed field experiment but where the environment is one where the subjects naturally undertake these tasks and where the subjects do not know that they are in an experiment" rented, etc.), area of land in hectares, land cover, land status (private, state-owned through social forestry program), existence of land conservation and its type, and involvement in farmer groups.

2.2.2 Capturing Watershed Problems and Local Management Options

The research team conducted a participatory landscape assessment (PALA) in two sub-watersheds: Way Ringkih and Way Lirikan. The PALA is an important part of Integrated Participatory Conservation Planning at watershed level, and it is designed through some rapid rural appraisal tools and some participatory rural appraisal tools (Fagerstrom et al., 2005). In this case, the field team conducted a series of field visits or ‗transect walks' across the sub-watersheds, followed by similar activities conducted together with local farmers. The key informants shared their opinions on local knowledge and their experiences of watershed management via non-structured interviews.

The objective of a PALA is to capture local knowledge on temporal and spatial scales, specifically the assessment aims to study farmers' perceptions of watershed problems such as erosion, flooding and landslides, and to understand farmers' management options and their actual choices as a way of helping them to develop land management plans. Information on farmers' knowledge of watershed problems and their management options to solve these problems is useful to the conservation agent or auctioneer developing conservation contracts. A conservation contract that accommodates the most doable and familiar conservation techniques for farmers will enjoy greater effectiveness and a higher performance.

A series of focus group discussions (FGDs) followed the field visits. The research team facilitated four FGDs involving 76 coffee farmers from three selected hamlets. The purpose of these FGDs was to explore perceived problems in managing land and practicing conservation techniques, including the types and causes of problems and efforts to avoid the problems. Meetings began with a brief introduction to the objectives of the research project and its activities. During the discussions participants were divided into three smaller groups to encourage opinion sharing.

2.2.3 Balancing Knowledge of Conservation Techniques: Capacity Building and Designing Conservation Contracts

Most of the farmers were familiar with and could mention some local conservation techniques. However, because of varied perceptions of the techniques' applications in the field, the research team conducted cross visits and field training. At this stage, the participants were not informed that they might have to participate in an auction.

In the three hamlets, the field facilitators conducted three cross visits involving 77 farmers and field training for 82 farmers. For the cross visits, the farmers visited two farmers in another village (Tri Budi Sukur village) who have been practicing soil conservation techniques. A local government field extension officer facilitated this process.

During the first cross visit techniques in constructing combined terrace and ridging were introduced. During the second session the application of natural vegetative strips or grass-strips was presented. The discussion topics of both sessions were on how to maintain these techniques and their costs. Some brief presentations about soil and water conservation followed these activities.

The field training had two sessions: theory and field practice. The resource person explained soil conservation techniques in the field. These techniques included terracing, ridging, making a sedimentation pit, and bench terracing. The field extension officer also showed farmers how to measure the field contour using a simple tool.

The farmers practiced these techniques at the nearby coffee field after the discussion. There were three groups of farmers, each with up to 11 farmers, who worked together using their own farming tools. Each group practiced measuring the land contour and constructing a layer of bench terracing with a water waste trench. In Talang Kuningan the participants also practiced constructing sedimentation pits measuring 4 x 1 x 1 metres. This activity took about three hours. At the short meetings after these training sessions, the participants discussed the application of these conservation techniques in their own coffee gardens.

Figure 2. Farmers Practice Conservation Techniques during the Field Training

2.2.4 Designing the Auction

When using a procurement auction, one needs to carefully assess its design to ensure the reliability of value estimates and its implications for the rural community. We designed the auction via two preliminary stages of experiments: conventional laboratory experiments and framed field auction experiments[6]. From the literature, we determined the basic design of the auction: a sealed-bid Vickrey

[6] This taxonomy of field experiments was proposed by Harrison and List (2004) and differentiated between field experiments and conventional lab experiments:

auction with multiple rounds. Each participant independently fills out and submits an offer-submission card that specifies the per-metre square or per-hectare price and number of metres square or hectares he proposes to join the contract. After the provisional winners are announced, either by their ID numbers or cut-off price, all participants (regardless of the status of their offer) are given the opportunity to hand in a revised offer or the experimenters can end the auction. In the event that the auction is ended, the provisional acceptances from the most recently completed round become the final acceptances. The payment format is a uniform format where the second highest bid is accepted.

Table 3. Characterization of Proposed Auction Designs

Auction component	**Options**
Auction type	One-sided, sealed bid, 2nd price Vickrey with budget constrained
Tie-rule	Random
Pricing rule	Uniform
Reserve price	Without reserve price
Bidding units	Total WTA
Bidder numbers	Known
Bidder strategy	No collusion
Activities contracted	Determined in advance
Number of rounds	Announced in advance <u>or</u> concealed
Announcement of provision winners	Announced ID numbers <u>or</u> cut-off price
Announcement of amount of limited budget	Announced in advance <u>or</u> concealed

Three scenarios were tested varying the amount of information received by the participants (Table 3): number of rounds, announcement of provision winners and announcement of the amount of limited budget. The results of the auction institutions from these experiments would be applied to the natural field auction experiments. Both the conventional lab and framed field auction experiments were hypothetical and non-binding. The natural field auction experiment, on the other hand, was binding for farmers; they joined contracted efforts to reduce erosion for one year.

A *conventional lab experiment* is –one that employs a standard subject pool of students, an abstract framing, and an imposed set of rules";

A *framed field experiment* is an experiment that –employs a nonstandard subject pool with field context in either the commodity, task, or information set that the subjects can use";

A *natural field experiment* is –the same as a framed field experiment but the environment is one where the subjects naturally undertake these tasks and where the subjects do not know that they are in an experiment"

2.2.4.1 Conventional laboratory auction experiment

Three conventional laboratory auction experiments involving undergraduate students were performed to familiarize the experimenters with the auction process and procedures, including the preparation of an auction spread sheet and script. The experiments were also done to train the enumerators in conducting the auction and in performing some surveys; to test some features in the auction environment; and to evaluate the auction performance in order to improve design at the field level. The experimenters decided that the scenario of this laboratory experiment would reveal the willingness of participants (e.g. undergraduate students) to accept a certain amount of money to do certain contracted activity.

The hypothetical contracted activity was to clean their boarding room (Table 4). Cleaning included sweeping the floor, washing the floor, tidying up their bookshelves or work table, and dusting all furniture inside their bedroom. The cleaning was to be monitored by their boarding host (or appointed family/parents). The labor allocation was up to the students – whether they decided to do it themselves or sub-contract the job to others. Their payment would be held back if they broke the contract or if they performed poorly.

The above scenario was applied to a real setting where farmers would be offered a bid to apply a contracted conservation technique on their private land. This conservation technique was assumed not only to reduce the erosion rate and river sedimentation on their farms, but also to maintain the fertility of their topsoil.

Table 4. Conventional Laboratory Auction with Students

Scenario	To clean their boarding room once a week
Frequency of monitoring	Every weekend – continuously for six months
Payment period	50 percent after signing the contract 30 percent after three months of good implementation and 20 percent at the end of the contract

This laboratory experiment consisted of four main consecutive sessions: a socioeconomic and time-preference survey, a risk aversion game, the auction, and follow-up questions to evaluate the process. The auction was designed to minimize collusion amongst participants by reminding them not to consult each other during the process.

2.2.4.2 Framed field auction experiment

Two framed field auction experiments were performed in the field as follow-up activities to the laboratory experiment and as additional pre-tests for the actual auction implementation. The hypothetical field experiment involved two farmer groups because they had similar characteristics to the real auction participants – they were private landowners, and they cultivated coffee gardens as their major source of income. The field experiment participants also had institutions at the community level that resembled those of the final participants, such as existing farmer groups and other religion-based community groups. In addition, these farmer groups were cooperative and they understood the nature of the research. It was expected that these criteria would be helpful in designing the final auction.

The contracted activity was to construct soil and water conservation techniques. The activity would be monitored by local forestry service extension workers accompanied by ICRAF staff. The end-of-contract payment would be withheld if the farmers broke the contract and performed poorly. The auctioneer set a limited budget of Rp. 20,000,000, which was the average budget provided by the potential buyer – the hydropower company – from their annual corporate social responsibility fund.

Table 5. Framed Field Auction with Farmers

Scenario	To apply ‗five eye' sediment pit and ridging combined with natural vegetative strip for one year
Frequency of monitoring	Every six months
Payment period	50 percent after signing the contract and 50 percent at the end of the contract

2.2.4.3 Natural field experiment

As the final experiments, two binding natural field auctions were conducted at two hamlets: Mulya Indah and Wanasari 1. The winners of these auctions would sign a one-year contract with ICRAF to conduct soil and land conservation activities on their land. The participants were farmers who privately owned and managed their coffee-gardens.

