ON STRUCTURED BUYER-SELLER NEGOTIATION FOR AGRICULTURAL LAND ACQUISITION - SIMULATION EXPERIMENTS WITH RULE-BASED MODELS AND UTILITY FUNCTIONS

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The acquisition of land from landowning communities for the purpose of expanding industry has been a part of economic strategy in many developing countries in the past decade. The lack of a structured negotiation framework to ensure equity and transparency in the process of acquisition has been an important issue in many of these countries, particularly India. Among the core issues are the lack of a well defined process framework, authorized regulatory and statutory entities to participate and oversee the process, and transparent mechanisms for calculating and communicating offers and valuations between the buyer and the seller communities. There is a need to explore alternative negotiation frameworks and models for calculation and valuation of bids and asks which can ensure an adequate level of equity and transparency. The models must ensure that the compensation packages cover certain basic needs of the small and medium farmers for whom loss of land is also loss of livelihood.

In this paper, we propose a framework for land acquisition negotiations in which mathematical models for the buyer generate price offers not only for land but also wage and other compensations. We also present utility-based models and a rule base for the seller to evaluate the offer, and mechanisms for the seller's responses to be communicated via intermediaries to the buyer in cycles of negotiation. Using simulated data representative of the agricultural land scenario in India, we explore ways in which the models and the framework could be used to support diverse and realistic land acquisition situations. Software for the implementation of the mathematical models and rule engine for evaluation of the bid-ask process described in this paper have been developed by the authors. The software can be customized for specific applications.

I. INTRODUCTION

In recent years, several large-scale land acquisition attempts for the purpose of expanding India's industrial footprint have been stuck in the quagmire of controversy. There has been both public outcry and serious published critiques (Sangvai 2006, Basu 2007, Chandra 2008, Sau 2008, Gupta 2008, Sanhati 2008, Banerjee et al 2007, Morris and Pandey 2007) that point to important lacunae in the process of land acquisition. There is also a raging debate on an array of legal and socio-economic development issues that

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seem to stand in the way of individual corporate efforts at the state level to acquire large parcels of land for industry. It is estimated that an investment of over $600 billion for about 200 proposed special economic zones (SEZs), many of which would require at least 1,000 hectares of land across India, has been held up due to land acquisition issues. It also appears that a complex combination of competitive pressures to draw large-scale private investment to state hinterlands in the hope of enhancing employment prospects often conflicts with the needs of industry to locate itself in close proximity to available resources of industrial/transportation infrastructure and labour. This very often places selected locations squarely in the midst of agricultural land rather than wasteland.

The result is that buyers have sought to acquire agricultural land from communities of farmers. Despite a few success stories, many efforts have largely been ineffectual, often leaving the potential selling community seeking aggressive, sometimes violent means to stave off what they consider “forced” acquisition attempt at highly “unreasonable” prices (Debroy 2008, Datta 2008, Das 2007). The situation has naturally been worse in cases where the large land parcel sought is highly fragmented with a larger proportion of marginal and small farmers, for whom loss of land is also equivalent to loss of livelihood. Valuation and pricing of such land is evidently a tricky trade-off, for it can impact not only the farming community but also the very financial viability of the industry whose presence and eventual growth is expected to lift substantial proportions of the farming community, especially small and marginal farmers, out of a potentially unsustainable income de-growth cycle (Bhaduri 2007). The problem is further exacerbated in regions where large populations continue to live off the land without proper titles, and when quasi-legal categories of rights are created by local governments for such communities (such as West Bengal, India).

At the core of the problem are a number of socio-economic, community development, legal and process issues that do not seem to address the concerns of the seller community.

The central concerns that have been articulated in current literature are:

(a) The legal framework is archaic and does not adequately secure the position of the sellers, even in the newly amended draft Act (India 2007a, India 2007b);

(b) Rates per hectare of agricultural land are not arrived at by negotiations in a scientific and transparent manner, but fixed using rather arbitrary and ad hoc mechanisms;

(c) The net compensations for marginal and small farmers do not adequately ameliorate their social standing through the provision of opportunities for alternative livelihood and/or sources of secure future income, rather they take away their only source of current income, however meagre;

(d) The process of acquisition often lacks transparency, the larger issue being the lack of a regulatory and ombudsman framework which can guide the process in the interest of equity and fairness to both buyers and sellers.

Many of the above issues have defied easy solutions. There have been reports of several debates on the legal aspects of how "public purpose" has come to mean "forced" acquisition (Basu 2007, Sau 2008). In this paper, however, we shall not concern ourselves with any of these legal aspects of land acquisition. Interestingly, in comparison with several other countries (Alias and Daud 2007), there is no mention of a *required* "negotiation" process for acquisition of land between buyers and sellers even in the new draft laws under consideration in India. Nevertheless, informal exchanges of bids and asks between the buyer, middlemen, and prospective sellers that have been followed in a majority of cases in India have, we believe, been one of the primary sources of conflict and confusion (Das 2006, Sanhati 2008). A structured negotiation framework is hence a key requirement for addressing this issue.

The "market" rate for agricultural land has defied a "standardized" index because of several factors, not the least of which is a transparent and honest registration process. As has been pointed out (Vijapurkar 2007b), averages over past years taken from neighbouring areas do not offer the benefit of a prospective growth to the seller. Other issues in this sphere point to a "speculative hold-out" by some sellers, which gives them an unfair bargaining position, while of course delaying closure of the negotiation (Bhaduri 2007). Most current proposals utilize some variation of a "guidance value" modulated by a "solatium" as a starting point. Equally, little has been said on a sound mechanism for sellers to evaluate an offer.

Our focus here is primarily on the mechanics of negotiation and on how to ensure transparency and equity in a process, which mandates that components of compensation be provided in order to protect the interests of the marginal and small farmer. While the data and context for the description of the problem have been taken to represent India in particular, we believe the overall solution approach may well be applicable to many other developing economies.

In this paper, we shall explore the possibility of building a structured approach to address the last two of the above concerns. Specifically, we propose a process by which the buyer and a group of potential sellers can arrive at a conclusive package of compensation for land through cycles of exchange of information capturing aggregate rates for compensation components. Our proposed process of negotiation requires that individual choice on the levels of compensation for each seller be collated and communicated to the buyer in such a manner as to avoid compromising the buy-sell posture of either economic agent while offering a degree of transparency through the definition of a scale-based response at the individual level. This exchange calls for intermediaries with specific roles, such as for financial intermediaries, potential government regulatory bodies or ombudsman bodies, and village-level or non-governmental organization (NGO) bodies. Within this structured framework for information exchange, we consider buyers and sellers as individual economic agents that evaluate compensation packages in accordance with the achievement of economic utility.

In order to explore the decision space in a quantifiable manner, we shall build mathematical models for the offers that the buyer can make, and similarly for the individual sellers to evaluate in terms of their own utility functions. We explore the possibility of a

lexicographically ordered scale as the means to convey seller positions, so that the buyer can rework offers to begin subsequent negotiation cycles. We have also proposed overall measures to evaluate the impact of the transaction in terms of costs and benefit at the individual as well as community levels.

The models have been tested through simulation using two data sets representing a fictitious buyer and groups of sellers, whose overall demographic and landowning characteristics have been closely matched to real distributions of land owning patterns in rural India. The results of the application of the framework, buyer and seller models on the data are analysed to evaluate the utility of the concepts herein. Software for implementation of the mathematical models and rule engine for evaluation of the bid-ask process described in this paper have been developed by the authors. The software can be customized for specific applications.

The organization of the paper is as follows. The next section (section II) presents the buyer's offer model and the seller's valuation model, together with considerations for a framework in which the "bid" and "ask" information could be exchanged to meet the goal of allowing the process to be monitored by a small set of entities, which ensures the integrity of information and fair-play in the transactions. A description of the data generated for the purpose of simulating cycles of negotiation between a buyer and the sellers appears in section III. Section IV summarizes the overall mechanism proposed for initiating and running negotiation cycles, and offers roles and tasks for specific entities that have been proposed. Results of the simulation exercise are presented in section V, and discussions and concluding remarks appear in section VI.

