CLAY MINING FOR BUILDING MATERIALS : FUTURE LAND USE

by

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Abstract

At present, there is no clear policy for clay mining in Sri Lanka. This paper analyses the condition to study the feasibility of future land use for clay mining. The future land use for clay mining is analyzed by comparing the net benefits of clay mining including the net benefits of refilling and allowing for any reductions in the residual environmental costs of clay mining that are avoided through refilling. As a result the implementation of the Mine Restoration Bond to internalize the externality caused by the excavated clay pit is suggested. A deposit-refund type of economic instrument is proposed for the Mine Restoration Bond required by the Mines and Minerals Act No. 33 of 1992 to motivate excavators to restore the clay pits after excavation. The implementation of the Mine Restoration Bond so that it becomes a market based non tax instrument is explored.

1.0 Introduction

In Sri Lanka, at present, there is no clear policy for clay mining. The Mines and Minerals Act No. 4 of 1973 did not refer to the mining of clay for building materials. The reason for this omission could be because clay mining was traditionally carried out manually. However, in some local authorities where large areas were mined for clay, a refundable deposit of Rs. 2500 per quarter acre, had to be paid to obtain a permit to mine clay. This fee was to be refunded when the clay pit was refilled by the excavator. The fee being so small, the excavators preferred to forfeit the deposit. According to the authorities no excavator has ever claimed the deposit1. The new Mines and Minerals Act No. 33 of 1992 explicitly identifies mining of clay for building materials as a mineral resource requiring a royalty payment to the state. Hence, a need exists for the development of a clear policy regarding clay mining in Sri Lanka.

The objectives of this paper are to study the feasibility of future land use for clay mining in Sri Lanka, and to suggest possible economic instruments that can be used effectively in the development of a policy for clay mining in Sri Lanka. Some of the literature on extractive minerals and natural resources 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 have looked at economic instruments such as tradeable permits, user charges, deposit-refund schemes, environmental taxes (charges), tax incentives, combined environmental charges and tax incentives, and compensation fees to achieve environmental goals.

In two previous papers, a framework to analyze private and social feasibility of clay mining for building materials, and future land use for clay mining, and an analysis of private feasibility and social feasibility of clay mining were presented. The focus of that study was the Dankotuwa Divisional Secretariat area, where the largest volume of clay on the Maha Oya River Basin has and is being mined. Three Grama Sevaka Division (GSD) areas in the Dankotuwa Divisional Secretariat area, namely Metikotuwa GSD, Jankurawela GSD and Yogiyana GSD were used for the research surveys16. A sample clay pit of 20 acre feet (Acft) was used throughout that paper for estimation purposes. The objective in using a sample clay pit was that all estimations could be compared at the same volume of clay and or the clay pit. That same sample pit is used in this paper for estimations. All estimations in this paper will be in British Imperial units because the market prices for clay, laterite and transport are still in respect of cubes in the study area (1 cube = 100 cubic feet).

The first condition estimated the net private benefits of clay mining in Sri Lanka from an economic benefit cost analysis16. That analysis excluded the social (environmental) costs of clay mining16. This condition, with the estimated economic benefits and costs for the sample clay pit are depicted in Figure 1. Then, assuming January 1, 1994 as time zero, net private benefit from mining the sample clay pit, when the economic discount rate is 6%, was shown to be Rs. 1,271,991 at time zero. The benefit cost ratio was 1.78. That analysis showed that clay mining in the study area was privately feasible (profitable).

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The second condition explored the social feasibility (profitability) of clay mining in Sri Lanka. That analysis estimated the net benefits from clay mining including the social (environmental) costs of clay mining but excluding the benefits of refilling to decide whether the clay mining in Sri Lanka is socially profitable. Three environmental costs, namely, health costs as loss of earnings and medical costs of the residents in the affected areas, productivity loss of adjoining rice fields and coconut lands, and the deterioration of village roads as off site costs, were identified as the main social costs of clay mining. This condition, with the estimated economic benefits and costs for the sample clay pit are depicted in Figure 2. It was assumed that the environmental costs due to transportation of clay, were the annual health cost due to Respiratory diseases (Rs. 200) and the off site cost due to deterioration of village roads (Rs. 290), and they occurred during the middle of first year. The annual environmental costs were annual health cost due to Malaria (Rs. 8260) and annual productivity loss (Rs. 21,740), and they occurred as long as the sample clay pit remained starting from the end of first year. For analysis purposes a study period of fifty years was assumed. Then, assuming January 1, 1994 as time zero, the present value of the environmental (social) costs caused by the sample clay pit was estimated at Rs. 473,331, and the net benefit at time zero from mining the sample clay pit, when the discount rate is 6%, was shown to be Rs. 798,660. The benefit cost ratio was 1.38. That analysis showed that clay mining in the study area was socially feasible (profitable).