The design of the contract components was based on FGDs with coffee farmers in the target villages. The FGDs were designed to gather information on farmers' preferences for soil conservation techniques and estimates of required labor investment. During the FGDs the experimenters did not mention anything about the auction or the specifics of the contract design. The potential for collusion in the auction setting was high, given the close community structure and social hierarchies within the communities. We decided to reduce collusion both in the preparation and the implementation of the auction.

2.2.5 Auction Data Analysis

The objective of this study is to design a set of auction rules for determining how the limited budget from the watershed rehabilitation fund will be allocated. The research focused on:

2.2.5.1 Observable and non-observable factors influencing the final bids

We observed the socioeconomic factors influencing the auction participants in submitting their final bids by applying a regression analysis with Reverse Helmert coding (or difference coding) as the additional coding systems for ordinal and categorical variables using the STATA 9.1 software. This system compares each level of non-numeric variables to the mean of the subsequent level(s). Each variable is compared to the mean of previous level(s)[7].

2.2.5.2 Validity of auction design in a rural setting

We analyzed the validity of applying this auction design in a rural setting in Indonesia by testing some factors. These factors were (1) technical factors, such as: farmers' understanding of auction rules, easiness of the rules, appropriateness of the bid offered during the auction, and fairness of the auction process; (2) social factors, such as: impact on relationships between contracted and non-contracted farmers, general interpersonal relationships between communities, and information exchange between farmers; (3) environmental factors, such as awareness of soil and water conservation and rate of contract accomplishment.

For the technical factors, we hypothesized that the bidders' (farmers') learning process is influenced by the number of wins from previous rounds as well as farmers' perceptions of auction design factors. Data from the multiple bids submitted by each individual allows insights into farmers' understanding of the auction and learning across the multiple bidding rounds. Jack (2009) provides an analysis of the learning observed in the auction using the adjustments of bids between rounds as an indicator of learning and finds that individuals are responsive to previous round outcomes and rejects a simulated null hypothesis of random bidding. The data suggests that individuals do use the trial rounds to learn how to bid, but conclusions about whether they learn about the auction structure itself or about the value of the contract remain unclear.

For analyzing the social factors (impact on relationships between contracted and non-contracted farmers, general interpersonal relationships between communities, and information exchange between farmers) and environmental factors (awareness of soil and water conservation and the rate of contract accomplishment), we applied Fisher's exact tests between two independent categorical variables. Fisher's exact test predicted the relationship between non-contracted and contracted farmers on each social and environmental variable. The application of Fisher's exact test assumes that each cell has an expected frequency of five or less.

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[7] Introduction to SAS. UCLA: Academic Technology Services, Statistical Consulting Group. from http://www.ats.ucla.edu/stat/Stata/webbooks/reg/chapter5/statareg5.htm#HELMERT (accessed July 10, 2009).

2.2.5.3 Risk and time preferences

As suggested by Ferraro (2004), in addition to survey data collected on the observable characteristics of auction participants, the risk preferences and time preferences of participants were also considered.

Risk preferences

To date several approaches have been used to assess the importance and nature of risk aversion. Simple lottery choice tasks involving cash prizes were used to estimate the degree of risk aversion as well as specific functional forms. This experiment was based on six lottery choices from real situations, adapted from Holt and Laury (2002) and Ferraro (2004).

Table 6. The Proposed Pay-off for Risk Experiment (Ferraro 2004)

Decision	Choice	Cash pay-off (probability)		
1	A	$ 5 (50 percent)	$ 5 (50 percent)	-
	B	$ 8 (50 percent)	$ 4 (50 percent)	-
	C	$ 11 (50 percent)	$ 3 (50 percent)	-
	D	$ 14 (50 percent)	$ 2 (50 percent)	-
	E	$ 17 (50 percent)	$ 1 (50 percent)	-
2	A	$ 5 (100 percent)	-	-
	B	$ 0 (5 percent)	$ 5 (75 percent)	$ 10 (20 percent)
3	A	$ 0 (75 percent)	$ 5 (25 percent)	-
	B	$ 0 (80 percent)	$ 10 (20 percent)	-
4	A	$ 5 (100 percent)	-	-
	B	$ 0 (20 percent)	$ 10 (80 percent)	-
5	A	$ 0 (5 percent)	$ 5 (75 percent)	$ 10 (20 percent)
	B	$ 0 (20 percent)	$ 10 (80 percent)	-
6	A	$ 5 (25 percent)	$ 10 (75 percent)	-
	B	$ 0 (5 percent)	$ 10 (95 percent)	-

Time preferences

Individual discount rate can represent time preferences. Harrison *et al* (2002) indicated that constant discount rates for specific household types was assumed, but not the same rates across all households. Respondents will be asked a simple basic question in order to elicit an individual discount rate: for example, applying to a time horizon of six months, do you prefer Rp. 50,000 in one month or Rp. 50,000+x in seven months? This delayed option involves greater transaction costs and the revealed discount rate would include these subjective transaction costs. By having both options entail future income, individuals hold any transaction costs or concerns about experimenter default constant.

Table 7. Time Preference Decision Sheet (adapted from Castillo et al, 2008)

Decision	Paid one month from now (Rupiah)	Paid seven months from now (Rupiah)	Discount rate
1	50,000	52,000	7.88 percent
2	50,000	54,000	15.56 percent
3	50,000	56,000	22.95 percent
4	50,000	58,000	30.13 percent
5	50,000	60,000	37.07 percent
6	50,000	62,000	43.74 percent
7	50,000	64,000	50.19 percent
8	50,000	67,000	60.25 percent
9	50,000	69,000	66.19 percent
10	50,000	71,000	71.89 percent
11	50,000	74,000	80.47 percent
12	50,000	77,000	89.96 percent
13	50,000	79,000	94.93 percent
14	50,000	82,000	103.23 percent
15	50,000	85,000	111.21 percent
16	50,000	88,000	118.94 percent
17	50,000	91,000	126.33 percent
18	50,000	94,000	133.49 percent
19	50,000	97,000	140.35 percent
20	50,000	100,000	146.93 percent

3 RESULTS

3.1 Characteristics of Auction Participants

Most of the farmers in the research sites are Sundanese, originating from West Java, and Javanese, originating from Central and East Java. They are either first- or second-generation Javanese migrants from the early 1950s–1970s, who mostly occupy certified private land. Each farmer owns an average of one hectare or less. Farmers who are owners and managers of their coffee farms derive their major income from coffee cultivation. Landowners with other occupations, such as smallholder-trading, teaching, motorcycle-rental, or working for local government, usually rent their land to others and share the coffee harvests.

Based on the hydrological survey of the sub-watershed, we selected two sites, Way Ringkih (Site 1) and Way Lirikan (Site 2), with a high sedimentation rate. In addition to this biophysical consideration, we set qualifications for selecting eligible participants for the auction project. The farmers had to own their land and be actively managing the land themselves. These stipulations were made in order to avoid conflicts on signature of contract and regarding payment, and to ensure that the farmers do not neglect their land after signing the contract. Farmers on private land need incentives to manage their land sustainably. Since this study took place in a sub-watershed, the minimum number of eligible farmers needed to increase the salience of the study was 20 (Ferraro 2004).

There were 44 and 45 households eligible in the sub-watersheds respectively. The Way Ringkih sub-watershed consists of two *talang* (hamlets in the local language): Talang Harapan and Talang Kuningan (Site 1). The Way Lirikan sub-watershed consists of one talang: Talang Anyar (Site 2). ICRAF scientists facilitated participatory water-monitoring activities in Way Ringkih and Way Lirikan. These water-monitoring activities gave additional benefits that contributed to the measurement of the study‘s environmental impact.

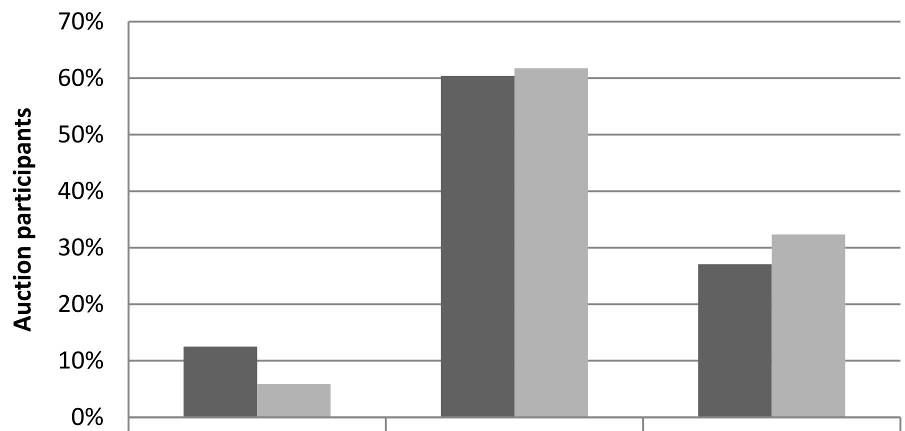
The farmers‘ livelihoods depend on coffee farming, either as owners of coffee gardens or as laborers to other farmers. Their daily wage was about USD 1.67 (Rp. 15,000). In Talang Anyar, many farmers had alternative jobs and did not rely on their coffee garden as their main livelihood. We observed that the farmers in Talang Kuningan and Talang Harapan were more responsive and enthusiastic compared to those in Talang Anyar. The community in Talang Anyar rarely got involved in collective action because of the scattered locations of their houses. Summary statistics from the survey for the auction participants in the two sites show some differences between the villages (Table 8).