II. APPROACH

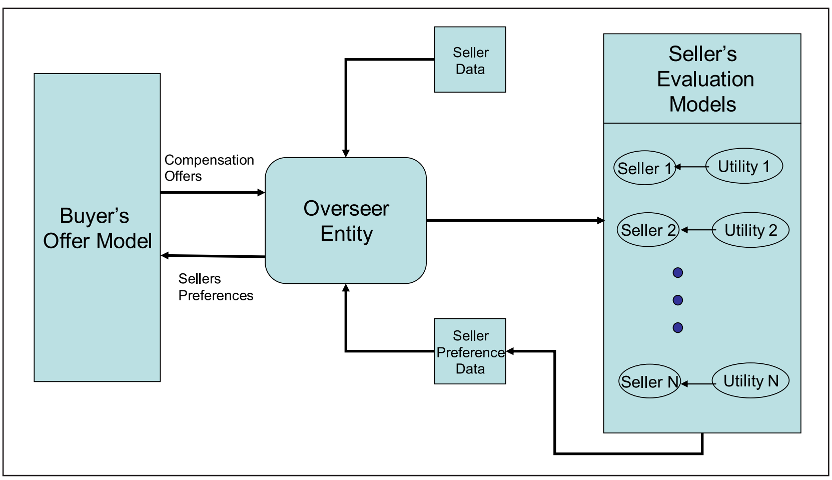
The setting for the decision problem is thought to comprise one prospective buyer who wishes to acquire M hectares of agricultural land owned by N members of a farming community. All M hectares are assumed to be contiguous. The N members are thought to map onto N families for simplicity, although it is quite possible that more than one member of a family might legally own one or more parcels of land. The majority of the N potential sellers are thought to belong to, at most, a small number of communities within the same geographical region.

The land acquisition process is seen here essentially as two coupled decision problems, one, for the buyer, and the other a set of seller decision sub-problems. The information exchanged between these coupled problems forms the substrate for the negotiation process, with each party evaluating the current offer and articulating prospective action. As part of the preparatory process, we shall postulate at this stage the presence of an overseer entity (OE) that regulates the flow of this information between the buyer and the seller, maintaining the integrity of the information, and recording the changes for each side.

We shall first set preconditions for the process. One precondition is that the buyer shall be required to offer the overall compensation in the form of aggregate (meaning not on a per seller basis) offers for three components: (a) an aggregate sum towards immediate compensation for land alone; (b) an aggregate phased payment towards wage and other compensations; and (c) an aggregate sum set apart for the social development of the selling community as a whole. In a typical scenario, the buyer would be required to set up an initial budget and allocate proportions of it for the three components; zero proportions shall not be allowed. In order to pursue the negotiation, the buyer will require certain basic information on the status of the M hectares, the N sellers, and their current holdings distribution and demographics. Such information shall be assumed to be available from the above OE – another precondition. The buyer shall thus disclose to OE sums as described in (a) through (c) above. The OE shall be tasked to break down the sums as net subpart compensations for each seller on the basis of individual utilities. These break-ups shall not be disclosed to the buyer.

Some further explanation of this precondition is in order. Let us start with the price of land. As is well known, the price of a hectare of agricultural land intended for agricultural use is really related to a variety of factors, such as fertility, cropping pattern, potential income, crop yield, availability of storage barn, wells and trees. It is fair to assume that, in a transaction between agriculturists, the buyer and the seller would arrive at the price per hectare by using a combination of experience, knowledge of local conditions and the known history of such transactions in the same geographical area. However, in a situation where the intent is to use the land for industrial purposes, the experience and history can only be used to calculate wages and income, not to determine the primary land price. Hence, the buyer proceeds with negotiations using only a base-line land price, referenced by a notional "market" price. Seller-level assessment of land compensation is driven by individual perceptions. We are now ready to consider a schematic flow for the negotiations, as depicted in figure 1.

Figure 1. Initial schema for negotiations between buyer and seller



We shall see that the above schema can be expanded with the introduction of other entities as we refine the process further. For now, we are ready to explore the buyer and seller valuation models.

Buyer Model

The buyer is not expected to deal directly with individual sellers, but make offers to the OE, using publicly available data on the land holdings covering M hectares. Hence, the buyer can approach the decision problem purely from the perspective of minimizing outflow while obtaining the best possible trade-off between prices or rates paid for the three components of the compensation package. To quantify this trade-off, let us first define three prices.

Let p_1 denote the gross rate per hectare for land, p_2 denote net additional compensation per seller, and p_3 denote net rate per package offered for community development. Note that while p_1 is related purely to land, p_2 is a composite rate per seller comprising compensation for wages lost due to the sale of his land. A buyer could consider offering annual compensation, for instance, for 75 per cent of a year at rates varying from $1.60 a day to a buyer-chosen upper limit. The third rate, p_3, represents a per-package cost for social/community development packages, broadly classifiable as a rehabilitation package. At the buyer end, we assume, these gross rates are sufficient to construct a gross compensation offer. In practice, it is indeed rare to find an industrial buyer attempting to delve down to the finer details in order to arrive at social and community development package prices.

The central theme around which the mechanics of a buyer model are built is to generate offers that fall within a budget for consideration by sellers. The upper limit of the budget will usually be set by a buyer on the basis of a variety of factors, most of which have to do with the alternative industrial use that the buyer will put the land to. How that should be done is clearly outside the scope of the negotiation process. We must simply accept the number provided by the buyer.

We need a simple calculation scheme to generate offers in a non-arbitrary manner, with the assurance that each subsequent offer, if higher than the previous one, is justifiably the best "compromise" among the prices.

The buyer needs to primarily make offers of prices (p_1, p_2, and p_3) to the sellers, given fixed quantities of compensation components, namely, land area (M), number of sellers (N), and number of rehabilitation packages (Q). The offer would be made on the basis of the total budget, b, available to the buyer:

$$b = p_1 M + p_2 N + p_3 Q \qquad (1)$$

We consider these quantities as being fixed because the acquisition is not equivalent to a speculative market commodity purchase, in which a buyer could have determined a "best" batch quantity based on market prices so as to achieve the desired level of utility U.

Instead, here we perceive that the quantities of land (area), the numbers of sellers and a minimum number of rehabilitation packages have been arrived at after due consideration of the common good, and that there is no other possibility for the buyer to purchase surplus land. Equally, there is the recognition that the transaction may not go through at all unless a minimum area of land is purchased. Hence, these quantities are fixed ahead of the process of generating a price offer in our case. Even more serious could be the task of estimating the utility U, since the buyer is not really concerned with such a quantity trade-off at all.

Also, prices are hardly "market" prices in our case of land acquisition. In fact, even a notional "land market" allowing for standardized pricing to be applied, in a case where the intent is to change the land use from agriculture to industry, does not exist in the country. Per unit area prices offered by the buyer need to be specifically customized for each type of acquisition environment, most often with very little prior history and knowledge of such prices in the same geographical area.

In this paper, we propose a somewhat fresh approach to building a buyer model. We propose that the buyer generate offers by minimizing a price trade-off function subject to a budget constraint in the general form:

$$\begin{aligned} &\min v_b = f(p_1, p_2, p_3) \\ &st \\ &b = p_1 M + p_2 N + p_3 Q \end{aligned} \tag{2}$$

where v is the price trade-off function that captures the concept that if the buyer is prepared to pay a higher price on one item, he will try to reduce the price offer on any or all of the others. The function v is intended to capture the trade-off between prices in a manner that enables the buyer to choose price offers that satisfy the budget equation while at the minimum v.