Table 8. Village Characteristics for Auction Participants

Variable	Talang Harapan and Talang Kuningan (Site 1)	Talang Anyar (Site 2)
Assets (Rupiah)	3,663.4	13,649.0
Age	41.1	43.4
Education (years)	5.28	6.41
Number of HH family members	3.7	4.0
Number of years owning land	14.2	15.4
Plot size (ha)	0.7	1.1
Social capital and conservation awareness[8]		
Farmers with experience in applying conservation techniques in the past	92 percent	91 percent
Availability of any current conservation techniques	69 percent	79 percent
Assistance from government	25 percent	41 percent
Trust		
Mostly trust internal members of the community	94 percent	74 percent
Always trust the outsiders	98 percent	88 percent
Land physical characteristics		
Farmers with slopes more than 25 percent	77 percent	100 percent
Vegetation structure of coffee garden		
Monoculture coffee	2 percent	9 percent
Shade coffee	25 percent	6 percent
Multistrata coffee	73 percent	85 percent
Distance to road (in minutes walking)	34.7	13.6

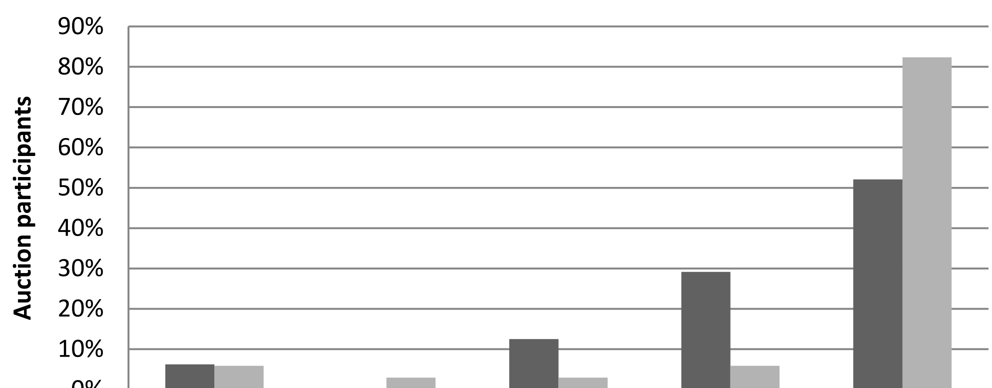
As shown in Table 8, the first site is poorer, with farmers working on smaller plots of land that are further from a paved road. In the second site participants had lower levels of trust in community members and in outsiders, and also got more assistance from the government. Most of the farmers had shade and multistata coffee gardens and had experience of applying conservation techniques in the past, which some farmers still practiced. On average, both sites have similar levels of risk preference. Most of the participants are risk-neutral to risk-loving (Figure 3). From the time preference experience we found that about 85 percent of the participants have severe (51 percent to 100 percent) and extreme (more than 100 percent) discount rates (Figure 4). This finding is consistent with the conditions in rural areas in developing countries, where the level of subsistence is very high and people heavily depend on their immediate cash to fulfill their daily food needs.

[8] All the social capital variables are dummy variables.



	Risk averse	Risk neutral	Risk loving
Site 1	13%	60%	27%
Site 2	6%	62%	32%

Figure 3. Level of Risk Preference at the Two Sites



	Almost neutral	Moderate	Intermediate	Severe	Extreme
Site 1	6%	0%	13%	29%	52%
Site 2	6%	3%	3%	6%	82%

Note: Almost neutral (less than 10 percent discount rate); moderate (18 percent-25 percent discount rate); intermediate (26 percent to 50 percent discount rate); severe (51 percent to 100 percent discount rate); extreme (more than 100 percent discount rate)

Figure 4. Level of Time Preference at the Two Sites

3.2 Perceived Watershed Problems and Farmers' Local Management Options

The PALA confirmed that there were major problems in the watershed, such as erosion, flooding, river ridge landslides, critical land, and clean water availability[9]. Most of the farmers did not frequency apply fertilizer and experienced high acidity and compacted soil, all of which cause difficulties in soil cultivation. These problems perceivably caused infertile and dying coffee trees and were responsible for low productivity. Another cause of the high erosion rate was the small numbers of shade trees – land with a high potential for erosion and landslides is located along the riparian and hilly ridge.

Farmers lacked technical knowledge of land management and soil conservation. Agricultural extension from the local government was inadequate in the area. Therefore, farmer groups were inactive and rarely conducted collective watershed maintenance action.

In the past, many farmers practiced land conservation techniques copied from their neighbors. However, most of these practices were discontinued because of a lack of incentives and motivation. The main reason was the lack of financial capital to invest in land conservation. Rather than spend money on land conservation, which would have been a beneficial long-term investment, some farmers chose to invest in alternative livelihoods. Despite these inadequacies, however, they showed genuine enthusiasm and a willingness to have better access to information. They realized that if they do not change their conditions the environment could be further degraded, resulting in lower coffee productivity. Some farmers in this area use erosion pits because it is a simple and cheap technique that is applicable even to land on a steep slope. The ideal number of erosion pits per hectare is 600 and the ideal model is the ‗five eye' model – featuring one erosion pit in the middle of four coffee trees within 20 working days. The width and depth of each erosion pit depends on the land conditions and the interval of coffee trees. In Talang Kuningan and Talang Harapan, some farmers have applied terracing. The number of terraces per hectare vary depending on the slope and size of the land – the steeper the slope, the more frequent the interval of terraces.

3.3 Contract Design of the Procurement Auction

The contracts offered are specified in Table 9. These contracts were in line with the farmers' preferred conservation activities.[10] The sediment pit is the most favored technique because it is cheap and easy to construct. The farmers stated that if a conservation program was to be conducted, they would prefer it to start in August–September, after the harvesting period had ended. In Talang Kuningan, there was a suggestion that monitoring be intensively conducted in the first three months, for example once a month, and after that monitoring could be performed once every three months.

The contract was for one year. The activities were monitored and evaluated by local forestry service extension workers accompanied by ICRAF staff every three months. The contract was to be

[9] Detailed information on PALA results can be found in Widodo (2006).

[10] Copies of the contract are available from the lead author upon request.

paid in two installments: 50 percent after signing the contract and 50 percent at the end of the contract (one year), as suggested by the FGDs. The second installment of the payment was withheld if the farmers broke the contract and performed poorly.

Table 9. Contract Offered for the Procurement Auction

Soil conservation activities	Sediment pits: 300 per hectare, evenly distributed, standard dimensions: 100 x 150 x 40 cm Ridging: 50 percent of plot Vegetation strips: surrounding pits and ridging Maintaining all the land conservation structure for a year
Payment schedule	50 percent at inception; 50 percent at one year contingent on performance
Duration and monitoring	One year with monitoring every three months; termination if 50 percent contracted activities are not completed by midterm monitoring date
Cancellation or non-compliance results: Ineligibility for second payment installation: Friction and conflict between community members, indications of corruption:	
Contract to be cancelled if any natural disasters or events occur	

3.4 Designing the Auction

3.4.1 Laboratory Auction Experiment

The outcomes of the student experimental auction guided the revision of the auction's implementation in the field testing and in the final auction. Firstly, feedback from the students' auction indicated what instructions, activities, or questions were unclear or misleading. This feedback was analyzed to provide guidelines in amending both the enumeration technique and the survey content that would be used for the field test among farmers. For instance, since the survey was the most confusing activity for the students, verbal enumeration may be conducted for farmers so as to allow them to interrupt and ask questions. To revise misleading questions (content), enumerators would have to note questions that farmers want clarified.

At the first auction, the ID number of each winner was announced after each round was completed. No other information was given, including the number of rounds. For the first scenario, the facilitators observed the participants and stopped the auction when they noticed the participants losing interest and the bid value became relatively stable. In this case, the second and third scenarios follow the tendency of the first auction and the experimenters decided to stop the auctions after eight rounds and announced this at the beginning of both auctions.

Table 10. Variation in Scenarios for Laboratory Experiment Auction

Session	Announce number of rounds	Announce cut-off price	Announce limited budget	Number of participants
1	No	No	No	14
2	Yes	No	Yes, before round 4	16
3	Yes	Yes	No	24

Comparison of auction outcomes indicates that announcing prices between bidding rounds may change bidding behavior in ways that are undesirable. This behavior suggests that bids may have been anchored on cut-off prices rather than on estimated opportunity cost. Given that one of the auction‘s objectives was to obtain accurate assessments of opportunity cost, removing this tendency to anchor can lead to more accurate results. Further evidence that announced prices may have been used as an anchor was the measure of the average price-WTA gap for each scenario. Averaging the amount that the uniform price exceeded winning bids indicated that students in the third scenario adjusted their bids upward, toward the announced price, resulting in a smaller gap in the third scenario. The cut-off price in the third scenario was also the highest of the three, indicating the least cost-effective results and fewest winners, which were also likely because of the anchoring of bids on the announced price, which draws up average bids and makes conservation – or cleanliness – more expensive.

The other two treatments – announcing the number of rounds and announcing the budget limit – did not appear to have a significant effect on bidding behavior as observed in the similar outcomes between scenarios 1 and 2. Variability in the final round was somewhat higher in the second scenario, when the number of rounds was announced; however, the difference was insignificant and the total variability was also somewhat higher. Also, in the second scenario, announcement of the total budget after the third round did not produce an observable change in bidding strategies.

Given the lack of significant effects from either of these treatments, selecting the most straightforward approach in order to minimize confusion among farmers, would produce the most reliable outcomes. Testing the announcement of the number of bidding rounds would still be feasible in the field auction trial. However, announcement of the total budget appeared insignificant. Hence, it may be best not to disclose the total budget to allow for greater flexibility in contract awards.

Based on the results of the experimental student auction, the following adjustments would be made and evaluated during the experimental farmer auction:

1) The auction would be implemented twice, both times using an n-sided, sealed bid, uniform second price Vickrey design with budget constraints and random tie breaking rule. Identification numbers of provisional winners would be announced between rounds. The number of participants and number of rounds would be kept constant between the two auctions, though in only one of the two would the number of rounds be disclosed in advance. Because of the sealed-bid, the experimenter must carefully explain the procedure in submitting bids, especially on how to write down the bid value.

2) Survey questions would be adapted from student-targeted information to farmer-specific questions, and additional questions would elicit qualitative measures of risk and time preferences. Specific attention would be paid to questions that may help identify variations in WTA emerging from farmer characteristics other than heterogeneity in direct implementation costs.

3.4.2 Framed Field Auction Experiment

Based on outcomes from the laboratory experiment and on the theoretical considerations discussed, the only aspect of the auction design that required further testing was the announcement of the number of rounds in the field trial. In the first trial, the number of rounds was not announced to the farmers prior to the auction, but it was announced in the second trial. Individual bidding behavior and total expenditures were compared to assess which approach induced preferred outcomes.

Table 11. Characterization of Framed Field Auctions

Auction component	**Options**
Auction type	One-sided, sealed bid, second price Vickrey with budget constraints
Tie-rule	Random
Pricing rule	Uniform
Reserve price	Without reserve price
Bidding units	Total WTA
Bidder numbers	Known
Bidder strategy	No collusion
Activities contracted	Determined in advance
Announcement of provision winners	Announce ID numbers
Announcement of amount of limited budget	Concealed
Number of rounds	Concealed **or** announced before the auction

Table 12. Variation in Scenarios for Framed Field Auction

Session	**Number of rounds announced**	**Number of participants**
1	No	46
2	Yes	43

An additional unresolved consideration of auction design involves the choice between a uniform price rule and a discriminatory price rule. The choice is likely to result in tradeoffs between equity and cost-effectiveness, with uniform pricing more likely to reveal farmers' true opportunity cost (Table 2). Consultations with farmers during the FGDs showed equal preference for uniform and discriminative pricing. For discriminative pricing, they considered high slope variability on their land's yield and different levels of difficulty in applying the conservation techniques. The household survey also tried to capture these payment formats. However, most farmers thought that the difference should have been based on the size of the land and on the cost of applying the conservation techniques but not the difference of payment per hectare. Since considerations of equity would not be revealed through bidding behavior, the choice of pricing rule was not tested in the field experiment. The ultimate choice to use uniform pricing came from a combination of theoretical considerations and farmer preferences revealed during the focus group discussions.

Since one of the objectives of this study was to reveal the farmers‘ willingness to accept joining a conservation program, uniform pricing strategy gave bidders incentives to bid their true opportunity costs (Latacz-Lohmann and Schilizzi, 2005).

Lessons from the theory and the experiments are that the returns in bidding come from cost and information advantages, that naïve bidding strategies can squander these advantages, and that the bidders without some advantage have little hope of earning much profit, but could with a little bit of carelessness suffer large losses (winner‘s curse).

In the field auction two scenarios were developed to determine the optimal auction design that would represent the farmers‘ willingness to accept joining a conservation program. The auction‘s results in the allocation of contracts would expectedly leave people better (or at least as well off). The enumerators and facilitators would then have chances to test the auction‘s procedures and script‘s explanations.

1. Auction procedures and script

Most of the farmers found that after joining several rounds they became familiar with the auction process. However, some farmers had difficulties with writing. For example, they could not differentiate how many zeros there were in thousands and millions. The enumerators had to help them to write their bids. For the real auction, we separated these farmers and requested that they to sit in the front row. We then divided the enumerators between these farmers so that they had someone to take care of them and to check their answers. During the data entries, the researchers also re-checked these farmers‘ answers and asked the enumerators to clarify anything that was not legibly written.

It was anticipated that some participants would be motivated to bid only for the money. Hence, the facilitator had to repeat the contract every two rounds in order to remind the participants to bid properly. In the field auction, two farmers submitted irrationally high bids. In a follow-up interview we discovered that they thought we wanted to bid for their land, hence they offered high land prices. Therefore, it would be advisable to repeat the substance of the contract and to re-check the bid values before data entry.

2. Contract

In the real auction, the contract would provide more information to farmers. Some contract elements, such as the number of sediment pits and their size, percentage of required ridging, and penalty and monitoring processes would be clarified and detailed.

3. Auction design

The field auction result indicated that there was no significant difference between concealing and announcing the number of rounds. Consultations with experts indicated that by concealing the number of rounds, one piece of information in the auction itself varied among participants. Since the number of rounds was not announced, each participant had his/her own subjective probability distribution about how likely it was that each round would be the last. This was a problem because in each round, some people acted like it was the last round, while others thought that they still had many more rounds to play. Therefore, for the real auction, the facilitator should pre-announce the number of rounds so that all the farmers approach each round with the same expectations.

The auction would be implemented at two pilot sites, both times using an n-sided, sealed bid, uniform second price Vickrey design, with budget constraints and the random tie breaking rule. Identification numbers of provisional winners would be announced between rounds and the number of participants and number of rounds would be kept constant between the two auctions. Further, the number of rounds would be pre-announced.

3.4.3 Natural Field Auction Experiment

Based on outcomes from the laboratory and field experiments and from the theoretical considerations discussed in this report, the design of this auction was a sealed bid auction with budget constraints, the random tie-rule, the uniform pricing rule, minimized collusion, announced ID numbers of provisional winners and a pre-announced number of rounds[11] (Table 13). The auctioneer set a limited budget of USD 2,000 (Rp. 20,000,000) per auction or a total USD 4,000 – which is the average budget provided by the potential buyer, the hydropower company, for its annual corporate social responsibility fund.

Table 13. Characterization of Actual Auction

Auction component	Options
Auction type	One-sided, sealed bid, second price Vickrey with budget constraints
Tie-rule	Random
Pricing rule	Uniform
Reserve price	Without reserve price
Bidding units	Total WTA
Bidder numbers	Known
Bidder strategy	No collusion
Activities contracted	Determined in advance
Announcement of provisional winners	Announce ID numbers
Announcement of amount of limited budget	Concealed
Number of rounds	Announced before the auction

The auction followed a fairly standard format, with a single buyer and multiple sellers submitting sealed bids representing their willingness to accept the soil conservation contract for their plot. Bids were assessed according to a per-hectare price and the cut-off price was determined by a pre-set budget constraint. The budget constraint remained concealed to prevent normative or distributional considerations from affecting bid prices. Each farmer entered only one plot of land and eligibility rules required that participants have clear land tenure and engaged in coffee farming as their primary occupation.

The pilot auction was modeled as a private value auction, and most of the literature on conservation auctions follows this approach. However, individual uncertainty over the labor costs of the contract may introduce some common value element to bidder behavior. The decision to use multiple rounds, with the final round setting the price allowed farmers to use early rounds as a learning opportunity, both to reduce confusion over the mechanism and to learn about the willingness to accept of other participants.

The number of rounds was announced in advance to eliminate subjective beliefs about the number of rounds and to induce participants to base their bids only on their willingness to accept in the final round. Bidder strategies in earlier rounds might include bid prices aimed at information elicitation. Bids were submitted simultaneously, and the anonymous identification numbers of the winners were announced between rounds. Ties at the cut-off price were broken randomly.