We now postulate that it would be possible to represent the buyer's interests while generating an offer on his behalf if we minimize the impact of trade-offs between the three rates by using the following function:

$$P_b = k_1 p_1^{\,2} + k_2 p_2^{\,2} + k_3 p_3^{\,2} - k_4 p_1 p_2 - k_5 p_1 p_3 - k_6 p_2 p_3 \,, \tag{3}$$

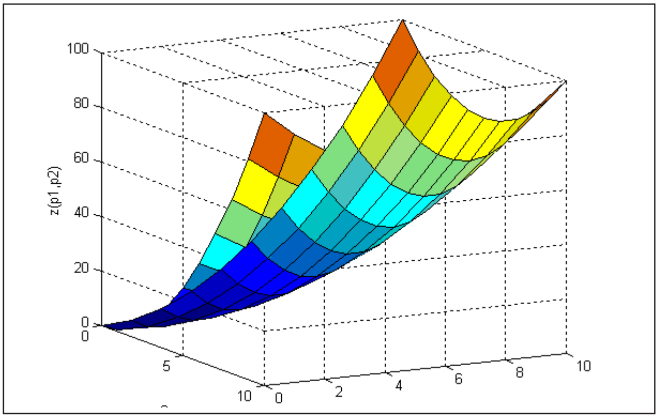
while meeting a budget constraint:

$$B_b = p_1 M + p_2 N + p_3 Q \tag{4}$$

In the price trade-off function in (3), the last three terms express the fact that, for a given value P_b, a price change in one direction should result in the other prices (in pairs) moving in the opposite direction The squared functions of the individual prices seek to ensure that the first three terms attempt to pull up the value of the overall price trade-off function when prices rise rapidly.

In order to visualize the impact of the trade-offs, we can view a 2D function of form (3), viz., $z(p_1, p_2) = p_1^2 + p_2^2 - p_1 p_2$ for values of p_1 and p_2 in the range of 0 through 10.

Figure 2. 2D Price function example



Note how the function curves up at larger values of p_1 and p_2. The prices chosen to minimize P_b need to satisfy the budget equation (4) where the quantities M, N and Q represent, respectively, the total size of the land in hectares, the number of sellers, and the number of rehabilitation packages to be offered.

It is fairly straightforward to determine such a price combination by constructing the Lagrangian:

$$V_b = (k_1 p_1^2 + k_2 p_2^2 + k_3 p_3^2 - k_4 p_1 p_2 - k_5 p_1 p_3 - k_6 p_2 p_3 + \lambda (p_1 M + p_2 N + p_3 Q - B_b) \quad (5)$$

and solving for the unknown prices and the Lagrangian multiplier λ from the set of linear equations resulting from:

$$\left.\begin{aligned}
\frac{\partial V_b}{\partial p_1} &= 2k_1 p_1 \quad k_4 p_2 \quad k_5 p_3 + \lambda M = 0 \\
\frac{\partial V_b}{\partial p_2} &= 2k_2 p_2 \quad k_4 p_1 \quad k_6 p_3 + \lambda N = 0 \\
\frac{\partial V_b}{\partial p_3} &= 2k_3 p_3 \quad k_5 p_1 \quad k_6 p_2 + \lambda Q = 0 \\
\frac{\partial V_b}{\partial \lambda} &= p_1 M + p_2 N + p_3 Q \quad B_b = 0
\end{aligned}\right\} \qquad (6)$$

In principle, the buyer need not know the explicit form of the trade-off between the prices but only express the relative importance of trade-offs by setting the values of $k_1 \ldots k_6$ on the basis of an initial starting value for the ratios of the proposed prices. V_b, the price function itself is convex in certain price ranges and exhibits a minimum in the price space in that range, for suitably selected values of $k_1 \ldots k_6$.

Solving for (6) in the form:

$$\begin{bmatrix} 2k_1 & k_4 & k_5 & M \\ k_4 & 2k_2 & k_6 & N \\ k_5 & k_6 & 2k_3 & Q \\ M & N & Q & 0 \end{bmatrix} \begin{bmatrix} p_1 \\ p_2 \\ p_3 \\ \lambda \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ B_b \end{bmatrix} \tag{7}$$

yields a batch of prices p_i, $i=1...3$ for a given budget B_b. That the price function exhibits a basic trade-off property between prices can be illustrated by setting the budget constant and generating new values of, say, p_2, and p_3, for increasing pre-set values for p_1 through an additional constraint in (7) as shown in the pseudo-code below. A plot of the values of p_1, p_2, and p_3 generated using the pseudo-code exhibits the trade-off property as shown in figure 3.

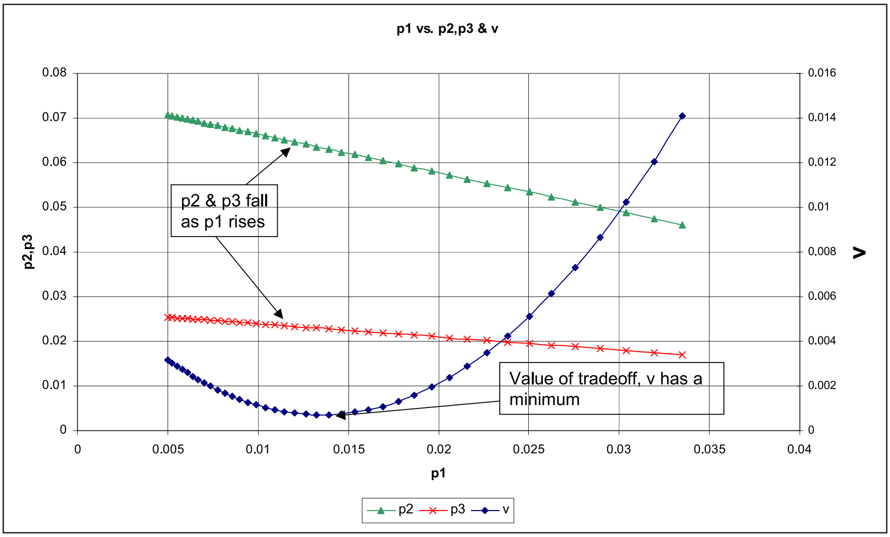
{
pr = 0.005;
for i=1:40{

$$\begin{bmatrix} 2k_1 & k_4 & k_5 & M & 1 \\ k & 2k_2 & k_6 & N & 0 \\ k_5 & k_6 & 2k_3 & Q & 0 \\ M & N & Q & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} p_1 \\ p_2 \\ p_3 \\ \lambda_1 \\ \lambda_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ B_b \\ pr \end{bmatrix}$$

pr*=1.05;
record p1,p2,p3, and v;

}
}

Figure 3. Price trade-off illustration



The plot of the values generated by the pseudo-code captures the non-linear trade-off in the convex price function, v, with the values of p_2 and p_3 falling as p_1 rises. The buyer model then essentially provides the basic mechanics to generate new price offers, given a budget, and quantity data. These prices are communicated to OE as the initial offer.

We shall shortly see how the buyer model accommodates changes to make a series of offers in response to the feedback from the sellers. But first, let us proceed with this initial cycle, and examine how the sellers might react to the offer.

Seller valuation models

From the seller's viewpoint, the primary concern is to ensure that the valuation for land compensates for both the land's perceived asset value and the potential losses in livelihood, wage income, and income from cultivation of the land parcel. For this purpose, we need to arrive at measures of income, wages and opportunity purely from a farmers' perspective.

The compensation should then address the following key concerns:

(a) The offer for the land should at least be better than the "market" value as perceived by the selling community;

(b) There should be a component that compensates for lost income from the cultivation and sales of produce from the land;

(c) There should be a component that compensates for equivalent family wages lost due to the sale of the land;

(d) There should be a component that provides for socio-economic development of the seller community as a whole.

On an individual seller basis, the important parts are items (a) to (c) above. We shall consider (d) later.

Let us start with the offer for the land itself. Let L_{min} denote a base price for land in the region, derivable possibly from the government's guidance value. Considering that the current offer from the buyer is p_1 (as communicated by OE), the seller j $(j = 1,\ldots N)$ seeks to maximize benefit from the difference:

$$w_j^1 = ls_j(p_1 - L_{\min}) \tag{8}$$

where ls_j represents the land size owned by seller j. Obviously, if p_1 is lower even than the guidance value L_{min}, the offer will be rejected outright by the seller. That takes care of the first component of the compensation.

The second component concerns farm income. Surveys of regional farm production and yields available with several government agencies offer an initial guidance value, over which it is perfectly legitimate to allow for further enhancements based on local conditions. We assume that the OE can collect and collate local information for the calculation of basic projected income in the form:

$$w_j^2 = (rev_j - \mathrm{cost}_j)\,(1 - r)^n \tag{9}$$

where w_j^2 denotes an estimate of profitability derived from estimates of revenue, rev_j and cost, $cost_j$, for seller j, should it be invested and grown over a period of n years at an interest rate of r per cent per annum. We postulate that each seller holds an expectation that this compensation will legitimately offset prospective gains that he would have made had he not sold the land.

We would also consider that loan liabilities not exceeding 25 per cent of the cost of the land per seller would be compensated as well.

In principle, a sum of the amounts of compensation in (8) and (9), together with the loan compensation above, should represent the overall expectation for each farmer. However, we should now consider the fact that the expectations can vary quite a bit depending on the actual values in (8) and (9), dependent as it is on the size of the land holding.

The size of a holding, for example, for a marginal farmer being of the order of about a hectare, the net compensation for land is expectedly small. For instance, a marginal farmer

with 0.3 hectare may get in the neighbourhood of \$4,800 in compensation for land even at \$16,000 per hectare, and his wage compensation offer is likely to be in the range of \$2,000 at best. For such a farmer, the attraction to land is clearly likely to be higher than for a large farmer, whose land compensation is surely likely to be several times the net wages for a family of his economic class.

In sum, the level of satisfaction with compensation components is likely to be less at smaller values of compensation, while more flexibility with offers is likely to be demonstrated when land holdings are large and consequent net compensations are large.

In order to capture this type of economic behaviour, we propose to calculate overall individual utility from compensation for seller j in the form:

$$u_j = q_1 \frac{(w_j^1)^{\gamma_1}}{\gamma_1} + q_2 \frac{(w_j^2)^{\gamma_2}}{\gamma_2} + l_j \tag{10}$$

where q_1 and q_2 are tuneable weights endowing differing degrees of importance to land compensation and other types of compensation, and l_j denotes the equivalent of a loan waiver subject to certain conditions. The impact of raising the compensation sums w^1_j and w^2_j to the power of γ_1 and γ_2, respectively, and dividing by the latter constants offers an interesting "saturation" effect when the constants are less than 1.

Shown in figure 4 is a plot of the function $f(w) = \frac{w^\gamma}{\gamma}$ against w on one axis for three different values of γ ($\gamma_1 = 0.3$, $\gamma_2 = 0.5$ and $\gamma_3 = 0.7$). Note that, for small values of w, the curves rise rapidly and flatten out at larger values of w. Plotted on the second axis is a set of graphs for the slopes over the same range of w, computed easily as:

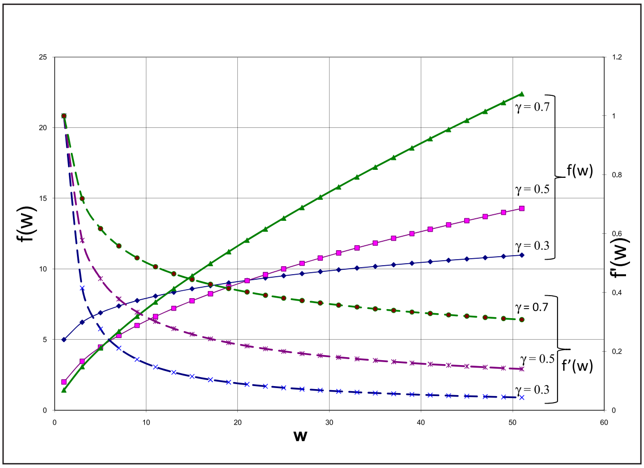
$$f'(w) = \frac{d(f(w))}{dw} = w^{\gamma \ 1} \tag{11}$$

The slopes also show how a degree of saturation sets in at higher values of w, allowing us to accommodate the notion that small farmers with smaller values of w may "want more", while small changes in the total value may not impact the perceived value of the deal in the case of large farmers.

Another benefit from this class of utility function in our case is that we now have the facility of using different values of γ to differentiate between farmers with different land holdings to express their degree of satisfaction with the achievement of the desired utility. The lower the γ, the sooner (in the sense that even for smaller values of w), the achievement of satisfaction.

We thus utilize this function to construct the overall seller utility in the following form in (10).

Figure 4. Plot of f(w) and f '(w) for different γ



Using individual seller data it is possible to construct the value of u_j for every prospective seller. Note that two price levels p_1 and p_2 in the original seller offer are utilized to calculate the u_j's.

What remains now is to specify a mechanism for rating deviations of the calculated u_j's from a reference that each seller needs to have for himself. The degree of under- or overachievement should provide us with a rating scale that expresses the seller's level of agreement with the compensation packages and his affirmation to sell his parcel.

We propose that each seller employ two simple references. The first is the level of overachievement of the offer for land alone over u_j, expressed as a percentage over the land compensation, i.e.:

$c_j^1 = (lcomp_j \quad u_j)/lcomp_j$ where $lcomp_j = ls_j p_1$, ls_j being the land size of seller j.

Another reference is required to rate the wage compensation component. Suppose the net family wage income is estimated as wg_j, comprising annual wages for all working members of the family, whether from labour in their own land or other land which is under the acquisition plan, we expect the wage compensation to be calculated on a per seller basis as before:

$$fam\_wg_j = \frac{(wg_j(1+r)^n)^{\gamma_4}}{\gamma_4} \qquad (12)$$

in a manner that accounts for invested future worth of the wages, subject to a treatment similar to previous utility calculations. This value can then be compared with the actual offer made by the buyer, which is simply p_2.

Each seller will then need to obtain his own measure of achievement

$$c_j^2 = (fam\_wg_j \quad p_2)/p_2 \tag{13}$$

We propose that the values of c^1 and c^2 for every seller not be disclosed to the buyer in a direct way so that the bargaining position of the sellers is not compromised. Instead, the numbers may be converted into a lexicographically ordered scale for use as a rule base. An example is illustrated below in table 1.

Table 1. Response gradati

c^1	Response-L	c^2	Response-W
$0<c^1<=0.1$	Very poor	$0<c^2<=0.1$	Very poor
$0.1<c^1<=0.2$	Poor	$0.1<c^2<=0.2$	Poor
$0.2<c^1<=0.3$	Satisfactory	$0.2<c^2<=0.3$	Satisfactory
$0.3<c^1<=0.4$	Good	$0.3<c^2<=0.4$	Good
$c^1>0.4$	Very Good	$c^2>0.4$	Very Good

Note: Response "L" is associated with land compensation, and Response "W" is associated with wage compensation.

By conveying responses in such scales calculated from the rule engine without actually revealing how they are arrived at, it becomes the responsibility of the buyer to work out by how much the offer may need to be improved before a seller will agree to the transaction.

Before we can set up full negotiation cycles, we need to determine how the buyer model can evaluate the scale-equivalent of c^1 and c^2, i.e the responses L (associated with land compensation) and W (associated with wage compensation) respectively, as defined in table 1, to make the next offer. For this we will need to go back briefly into the buyer model.

Buyer model revisited

It is in the interest of the buyer to tactically offer higher levels for wage and other types of compensation first, keeping the land price just at par with market prices. One should expect that the buyer will start the negotiations with some informal minimal proportions for the three components in mind. As an example, he could start by setting apart $a_1 = (p_2 * N + p_3 *Q) = 20$ per cent of the budget B_b, suggesting that the land compensation component would be 80 per cent of the total outlay. The buyer might set up an initial budget, choose an initial a_1, and make the rate offers to OE.