A uniform second price rule was used to set the final contract price, though a discriminatory second price rule would have further eliminated rents to the farmers. The decision to provide a single price was based on several contextual considerations. Firstly, communication among participants following the auction was judged to be very likely and a discriminatory price auction was seen as a potential source of conflict between contracted farmers. Secondly, because the farmers were relatively poor and the project wanted to minimize the risk that any farmer may be made worse off under the contract, an approach that allowed for greater uncertainty around the bid prices was preferred. An estimate of the potential conservation forgone, using elicited bid prices suggested that just over one additional hectare of soil conservation activity could have been purchased on the margin had a discriminatory second price rule been used instead of a uniform second price rule.

3.5 Natural Field Auction Data Analysis

In total, 82 farmers – 48 farmers from Mulya Indah and 34 farmers from Wanasari – participated in the two auctions. Of these, farmers were awarded contracts that provided for soil conservation activities in 25 hectares (Table 14). The contract price per hectare was USD 172[12]; the mean bid was USD 263.

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[12] USD 1 = 9,300 Rupiah

Table 14. Auction Summary Statistics[13]

	Site 1	Site 2	Pooled	Pooled (without outlier)
Number of participants	48	34	82	
Number of winners	19	15	34	
Number of hectares contracted	10.75	14.25	25	
Contract price per hectare (USD)	178	167	172	
Median bid (USD)	222	167	182	
Mean bid (USD)	311	269	294	263
Minimum bid (USD)	100	67	67	67
Maximum bid (USD)	2,778	778	2,778	1,111
Std. deviation bid (USD)	178	167	172	0

The bids followed an exponential distribution with a long tail at the low cost end (Figure 5). As a result, the distribution of bids below the cut-off price was fairly tight, which is reflected in the low estimate of additional cost savings through a discriminatory price approach. The distribution also had implications for the design of a fixed payment system and for the purchase potential of different budgets.

[13] Standard deviations and maximum bids are highly influenced by a single high outlier in the first village.

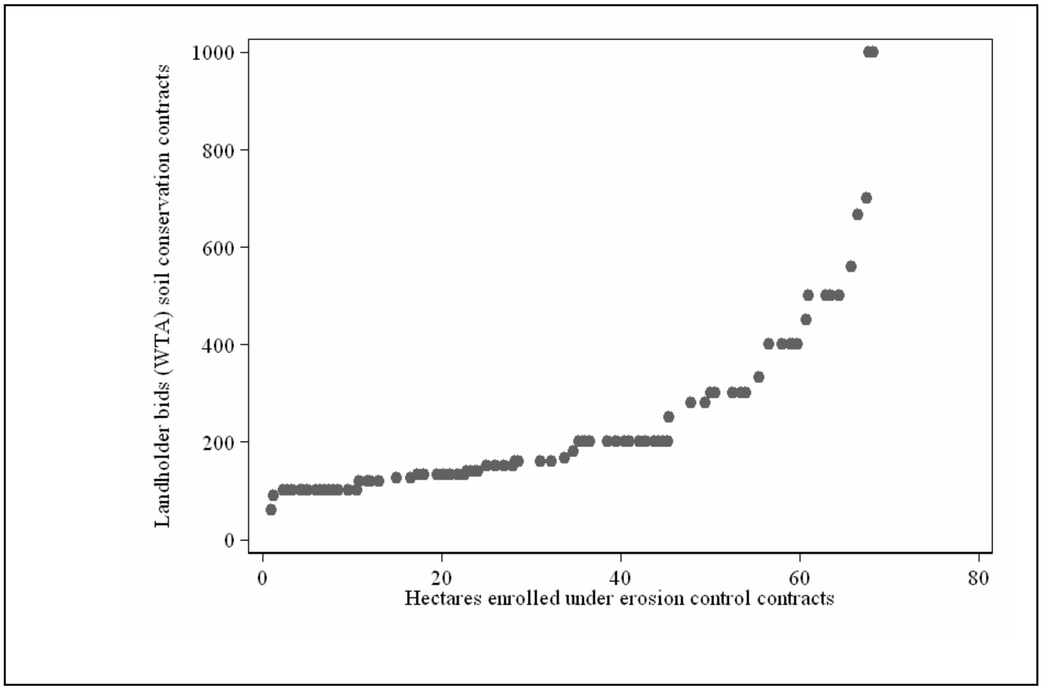

Figure 5. Supply Curve Resulting from the Procurement Auction

To validate the results of the auction, the implementing organization collected information to estimate labor costs using two approaches: an individual household survey and FGDs. The researchers asked farmers if they had implemented any of these activities in the past, and if so, how many days were required. The estimates based on retrospective calculations were slightly lower, around USD 300 (Rp 2,800,000 – Rp 3,000,000), including forgone wages from the farmers' own labor investment. The price set by the auction mechanism was USD 172 (Rp. 1.55 million) per hectare, and was determined by a combination of the budget and the bid distribution.[14] The estimated labor costs were 81 percent higher than the auction price, and 30 percent higher than the median bid. With the estimated labor costs, the contractor could have only purchased 6.7 to 7.1 hectares, as opposed to the 25 hectares purchased through the auction.

An auction mechanism faces two important potential limitations. Firstly, landholders must have private information about costs. If costs are derived entirely from a common value embedded in contract implementation, then the auction will not be able to truthfully reveal any private information (or the auction mechanism is not *incentive compatible*). Secondly, participants must understand the

[14] Total hectares of conservation activity purchased was determined by the budget restriction and by the plot size of the marginal winning bids. In the first site, the budget was not fully used because the price for including an additional plot exceeded the available funds.

mechanism well enough to be influenced by the competitive nature of the bidding process. By holding seven trial rounds prior to the final allocation round, the Sumberjaya auction design allowed for learning about common values and the auction mechanism. Follow-up survey data on participant impressions and information from contract monitoring suggested whether or not both of these assumptions were satisfied.

3.5.1 Factors Influencing Amount of Final Bids

The objective in analysing the bid outcomes was to understand the socioeconomic factors that influence auction participants when submitting their final bids. Factors influencing the amount of final bids were categorized as respondents' characteristics (assets, age, education, number of household members, and number of years owning farming land), the physical characteristics of the land (slope, position, soil texture and color, vegetation type, and distance to road), social capital and conservation awareness (past conservation investment, current conservation investment, access to assistance from the government, and internal and external trust), and risk and time preferences (Table 15).

The observable variables, such as the characteristics of respondents, their land, social capital, conservation awareness level, and risk and time preferences, had low explanatory power for the submission of final bids. The adjusted R^2 value from the regression analysis was 0.1423 and the regression was only slightly significant. However, the model shows that the mean of the final bid submitted by farmers owning coffee gardens with multistrata systems was relatively lower and significant at 5 percent, compared to the mean of the final bid submitted by farmers owning monoculture coffee gardens with shade coffee. Farmers with mixed crop coffee submitted lower bids compared to farmers with monoculture and shade coffee. Farmers owning land on steeper slopes submitted lower bids compared to farmers with land on flat and medium slopes. This result was at odds with our hypothesis that steeper land is usually more costly than flat land. Farmers with sandy clay soil submitted higher bids compared to farmers with clay soil (this was assessed by interpreting soil texture data). Sandy clay soil is easier to cultivate compared to clay soil. The distance to the road variable was significant at 10 percent and farmers with land further from a tarmac road submitted higher bids, revealing that farming practices far from roads bear an increased cost.

There was a significant difference of 15 percent between the mean final bid submitted by farmers with intermediate time preferences compared to the mean final bid of farmers with moderate or almost neutral time preferences. People with a higher discount rate submitted lower bids. People with a higher discount rate were judged more likely to be impatient, implying a greater propensity to consume now, rather than later, and a tendency to be less motivated by future consequences (Reyes-Garcia et al 2007; Skog 2001).

Table 15. Factors Influencing the Submission of Final Bids in Logarithmic Scale

Variables	Coefficient	Standard Error	P > | t |
Respondents' characteristics			
Asset[1]	0.0911	0.1172	0.44
Age	0.0086	0.0081	0.29
Education	0.0288	0.0295	0.33
Number of HH family members	0.0791	0.0723	0.28
Number of years owning land	-0.0020	0.0099	0.84

Variables	Coefficient	Standard Error	P > | t |
Social capital and conservation awareness			
Experience in applying conservation techniques in the past	-0.2176	0.3019	0.47
Availability of any current conservation techniques	-0.0402	0.2057	0.85
Assistance from government	0.2166	0.1949	0.27
Trust			
Trust in community	-0.0737	0.2429	0.76
Trust in outsiders	-0.0052	0.3461	0.99
Physical characteristics of the land			
Slope			
Flat	-	-	-
Medium (15-25%)	-0.0734	0.2748	0.79
Steep (25-40%)	-0.4419	0.2212	0.05**
Position			
Top	-	-	-
Middle	0.0466	0.2539	0.86
Bottom	-0.2565	0.1759	0.15
Soil texture			
Clay	-	-	-
Sandy clay	0.4172	0.2529	0.11*
Sand	-0.2359	0.2309	0.31
Soil color			
Black	-	-	-
Red	-0.2151	0.2111	0.31
Yellow	-0.1112	0.2096	0.60
Vegetation structure of coffee garden			
Monoculture coffee	-	-	-
Shade coffee	0.3416	0.4253	0.43
Multistrata coffee	-0.3989	0.2437	0.11*
Distance to road	0.0083	0.0046	0.08**
Risk and time preferences			
Risk preference			
Risk averse	-	-	-
Risk neutral	0.2206	0.2631	0.41
Risk loving	-0.1720	0.1912	0.37
Time preference			
Almost neutral	-	-	-
Moderate	-0.1010	0.8540	0.91
Intermediate	-0.7195	0.4693	0.13*
Severe	-0.3407	0.3337	0.31
Extreme	-0.2776	0.2292	0.23
N = 82			
Prob > F = 0.1029			
R-square = 0.4282			
Adj R-Sq = 0.1423			

Notes:
[1] in logarithmic scale
*** Significantly different values at the 5 percent level
** Significantly different values at the 10 percent level
* Significantly different values at the 15 percent level

3.6 Auction Applicability and Aftermath

3.6.1 Design Factors: Farmers' Understanding of Auction Design and the Auction Aftermath

A post-auction interview revealed that most farmers understood the rules when implementing the conservation auction (Table 17). Three farmers out of 48 (4 percent) did not understand the rules and all of them lost. About 32 percent of the farmers, both winning and losing, understood the rules very well. Most farmers were satisfied with the completeness of information provided by the facilitators when implementing the auction. The participants found it relatively easy to understand the rules for implementing the auction and for deciding the winners. The wining farmers interpreted the rules more easily compared to the losing ones. Most farmers thought that the auction process and the determination of the winner had been conducted fairly (88 percent). The farmers who felt that the auction was unfair mostly lost. Most farmers (78 percent) were fully aware that competition was taking place the auction participants in order to win the contract and that the budget of auctioneer was limited.

Table 16. Descriptive Analysis of Post-auction Technical Factors

Variable	Frequency Non-contracted (N=48)	Frequency Contracted (N=34)	**Total**
Understanding of the auction rules			
Not understand at all	3 (0.06)	0 (0.00)	3
Moderately understand	16 (0.33)	8 (0.24)	24
Quite understand	11 (0.23)	12 (0.35)	23
Understand	3 (0.06)	3 (0.09)	6
Understand very well	15 (0.31)	11 (0.32)	26
Complexity of the auction rules			
Very difficult	2 (0.04)	1 (0.03)	3
Quite difficult	17 (0.35)	14 (0.41)	31
Quite easy	7 (0.15)	10 (0.29)	17
Easy	18 (0.38)	7 (0.21)	25
Very easy	4 (0.08)	2 (0.06)	6
Fairness of the auction implementation			
Not fair	7 (0.15)	3 (0.09)	10
Fair	41 (0.85)	31 (0.91)	72
Awareness of competition among participants			
Not aware	10 (0.21)	9 (0.26)	19
Aware	38 (0.79)	25 (0.74)	64
Contract value received			
Too low	19 (0.40)	5 (0.15)	24
Not too low	17 (0.35)	17 (0.50)	34
Moderate	12 (0.25)	12 (0.35)	24

High	-	-	-
Too high	-	-	-
Willingness to change the offer			
Yes	12 (0.25)	12 (0.35)	24
No	36 (0.75)	22 (0.65)	58

Note: proportion in parenthesis

As predicted, about 40 percent of the losing farmers considered the contract value per hectare to be too low. About 70 percent of all participants found that the value was either not too low or moderate. The median appropriate total amount of contract value per hectare according to interviewed farmers was USD 246 (Rp. 2,000,000) or about 12.5 percent higher than the cut-off price. Most of them would be likely to change their previous bid if they had another chance to offer a new bid. From the follow-up interview, however, we found that 32 percent of farmers wanted to change their previous bids, 28 percent of farmers would decrease their offer and the remaining 40 percent of farmers would increase their offers. A statistical test revealed that the average final bid as the result of the auction differed to the mean of the appropriate amount of contract value in the participants' opinion after the auction (Table 18). The overall value proposed after the auction was higher.

Table 17. Contract Value per Hectare Offered by Farmers after Auction

Variable	Mean	Standard Deviation	Minimum	Maximum	P-value
Appropriate total amount of contract value per hectare	246	120	161	753	0.0000***

N: 80 individuals

*p<.15, **p<.10, ***p<.05

We used the framework of bid adjustments during the trial as a proxy way of learning (Jack 2009) to further investigate farmer responses about understanding the auction process (Table 18). The independent variable was *bid adjustment for each respondent at each round* and the dependent variables were parameters representing farmers' perceptions of design factors such as *understanding of auction rules, easiness of the rules*, *fairness of the auction process* and *awareness of competition between participants*. We found that farmers who stated that they —understand" the auction rules had reliable different mean of bid adjustments compared to the average mean of bid adjustment of farmers who stated —not understand at all", "moderately understand", and —quite understand". Farmers who thought that the auction rules were quite easy adjusted their bids upward compared to those who stated that the auction rules were very difficult or difficult (level 1 and level 2). We analyzed the mean bid adjustments of famers who were aware of competition and found a significant difference compared to the means of farmers who were not aware of competition. The latter had a lower mean of bid adjustment.

Table 18. Farmers' Understanding of Auction Design

Variables	Coefficient	Standard error	P-value
Understanding of the auction rules			
Not understand at all	-	--	-
Moderately understand	-0.1077	0.06	0.09**
Quite understand	-0.0262	0.05	0.57
Understand	-0.1035	0.05	0.03***
Very understand	-0.0121	0.05	0.80
Easiness of the rules			
Very difficult	-	-	-
Difficult	-0.0019	0.07	0.98
Quite easy	-0.0856	0.04	0.04***
Easy	0.0112	0.05	0.82
Very easy	0.0191	0.05	0.70
Fairness of the auction implementation			
Not fair	-	-	-
Fair	0.0054	0.04	0.90
Awareness of competition between participants			
Not aware	-	-	-
Aware	-0.0604	0.04	0.14*
Number of observation = 492			
Number of groups = 82			
Wald chi-square(12) = 49.94			
Prob > chi-square = 0.00			

Note:

*p<.15, **p<.10, ***p<.05

3.6.2 Social Factors: Impact on Communities

As far as social conditions and interaction among community members was concerned, the auction participants experienced slightly significant changes (Table 19). There was a statistically significant 5-percent difference between the non-contracted and contracted farmers when evaluating the relationship between winners and losers. Non-contracted and contracted farmers had an almost similar perspective on interpersonal relationships among the community in the *talang* after the auction. The impact on information exchange between farmers was statistically significant at 10 percent. The contracted farmers gave better evaluation of the social impacts of the auction and of conservation contract activities compared to the non-contracted farmers.

Table 19. Perspective of Non-contracted and Contracted Farmers on Social Impacts

Variable	Frequency Non-contracted (N=48)	Frequency Contracted (N=34)	Fisher's exact test P-value
Impact on relationships between winners and losers			0.143*
Very bad	0 (0.00)	0 (0.00)	
Bad	5 (0.10)	6 (0.18)	
Quite good	17 (0.35)	9 (0.26)	
Good	21 (0.44)	19 (0.56	
Very good	5 (0.10)	0 (0.00)	
Impact on general interpersonal relationships among the community			0.175
Very bad	0 (0.00)	0 (0.00)	
Bad	3 (0.06)	2 (0.06)	
Quite good	18 (0.38)	13 (0.38)	
Good	21 (0.44)	19 (0.56)	
Very good	6 (0.13)	0 (0.00)	
Impact on information exchange between farmers			0.055**
Very bad	1 (0.02)	0 (0.00)	
Bad	7 (0.15)	0 (0.00)	
Quite good	19 (0.40)	17 (0.50)	
Good	13 (0.27)	14 (0.41)	
Very good	8 (0.17)	3 (0.09)	

Note: proportion in parenthesis

3.6.3 Environmental Factors: Awareness of Conservation and Rate of Accomplishment

There were no significant differences between contracted and non-contracted farmers of their awareness and willingness to implement soil and water conservation on their land (Table 20). Some farmers expressed the view (via interviews) that enthusiasm amongst farmers for conserving the environment and for land conservation practices improved after the training, meeting and auction process.