The OE assists in working out the L and W responses of all N farmers, and communicates the consolidated responses back to the buyer. The buyer needs to do some basic grouping of responses to determine, for example:

- The percentage of N that fell into each class of c^1 and c^2

- The percentage of N that might accept the wage compensation and land offer
- The percentage of N that might accept the wage and NOT the land offer, and vice versa

This analysis should help the buyer decide how to modify the offer and by how much. The buyer can next be expected to want to see if the number of sellers who accepted, say, the wage compensation increases merely by increasing a_1 (increasing the initial proportion) without actually increasing the overall budget. Note that the buyer is not informed of the individual responses of the sellers; the buyer only receives a group report that indicates how many sellers in any category responded to what level.

The buyer recognizes that, once an offer is made, reducing it for any component will be difficult unless some other component is made substantially more attractive. Hence, the buyer can be expected to increase the offer only in small increments.

The buyer is usually constrained by the fact that, unless a very large proportion of the land—say 90 per cent—is covered by the sellers giving a high ranking to values L and W, the transaction may not close. Hence, he will attempt to get concurrence on a component that costs him less before proceeding to budget more on other components. For instance, suppose that he discovers that all the sellers will agree to his current wage compensation offer, $w = p_2{}^*N$; he will introduce this equation as a new constraint into his original model. This will only add an additional λ parameter into the set of equation (6). The solution effectively "continues" setting wage compensation to the agreed level.

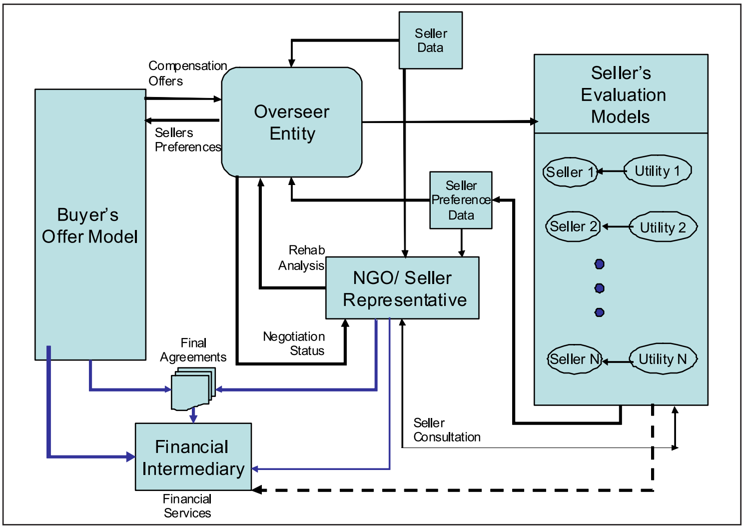
It is critical to note that the buyer is not allowed to make separate offers to "obdurate" sellers, whether in terms of wage compensation or for land. Equity demands that the rate of land be the same, while wage compensation may be customizable to individual seller's socio-graphics—but even that must be done in a transparent manner.

One final point, before we examine real negotiation cycles and data, is about the third component of compensation—the Rehabilitation Package. This package is for the entire seller community and cannot be appropriated by individual sellers. Hence, its utility needs to be assessed by the seller community in coordination with an agency that has the expertise to analyse and explain the offer to the community. This is typically a task for an NGO.

Once there is overall agreement between the buyer and the seller on rates, there is a need for a financial intermediary to step in and coordinate transactions between them in concert with the OE and the NGO. We envisage that the services of this intermediary would not be for profit and would probably be ideally suited to an established bank in the public sector. Given that the transactions can take place over a period of time and may include annuity type of payments in part, there is a need for an entity to play the role of guarantor to avoid situations where the buyer and some sellers may backtrack after the agreement is reached.

Broadly, therefore, the economic utility models that we have explored for the buyer and the seller need to play out the negotiation cycle within a process framework, which includes the additional entities mentioned above. The original schema of figure 1 can thus be enhanced to include these entities, as shown in figure 5 below.

Figure 5. Enhanced structure of entities for negotiation



We envisage that the role of a seller's representative who can speak with the OE on behalf of the sellers and vice-versa is a critical one, for that representative will have the necessary information from other entities to explore and discuss seller-level issues and explain the impact of choices to individual sellers. This entity will also have the data to analyse the rehabilitation package for the socio-economic development of the community as a whole.

The financial intermediary is expected to play a larger role only after the final agreement is reached between other parties. As mentioned, it needs to play the role of guarantor and facilitator, and offer the services of a banker to the sellers. We shall revisit these issues following explorations into simulated negotiations in the next section.

III. DATA FOR SIMULATION OF NEGOTIATIONS

This section describes data sets we created for simulation experiments with the above buyer and seller models. As can be expected, the composition of sizes of land parcels, and the pattern of ownership will play a significant role in the negotiations. Hence, we shall consider two different scenarios: one with a rather high degree of fragmentation of land, somewhat mirroring the situation in, for example, Singur in West Bengal (Sau 2008), and a second where the land parcels are somewhat larger.

In order to obtain a realistic situation, we have generated data on a number of demographic and sociographic variables, the principal among which are given in table 2.

Table 2. Baseline seller data

Variable	Type	Remarks
Seller_ID	number	Identifier
Lsize	number	Land size in hectare
Ltype	alphanumeric	Land Type Classifier: a1: Multi-crop, irrigated; a2: Single Crop, irrigated, etc [Used to calculate potential yield]
Ctype	alpha	Crop-season identifier
Cost	number	Estimated input cost in United States dollars per hectare [Depends on combination of ctype and ltype; does not include wages for family labour]
Rev	number	Estimated revenue from sale of output in dollars per hectare [Depends on ctype, and estimated market prices]
Fsize	number	Number of members in seller's family [Counted once only, even if more than one plot is owned by the family]
wgincome	number	Estimated income from wages when family members work in their own or other land holdings under consideration for acquisition
regcost	number	Declared land value under registration system in United States dollars
Louts	number	Outstanding current loan burden on family as a whole

Source: Variable definitions used for model development by the authors

Cost and revenue numbers need to be estimated on the basis of a combination of crop-type and land-type. In our experiment, we assume that the contiguous land the buyer seeks is about 800-1,000 hectares in a single geographic area, allowing the possibility of nearly identical soil, weather and fertility conditions, with differences in cost and revenue arising merely from subtle variations in cropping patterns.

In order to mirror a realistic situation, we have considered the following pattern data for small, marginal and large farmers shown in table 3.

Table 3. Illustrative crop pattern data

Type of Farmer	Land Holding	Crop Pattern
Marginal	<= 1 hectare	high yielding rice kharif crop followed by rabi rice
Small	>1<=2 hectare	high yielding rice kharif crop followed by mustard
Medium/Large	> 4 hectare	high yielding rice kharif crop followed by potato

Source: Farmer and cropping pattern classification used for model development by the authors

The yield and price data for such a scenario has been referenced and based on published sources (Maji and others 1995). Using this baseline data, we created two cases differing in the distribution of land holding. Case 1 offers a scenario with a higher degree of fragmentation than case 2.

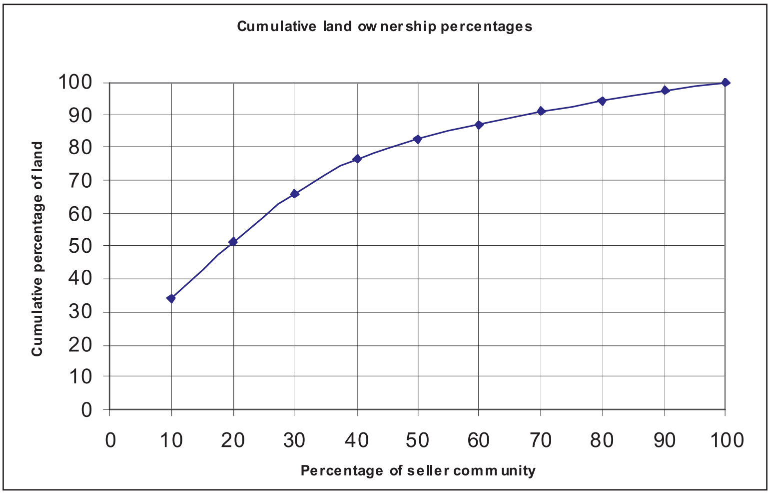
Case 1

The distribution of land in this case is shown in table 4.