Table 20. Perspective on Environmental Impacts from Non-contracted and Contracted Farmers

Variable	Frequency Non-contracted (N=48)	Frequency Contracted (N=34)	Fisher's exact test P-value
Awareness of soil and water conservation			0.188
Very bad	0 (0.00)	0 (0.00)	
Bad	2 (0.04)	1 (0.03)	
Quite good	30 (0.63)	16 (0.47)	
Good	7 (0.15)	12 (0.35)	
Very good	9 (0.19)	5 (0.15)	
Willingness to implement soil and water conservation			0.340 (0.509)
No	2 (0.04)	0 (0.00)	
Yes	46 (0.96)	34 (1.00)	

Note: results from two-sided Fisher's exact test are in parenthesis. The others are calculated from one-sided Fisher's exact test

For the frequency column, proportion is in parenthesis

3.7 Contract Monitoring

The research team conducted alternate qualitative and quantitative monitoring activities in the field every three months. The qualitative monitoring gathered information on contract implementation by using open-ended questions. The enumerators checked the general quality of the conservation structure and asked farmers whether or not they had any difficulty implementing their contacts. During the quantitative monitoring the enumerators counted the numbers of sediment pits, grass strips, and ridging. They measured the size of sediment pits and observed the quality of the grass strips and ridging. They also surveyed social interactions between farmers and other conservation structures that were not required by the contract, such as water drainage and terracing. This monitoring involved two external evaluators from the District Forestry Service who independently gave scores on the farmers' accomplishments. The head of the village accompanied the team as a witness to fair evaluation. Farmers who could not accomplish at least 50 percent of the contracted activities had to give up and could not continue their contracts. At the final monitoring, the implementing agency paid the remaining fund to farmers who accomplished at least 80 percent of the contracted activities.

Most farmers built good quality ridging. The quality of ridging improved after the observation conducted in Phase 1 of the monitoring (three months after signature of contract). Out of 34 contracted farmers, three farmers had to amend their ridging and one farmer had not instituted any ridging at all. Almost all of the farmers constructed sediment pits of the required size and standard. Two farmers failed to fulfill the 50 percent target of the total number of sediment pits required. However, in general, most of the farmers achieved above and beyond the contract for the construction of both ridging and sediment pits. The average total achievement in Wanasari 1 was 86 percent and 102 percent in Mulya Indah. The planting of grass strips was problematic. Only half of the farmers planted the grass due to the dry season and the difficulty of finding seeds. Most farmers prioritized the ridging and sediment pits instead and put off grass planting in the meantime. The coffee harvesting season also delayed the grass-planting process.

A contract with a farmer from Wanasari I (Site 2) had to be terminated because of poor performance (only 4 percent accomplishment). The exit interview revealed that the main reason for the farmer‘s poor performance was the higher opportunity cost of getting jobs beyond than the contract‘s value. Because of his lower economic status compared to others and his small landholding of only 0.5 hectare, the farmer had to spend most of his time working as a farm laborer, leaving him little time to manage his own coffee garden. However, the farmer affirmed that the auction was fair and that the conservation program was important in motivating farmers to conserve their lands.

3.7.1. Second Qualitative Monitoring and Final Quantitative Monitoring (Phases 3 and 4)

During the final quantitative monitoring, most of the farmers showed good progress in implementing their contracts. Table 21 compiles the results of how they implemented the conservation efforts stipulated in their contracts. They excelled in constructing ridging (128 percent accomplishment) and sediment pits (114 percent accomplishment, but they lagged behind in making the vegetative strips (88 percent accomplishment). They also practiced other conservation techniques like the building of terracing and drainage that could optimally support the contracted conservation efforts. All the farmers constructed terracing, which could be done simultaneously with ridging. Half of them built drainage systems.

Table 21. Conservation Results at the End of the One-year Contract

Site	Ridging				Sediment pit				Vegetative strip			
	I	%	II	%	I		II	%	I		II	%
Site 1												
Talang Kuningan	313	**180**	313	**180**	1583	**95**	1789	**111**	212	**122**	223	**128**
Talang Harapan	175	**97**	188	**104**	1178	**93**	1339	**106**	23	**13**	75	**42**
Sub-total Site I	488	**138**	501	**142**	2761	**94**	3128	**109**	235	**66**	298	**84**
Site 2												
Wanasari I	254	**112**	265	**124**	1989	**111**	1986	**124**	59	**26**	200	**93**
Talang Anyar	184	**95**	208	**107**	1258	**99**	1448	**114**	103	**53**	170	**88**
Sub-total Site II	438	**104**	473	**116**	3247	**106**	3434	**120**	162	**38**	370	**91**
Total	926	**121**	974	**129**	6008	**100**	6562	**114**	397	**52**	668	**88**

Note: I: Mid-term monitoring; II: Final monitoring

At Site 1 (Talang Harapan and Talang Kuningan), two farmers failed to construct ridging (72.2 percent and 76.5 percent, respectively) and two others failed to build sediment pits (75.8 percent and 76.8 percent, respectively); these farmers all came from Talang Harapan. Only 10 farmers, or half of them, successfully planted the vegetative (grass) strip. They chose the right types of grass (local names: *Satria Lampung* and *Gagajahan*). These grasses were suitable for fodder and for terrace construction.

The farmers‘ cited the same reasons they gave during the mid-term evaluation for failing to plant grass strips; it was hard to find grass seedlings and to plant during the dry season, they were busy with other non-farming activities, and the construction of ridging and sediment pits were the priorities. By contrast, all the farmers in Talang Kuningan accomplished the contracted activities, including the grass planting. We later found out that because most of the farmers raised livestock (goats), they planted grass for fodder as well as for conservation. Farmers in Talang Harapan may need to be motivated in the drive to make them responsible for planting strip grass as this planting is, after all, still a new conservation approach for farmers in Sumberjaya. Nine farmers from Site 1 (47 percent out of 19 farmers) failed the criteria during the final monitoring and evaluation.

All the farmers at Site 2 constructed the ridging. One farmer accomplished only 74 percent of the contacted agreement on ridging, but he was rated as having passed the contract because most of his land was located on very steep slopes. One farmer failed to construct the correct number of sediment pits (only 26 percent accomplishment). Five farmers were not successful at planting grass strips. In total, five farmers from Site 2 (36 percent out of 14 farmers) did not accomplish their contracts.

In summary, 19 out of 34 farmers successfully accomplished their contracts. This translates to 55 percent accomplishment between the two sites. Fourteen farmers did not pass the final evaluation and one farmer failed at the mid-term evaluation. Most of the farmers failed to plant the grass strips, although many of them constructed both ridging and sediment pits, and some farmers even exceeding the contractual agreement. We decided that, finally, the percentage of accomplishment would not be calculated cumulatively. We did not add up all the percentages but evaluated them individually. Therefore, farmers who failed one of the contracted components were considered to have failed and did not receive the final payment. Although the rate of accomplishment could be categorized as low, we could not conclude that the overall conservation effort was unsuccessful. Table 22 shows that the rate of accomplishment was more than 80 percent for all contracted techniques: ridging (128 percent), sediment pits (114 percent), and grass strips (88 percent).

Each *talang* (hamlet) of the two sites had different rates of success in accomplishing their contracts. At Site 1, all the farmers (100 percent) in Talang Kuningan fulfilled their contractual agreements, while in Talang Harapan, no farmer received the final payment. The rate of success at Site 2 was higher (67 percent) and well-distributed at each *talang* compared with Site 1, which had a success rate of 47 percent.

Table 22. Rate of Contract Accomplishment

	Total number of farmers	Number of failed farmers	Rate of success (%)
Site 1	**19**	**10**	**47**
Talang Kuningan	9	0	100
Talang Harapan	10	10	0
Site 2	**15**	**6**	**67**
Wanasari I	10	4	70
Talang Anyar	5	2	60

The contractual arrangements between the two sites were different. At Site 1, two farmer groups (one from each *talang*) signed the contracts. The members arranged working in rotation, shifting from one plot to another until all the contracted activities were finalized. At Site 2, farmers signed the contract individually with ICRAF. In other words, there were two contracts at Site 1 and 15 contracts at Site 2. Obviously, these different contractual arrangements and institutions influenced the rate of success of each *talang*.

In the exit interviews most of the Talang Harapan farmers cited a lack of leadership and a lack of coordination as the major reasons why their group was not motivated to perform well. The field assistant observed that the group did not choose the leader voluntarily, and the group leader was not an active community member. They also lacked time because of other activities, such as harvesting coffee, working in rice fields, working in other gardens, engaging as daily laborers, and renting motorbikes. They also cited unsuitable weather. In reality, many of the other farmers easily found grass seeds to plant and were able to fully accomplish their conservation activities during the current weather. However, most of the farmers felt that they could not accomplish the contract at the sixth-month point because this coincided with coffee harvesting. Some of them also assumed that getting a low score at the mid-term evaluation would influence the final result, hence lowering their enthusiasm for finishing the contract.

The farmers suggested some improvements to increase the conservation program‘s rate of success. At least six farmers proposed having individual contracts rather than a group contract because weak coordination between members could make the whole group fail. They also suggested that some contract components should be more flexible. Most of the farmers agreed that there should be sanctions and that the current sanction was suitable. None of the farmers had a problem with the design of the auction and the contractual agreement. An analysis found that that there was no reliable difference between farmers who fully complied with the contract and those who failed when conservation awareness level, understanding of the auction design (rules, complexity), information quality, and the level of satisfaction was taken into account (Table 23).