Table 4. Land distribution for case 1

Number of sellers	Land holding (hectare)	Remarks
500	.2 - .4	Marginal
100	.41 - .6	Marginal
40	.61 - .85	Marginal
10	.86 – 1.0	Marginal
160	1.1 - 1.4	Small
90	1.41 - 1.6	Small
40	1.61 - 1.85	Small
10	1.86 - 1.99	Small
40	2.1 - 5	Medium/Large
6	5.1- 6	Medium/Large
4	>6	Medium/Large

Figure 6. Cumulative land distribution pattern



The distribution is plotted in the form of cumulative proportion above. With about 83 per cent of the land owned by 50 per cent of the community, and about 65 per cent of 1,000-strong seller community being marginal farmers, this clearly represents a case where the degree of fragmentation is rather high.

Case 2

The distribution of land in this case is shown in table 5.

Table 5. Land distribution for case 2

No. of sellers	Total land size (in hectare)	Remarks
115	100	Marginal farmers
118	200	Small farmers
79	700	Medium/large farmers

The farmers in case 2 are better placed economically with just one fourth of them holding about 70 per cent of the land. As the land is not very fragmented, it is expected that the buyer will spend less to acquire these 1,000 hectares.

IV. THE NEGOTIATION PROCESS MODEL

In this section, we shall put together all the elements of the buyer and seller models discussed above into a more formal description of the process.

We believe that the negotiation process should ideally comprise four phases: (a) preparatory or pre-negotiation; (b) negotiation; (c) execution; and (d) evaluation. It is quite possible that acquisition tasks in many practical cases, and even in those cases that have resulted in failure, have indeed broadly followed these descriptions. However, we would like to place emphasis on formally outlining the tasks in these phases, particularly the conditions that must be examined at the beginning and end of each phase. The conditions are meant to provide a set of simple tests that tell us if the process is moving satisfactorily and if there might be issues that can stymie the land acquisition exercise.

Preparatory pre-negotiation phase

In this phase, all parties concerned with the acquisition are identified, and data pertaining to the land, seller community, buyer, Overseer, local authorities, NGO etc. is shared and verified. Key participants need to formally agree on:

1. Extents and ownership of land proposed to be acquired;
    a. Componentization of Compensation into
        i. Land Compensation
            - Minimum Price for Land

ii. Wage and Other Per-Seller Compensation
- Minimum Rate for Wage Compensation

ii. Rehabilitation Package for Whole Seller Community
- Minimum number of packages and rates

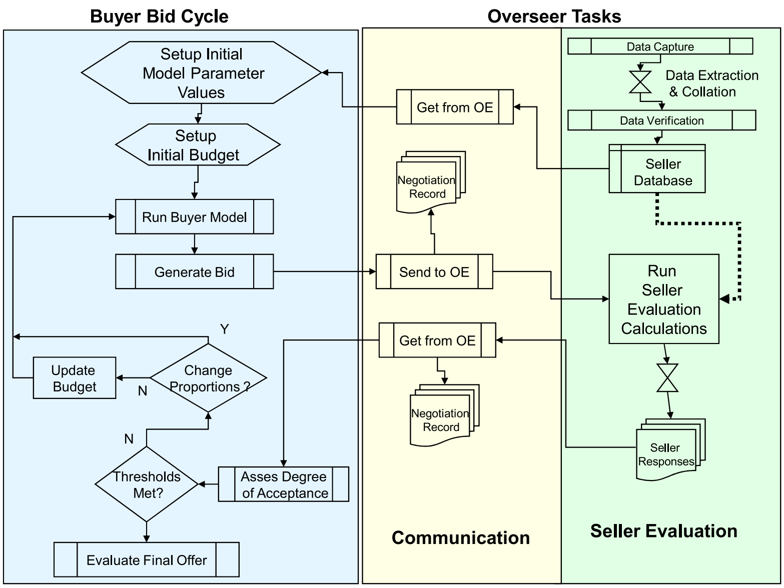
2. Principle that the negotiation shall follow prescribed procedures
   a. with specified disclosures of information;
   b. with prescribed ownership of information;
   c. with prescribed exit conditions
      i. for Buyer
      ii. for Seller Community

We shall not delve into the details of the preparatory phase, as that would require describing legal and other steps that would be outside the scope of this paper. It is sufficient to state that the tests to determine whether agreement has been achieved between parties on authenticity, integrity and completeness of data have yielded positive results, and parties agreed to proceed with negotiations on the basis of acknowledged minimum values of component compensation rates.

Negotiation processes

The negotiation process involving the buyer and the seller through the overseer entity is pictured in the flow diagram shown in figure 7.

Figure 7. Negotiation process and communications



The OE clearly needs to perform both the tasks of initial data capture and collation from the sellers so that it has all data to play the intermediary role in negotiations. The buyer model is set up using inputs from this database. An initial budget (typically arrived at on the basis of agreed minimum rates) is set up by the buyer to run the model and generate the first bid, which is then sent to the OE.

The OE uses this bid to work out compensations on a per seller basis, which is conveyed to individual sellers together with calculated levels of achievement of the utilities. The responses c^1 and c^2 are converted to levels L and W using a pre-agreed range scale. At this time, the OE in consultation with individual seller may allow specific tuning of L and W within pre-agreed limits.

The responses are sent back to the buyer, who then assesses the degree of acceptance, applying his own criteria to judge whether to tweak the proportions of compensation, keeping the same overall budget, or to increase budget.

This done, the next cycle bid calculation and communication is started. It is up to the buyer to decide when to stop making further offers, expectedly based on an internal and undisclosed constraint on the overall budget. For instance, if the buyer finds that, say 95 per cent the owners of say, 95 per cent of the land parcels have agreed to sell at the current bid, and acquisition of the remaining 5 per cent may come only at a significantly higher price, the buyer may choose to stop the negotiations and try to close the deal at this stage. It is obviously up to the sellers to determine how much they might be able to stretch the buyer's bid.

The exit conditions can also be pre-agreed, in that the buyer and the sellers can agree on an outer limit for rates as well, even before negotiations start. Exit clauses can also include conditions that put an upper limit on the number of cycles or the threshold percentage of land up to which wage compensation will not be increased, and many more such variations.

V. RESULTS

We shall present the results of negotiation cycles with data in case 1. As will be recalled, this case has a higher degree of fragmentation.

Case 1

The total land parcel owned by 1,000 sellers in this case is 860.41 hectares. Table 6 shows the values of $\gamma_1,..\gamma_4$ that we have set in the individual utility functions for the sellers in this experiment.