Table 23. Comparing Farmers who Complied and did not Comply with the Contracts

Variables	Frequency Non-contract compliance (N=15)	Frequency Contract compliance (N=19)	Fisher‘s exact test P-value
Understanding of the auction rules			0.790
Not understand at all			
Moderately understand	3 (0.20)	5 (0.26)	
Quite understand	4 (0.27)	6 (0.32)	
Understand	2 (0.13)	1 (0.05)	
Very understand	4 (0.27)	7 (0.37)	
Easiness of the rules			1.00
Very difficult	- (0.00)	1 (0.05)	
Difficult	6 (0.40)	8 (0.42)	
Quite easy	5 (0.33)	5 (0.26)	
Easy	3 (0.20)	4 (0.21)	
Very easy	1 (0.07)	1 (0.05)	
Competitiveness of the auction			1.00

Aware	4 (0.27)	4 (0.21)	(0.506)
Not aware	11 (0.73)	15 (0.79)	
Awareness of soil and water conservation			0.354
Very bad	0 (0.00)	0 (0.00)	
Bad	0 (0.00)	1 (0.05)	
Quite good	5 (0.33)	11 (0.58)	
Good	7 (0.47)	5 (0.26)	
Very good	3 (0.20)	2 (0.11)	
Quality of the information provided by facilitators during the auction			0.803
Very bad	- (0.00)	- (0.00)	
Bad	2 (0.13)	2 (0.11)	
Quite good	6 (0.40)	11 (0.58)	
Good	6 (0.40)	5 (0.26)	
Very good	1 (0.07)	1 (0.05)	
Completeness of information provided			0.347
Very unsatisfying	0 (0.00)	0 (0.00)	
Unsatisfying	0 (0.00)	1 (0.05)	
Quite satisfying	7 (0.47)	11 (0.58)	
Satisfying	6 (0.40)	7 (0.37)	
Not satisfying	2 (0.13)	0 (0.00)	

3.8 Effect of Contract Implementation on Sedimentation Reduction

The conservation activities were conducted in two sub-watersheds: Way Ringkih (Site 1: Talang Harapan and Talang Kuningan) and Way Lirikan (Site 2: Wanasari 1 and Talang Anyar). The field researchers took water samples three times a year: June, November, and December 2007, at three observation points located at the final outlet of the Way Ringkih and Way Lirikan River, before it enters the Way Besai, and at the end of Talang Kuningan stream before it flows into Way Ringkih. At the first two points, the sedimentation data for 2005 was available for comparison.

The effect of a one-year contractual agreement to reduce river sedimentation fluctuated. In Way Ringkih the sedimentation rate at the beginning of December 2007 was higher, then became lower, at the end of December 2007 compared with the rates from 2005 to mid-2007. In Way Lirikan, the sedimentation rate in December 2007 was consistently lower than the rates in 2005 to mid-2007. In general, compared to the sedimentation rate calculated from 2005 to mid-2007, the sedimentation rate at the end of the contract (December 2007) was likely to be lower at both sub-watersheds. In Way Lirikan, the decrease of the rate of erosion was lower than in Way Ringkih because River Care program activities were already being carried out in the area during roughly the same period. River Care is a collective action to reduce sedimentation that includes repairing the riverbank, compacting dirt paths, dredging river mud and building small dams to retain erosion.

The conservation activities of the conservation auction project, however, are not the main factors in decreasing sedimentation rates – the scale of conserved land under the contract was too small, covering only 25 hectares, and the one-year contract period was too short. It takes between 10 and 50 years for real erosion reduction to take place at watershed scale[15]. Living and dead plant biomass, vegetative cover, soil structure and the amount of rainfall are just some of the factors that can influence erosion (Verbist, 2008; Pimentel et al., 1995).

[15] Dillaha, T. 2007. Monitoring Changes in Hydrologic Response due to Land Management Changes at the Watershed Scale: Time Lag and Other Issues. Presented at the Global Event on Payment/Reward for Environmental Services, Mataram, Indonesia, 22-27 January 2007.

4 CONCLUSION AND RECOMMENDATIONS

Based on the outcomes from the laboratory and field experiments and theoretical considerations, the design of this auction was a sealed bid auction with budget constraints, the random tie-rule, the uniform pricing rule, minimized collusion, the announced ID numbers of provisional winners and an announced number of rounds. The auction followed a fairly standard format, with a single buyer and multiple sellers submitting sealed bids representing their willingness to accept the soil conservation contract for their plot. Bids were assessed according to a per-hectare price and the cut-off price was determined by a pre-set budget constraint.

Our auction design considered choosing the uniform price rule for equity reasons. Literature on auction design has argued that uniform pricing is more likely to reveal farmers‘ true opportunity cost because bidders only determine the chance of winning. However, uniform pricing is relatively cost-ineffective compared to the discriminative price rule. We analyzed some factors in choosing the uniform price rule, such as bidding strategy, transaction cost, fairness, political interests, the efficiency of ES buyers, the effect of risk aversion, and the effort of over-bidding.

The auction was a multiple round auction consisting of eight rounds with a final binding round. The benefit of multiple rounds was that farmers learned from each round of the auction. However, the announced last round may introduce forms of strategic behavior. Concealing the number of rounds makes participants more uncertain because they use their own subjective probability distribution about the chance of being in the last round. By announcing the last round, we combined the benefits of the farmers‘ learning via the previous rounds and the advantages of a one-shot auction for the last round.

The bids submitted by farmers were independent of farmers‘ observable factors. The analysis shows that farmers‘ learning during the auction process had a positive influence on their winning frequency. Levels of farmers‘ understanding of the auction mechanism were satisfying and farmers did understand the nature of competitiveness and budget limitations during the auction. The participants considered the auction mechanism to be fair. The farmers who had the greatest understanding of the auction were aware of competition between participants and thought that the auction was not complicated – these farmers tended to win the auction. From a social perspective, the auction and conservation contract with cash payment did not have any negative effects on relationships between community members. In conclusion, we interpret that the design is acceptable and doable for rural setting in developing countries.

Finally, the rate of accomplishment was moderate. There were various reasons for this, ranging from a lack of leadership and coordination between members of the farmer‘s groups, to the difficulty of finding grass seedlings, to a conservation activity‘s clash with coffee harvesting time. In this specific case, private contracts tend to be more successful than a collective contract where leadership is lacking or there is no ‗champion‘ amongst the community members. Institutional factors and contract flexibility sometimes influences the accomplishment of conservation efforts. Our analysis showed that there were no significant differences in levels of understanding, complexity, competitiveness, and conservation awareness between farmers who complied with the conservation contracts and those who did not comply.

The limitation of this study is that we treated all the units of our pilot site as homogeneous, rather than heterogeneous, in their contribution to erosion and downstream sedimentation. These sites' contribution to environmental services was also heterogeneous and tied to hydrological and geophysical factors that are unlikely to be correlated to cost. The emphasis at the pilot stage was to assess the feasibility of the approach and to understand the drivers of the willingness to accept. Hence, we recommend in future researches a scoring rule that would give higher values to plots that contribute more to downstream problems. For instance, plots that are more steeply sloped and closer to rivers and streams can be assigned higher values to enhance the cost effectiveness of a larger scale auction. The simplifications in the pilot auction were deemed appropriate for the research and valuation intentions of the study. For a larger scale allocation auction, modifications like using a supply curve resulting from this procurement auction would be more appropriate. Any valuation information provides a reasonable platform for designing a scaled-up fixed payment scheme, including differential rates and eligibility rules necessary for targeting participants.

The design of experimental auctions should fit the purpose of the overall objectives of a conservation program. In this case our design challenge was a fair auction design for farmers with low levels of formal education who are prone to social conflicts and are influenced by the power structure within their community. Some potential further analysis of the auction and conservation contract design could include comparing farmers' behavior under the hypothetical framed and real natural field experiment, analyzing factors contributing to contract compliance and farmers' adaptation to conservation, and the efficiency of the auction compared to other methods for ES budget allocation.

The research team performed the monitoring of actual sediment loads to evaluate the environmental effectiveness of the approach, though payments did not depend on the final outcomes but on compliance with the proxies. As expected, due to the small plot size and limited time, the effect of contract implementation on river sedimentation was fluctuant. In general, compared to the sedimentation rate calculated from 2005 to mid-2007, the sedimentation rate at the end of the contract (December 2007) was likely to be lower at both sub-watersheds. The best conditionality in performing a PES scheme in theory should be based on environmental outcomes, such as the sedimentation reduction rate. However, the program designers and relevant stakeholders, including environmental service buyers and policy makers, should consider the scale of the project and the time lags and program the budget with the expectation of an incremental level of environmental services.

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