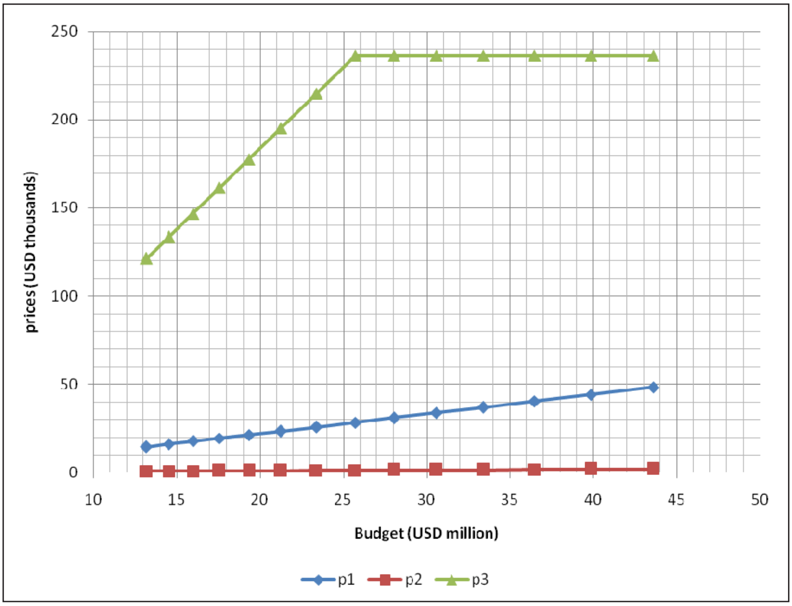
Table 6. Settings for gammas

Seller type	γ_1	γ_2	γ_3	γ_4
Marginal farmer	0.8	0.6	0.6	0.8
Small farmer	0.7	0.7	0.7	0.7
Large farmer	0.6	0.8	0.8	0.5

The values of γ for marginal farmers and small farmers have been set higher than those of large farmers to reflect the perceived notional attraction to land, since farmers with only a small holding expect small total compensations, which can nevertheless be several times their annual income, their attraction to the land parcel can be considered to be stronger. Hence, γ saturation will occur far more slowly, i.e. their behaviour is better represented by higher values of γ. On the other hand, sellers with larger land holdings may be expected to be less sensitive to small changes in the price since the total compensation expected is itself large, while their annual income from the land itself is also large. Hence, we have set smaller γ values for them in our experiments.

We initiate the buyer offer process with a starting budget value of $12 million. The manner in which the price offer increases in response to the seller valuations is shown in figure 8.

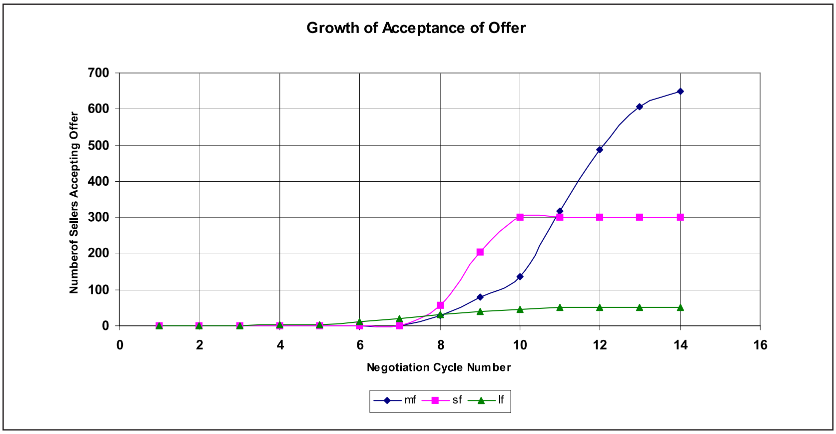
Figure 8. Evolution of bid prices during negotiations (case 1)



The buyer has increased the price p_3 for the rehab package (the green curve) from about \$120,000 to about \$237,000 over eight cycles, until receiving acceptance from all sellers. During these cycles, the buyer model has maintained p_2, the price for wage compensation constant, and increased land prices marginally to accommodate the large percentage of sellers who have demanded more on this account. Beyond the eighth cycle, the buyer has held both these prices at the last offer price and increased land prices over the next eight cycles until acceptance by all sellers at the final price of p_1=\$48,000/ha, p_2=\$1,833 (approx.) of wage compensation per seller, and p_3=\$237,000 for payment towards the rehabilitation package. The total payout proposed by the buyer model is \$43.56 million, of which land compensation alone is about 95.2 per cent, the bill for wage compensation for all 1,000 sellers is 4.2 per cent, and the rehabilitation package for the community of sellers is 0.54 per cent.

The sellers have evaluated the offer against their utilities as conveyed acceptance using c^1 and c^2 over the 16 cycles in the trajectory graphed below.

Figure 9. Growth of acceptance proportions during negotiations (case 1)



It is interesting to note that the large farmers (green curve) have begun to convey overall acceptance starting from cycle 6, and nearly all have accepted the offers by the eleventh cycle. The small farmers (pink curve) begin to find the offer satisfactory only a cycle later, and all accept the offer just a cycle ahead of the large farmers. But it is clearly the marginal farmers (blue curve) with very small land holdings who appear to hold out until the last cycle, with only about 50 per cent of them accepting the current offers at the eleventh cycle.

As can be seen at this late stage of the negotiation (eleventh cycle), it has been the land price that has been the stumbling block for the vast majority of the marginal farmers, while the other farmers owning large land parcels have clearly begun to accept the current offers.

Hence, our model, offer evaluation, and response evaluation process appear to have captured the notion that sellers with very small land holdings often have a stronger attraction to land because it may be their only livelihood, while owners of larger holdings become less sensitive to small changes in land prices because their overall land compensation sizes become larger, and the wage or other compensations become less significant at this stage.

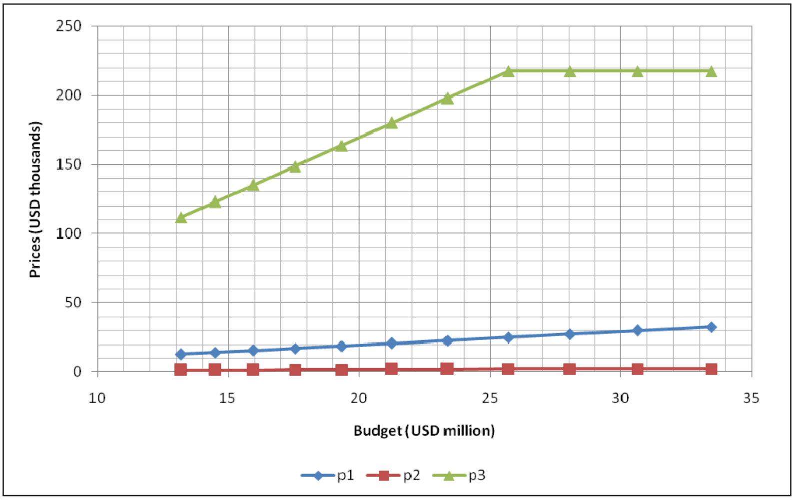
It is again no surprise that the simulation experiment points to more protracted negotiations due to a large number of marginal farmers in the community of sellers—i.e., the land parcel is more fragmented.

We shall now examine the situation prevailing when the land is less fragmented.

Case 2

In this data set, we have fewer marginal farmers. The price growth chart for the negotiation cycles is simulated in figure 10.

Figure 10. Evolution of bid prices during negotiations (case 2)

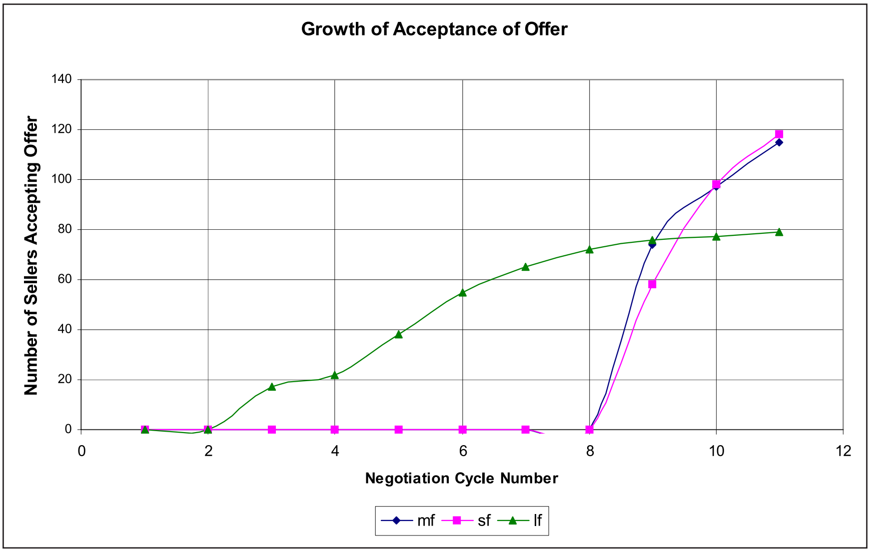


The negotiation cycles, starting with a budget of $12 million, are completed in just 11 cycles in case 2, with a final settlement value of $33.44 million (over $10 million less than in case 1). Full acceptance for wage compensation and rehabilitation appears to come by as early as the eighth and fifth cycles respectively.

The total land bill for the buyer in this deal is 97.38 per cent of the above total compensation package, while the other two packages are 1.95 per cent and 0.65 per cent respectively. The final agreed price for land works out to about $32,570/ha. The lower land

price is a consequence of the softer bargain driven by the bulk of a larger number of large land owners, as can be seen in figure 11.

Figure 11. Growth of acceptance proportions during negotiations (case 2)



The acceptance behaviour of the small and marginal farmers is somewhat similar in this case, with the bulk of them accepting the offer over the last three cycles. The large farmers, forming about 25 per cent of the seller community in case 2, begin to accept the offers in small groups starting from the second cycle until all of them agree gradually over the next eight to nine cycles.

The fact that there was significantly less fragmentation of land in case 2 has clearly helped in getting the buyer a larger land parcel (1,000 hectares distributed over 312 sellers) at a lower price per hectare, as well as lower total compensation.

The problem with higher fragmentation is that there are a larger number of individual utilities to achieve, which constitute a larger compensation sum even though they are individually smaller.

VI. CONCLUDING REMARKS: POLICY RECOMMENDATIONS

The central objective of this work has been to explore the possibility of building a mathematical foundation for negotiations between a buyer and a community of sellers for acquisition of agricultural land. In the Indian context, this class of transactions has been

surrounded by a variety of controversies, primarily emanating from the lack of an established, regulated, transparent and fair mechanism for negotiations between buyers and sellers. The valuations of land and processes for making and communicating offers have generally been *ad hoc*.

To the best of our knowledge, the practical methods followed by buyers today do not go beyond a very simplified rule: (a) find minimum guidance value from different sources; (b) add minimum solatium; (c) make offer. If the offer is unacceptable, as evidenced by reluctance to sell, the buyer decides whether to raise the offer or back out of the transaction for good. It is not uncommon for a variety of problems—ranging from a "hold out" among sellers, to partial collusion among some sellers to seek better prices, to a complete breakdown of transactions—to arise at this stage.

The sellers of agricultural land have mostly been rural folk without the means to assess the offer in a scientific manner. The pulls and pressures of community dynamics and individual compulsions, such as outstanding loans, and declining family incomes often drive the decisions of individuals.

Among other criticisms is the fact that the valuation processes do not prescribe methods to determine if the compensation adequately covered loss of wages, livelihood, or other income-generating means for the sellers, particularly those who would be parting with small landholdings.

Considerations of compensations for lost livelihoods and wages are rarely reflected in the final figures unless political or other pressures are brought into the picture. It is indeed rare for the compensation to cover community development activities, such as common infrastructure facilities for roads, health care, hygiene, education or vocational training.

In this paper, we have taken the approach that the solution needs to be arrived by considering actions from three different angles, with a legal framework that stipulates basic rules of engagement:

1. That, in cases where land parcels to be acquired are larger than a few hundred hectares of agricultural land fragmented beyond a specified limit, compensation must have at least three components, viz, land, wages, community development; the latter two components may be considered for payment in annuity form;

2. That it must become statutory to have certain identified entities that provide regulatory, overseer, ombudsman, financial and communication services between buyers and sellers;

3. That a process workflow be followed, which takes information generated in the negotiation in a systematic manner between the parties involved, maintaining transparency where it is required and security of information where it is required;

4. That a set of agreed mathematical models be deployed for:

   a. The buyer to generate the offers;

   b. The sellers to evaluate the offers;

   c. The conversion of seller valuations to scaled ranges of variables which the buyer can interpret to generate the subsequent offers.

The focus of this paper was primarily on the last two of the above. We stated the critical requirements for (1) underscoring the need for setting up the entities for achieving the requirements in (2). We then proposed models that might satisfy the requirement for (3). Among the key issues in setting up the models, we have attempted to address the problem of a mechanism for generating offers by the buyer. The offers are evaluated using individual utilities of the sellers, and converted to usable responses by the seller, in order to accept a modified offer in another cycle of negotiation.

In this paper, we have proposed a price-trade-off driven model for the buyer, which allows the generation of price offers in a manner that is not *ad hoc* nor requires serious knowledge of downstream cost factors. For instance, a buyer might need to set up only upper and lower limits for prices on the basis of detailed information on future use of the land (after industry is set up, etc.). But generating a price offer for the land within these limits is only seen as a question of obtaining a good trade-off between price components, given the acceptance criteria of the sellers. The seller model thus uses only information local to the offer model and its components. The parameters in the model offer more than enough flexibility to enable it to be applied to different situations.

We also explore methods whereby the seller can evaluate the offer on an individual basis, using data pertaining to that individual within the seller community. Here, we have explored setting up utility functions, which can be fine tuned to the needs of individual sellers. Using the value of γ, for instance, to tune the degree of satisfaction helps capture the possible higher attraction for land among marginal farmers, for whom its loss might even take away their only source of livelihood.

While we have considered several variables, such as size of family and income from land, several others could easily be added to refine the valuation of a land parcel in practical circumstances—for instance, number of trees, number of water sources (such as borewells), shed/barns, and a soil fertility index. We have also considered the possibility of evaluating wage or other cash compensations in the form of a future value over a period of time. This may be of particular relevance to marginal landowners.

The translation of the acceptance criteria at individual seller levels to a five-point scale was done here to illustrate the process of communication between the buyer and the sellers. Obviously, many alternative mechanisms could be devised. However, the objective

here was to ensure that the bargaining position of individual sellers, contained in the limiting values of their utilities, would not be revealed to the buyer, for then he would naturally try to just meet it. Without that knowledge, the buyer might even exceed it, benefiting the selling community as a whole. In other words, the sellers can convey they want “more”, without saying “how much more”, while it becomes the buyer’s responsibility to offer what he thinks is the lowest amount that might satisfy the largest number of sellers in that negotiation cycle. The other critical benefit is that the possibility of a “speculative hold out” is considerably reduced in this process because the buyer cannot track individual responses and the seller does not know how his response is impacting subsequent offers—only aggregate behaviour drives the bids.

Finally, it is important to mention that the process of negotiation will gain substantial credibility in the Indian context, if aside from NGOs and government regulatory body participation, there is a healthy role for government-backed financial institutions which can serve as an intermediary offering services to both buyer and seller parties. Its presence adds a significant value to the financial security of prospective transactions.

The simulation experiments we conducted with two sets of data appear to bring out the interesting relationship between higher compensations and higher fragmentation of land ownership patterns. While the increase has traditionally been associated with the additional burden of managing a larger group of sellers, there is really a cost associated with increased compensations for marginal landowners who have a higher “attraction” to their land, as theorized from a land assembly economics perspective (Evans 2004).

In our experiments with data representing a higher degree of fragmentation, the fact that the sellers in the small and marginal farmer category “held out” longer than the large farmers in anticipation of higher compensations is a result of the threshold settings on their utility functions in the simulation. In a practical exercise, one would like to set up the model parameters in manner that would closely mimic the behaviour of the sellers, and both our approach and the methodology described here offer such facilities. While economic theory (Evans 2004) indeed suggests that such behaviour should be expected, studies in several areas in India have shown an interesting contra-behaviour (Sanhati 2008). Marginal and small farmers in regions where agricultural productivities have plummeted seem to prefer to opt out of agriculture at first opportunity, and sometimes have settled for less.

In conclusion, this paper is an exploration into structured models and processes for acquisition of agricultural land. While there is much to be done towards establishing fair and transparent legal systems and regulatory frameworks in the Indian context, there is also a strong need to build structured models for generating and evaluating offers. Further work is intended to address issues related to group behaviour among prospective sellers, and how such behaviour might influence acceptance criteria.

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