This paper is structured as follows. In the next section the condition to study the feasibility of future land use for clay mining in Sri Lanka is analyzed. This condition estimates the net benefits of clay mining using an economic benefit cost analysis by including the net benefits of refilling and allowing for any reduction in the residual environmental costs of clay mining that are avoided through refilling. As a result, in the third section, a deposit refund type non-tax economic instrument is suggested for the Mine Restoration Bond required by the Mines and Minerals Act No. 33 of 1992. The use and implementation of the Mine Restoration Bond for developing a successful policy for clay mining is discussed. Finally, the conclusions of this study and policy recommendations are highlighted in the fourth section.

2.0 Future Land Use for Clay Mining

This section will analyze the condition for future land use for clay mining developed in the previous paper. The condition estimates the net benefits of clay mining including the net benefits of refilling and allows for any reductions in the residual environmental costs of clay mining that are avoided through refilling. The condition for future land use for clay mining is,

$$- CCL + NPBc - SCc - RC - OCL + NPBr + NSBr > 0 \quad (1)$$

where CCL is the economic cost of the clay land, NPBc is net private economic benefits of clay mining, SCc is social (environmental) costs due to clay mining, RC is the replacement cost, OCL is the opportunity cost of the refilled land, NPBr is net private economic benefits of the refilled land, and NSBr is net social benefits of the refilled land, at time zero. The condition assumes that the sample clay pit will be mined within the first six months of obtaining a permit and will be restored within six months of completing the mining. In other words, this analysis assumes that the excavator will complete mining and restoring within one year of commencing operations. The condition for the restoration of the clay pit after clay mining is a sub condition of the future land use condition given by equation (1).

2.1 Available Data

As illustrated in Figure 2, the economic cost of clay land, CCL, the net private economic benefits of clay mining, NPBc and the social (environmental) costs due to transportation of clay, SCc, were estimated previously, as Rs. 800,000 (1 US$ = Rs. 50), Rs. 2,102,395 and Rs. 490, respectively in 1994 prices. Those values will be used in the analysis of this condition.

2.2 Replacement Cost

This section will calculate the replacement cost of the sample clay pit. Replacement cost calculates the cost that would have to be incurred in order to replace a damaged resource. Since the damaged resource cannot be replaced completely, the replacement cost is a lower bound estimate. In this case it would be only the cost to refill the sample pit with a different fill material. For example, cost of replacing approximately sixty five mature coconut trees that are lost per acre of land is not included.

A number of fill materials available in the study area such as, laterite soil, coconut fibre dust and those that can be transported into the study area such as, compost, were studied. As a result of that study laterite soil was found to be the most economical at present. Laterite hills, ranging from 5 feet to about 40 feet above the road level are freely available in the study area.

Laterite has proven to be a good fill material with which many clay pits along the Class A roads in the study area have been filled in the past. Some of the laterite hills in the study area are being excavated at present for fill material. If excavation is stopped at the road level a considerable increase in the market value of that land can be achieved. The reason for this increase being that when laterite hills are sold as housing blocks, the house builder has to spend a lot more money not only to build the house but also to reach ground water for his daily requirements. When a hill is excavated to the road level most people are willing to pay a higher price for the land.

An important data that is required to estimate the replacement cost of using a fill material is the natural settlement rate of that fill material. A previous study has estimated the natural settlement of laterite soil at approximately 80%. Hence, one would need approximately 1.25 cubes of laterite soil to refill 1 cube of insitu clay mined from a pit. Therefore, the volume of laterite soil required to fill the sample pit of 20 Acft is approximately 10,890 cubes.

The excavated laterite soil is mainly transported from borrow pits by tractors. The main reason for this choice is the difficulty of large tipper trucks which could be more economical, to travel on village roads leading to borrow pits. For calculations on cost of refilling, the tractor was considered as the mode of transport for fill material, as it is the most expensive of the vehicles that have the ability to transport and tip fill material.

At 1994 market prices a tractor load of laterite in the study area was sold at Rs. 110. The maximum transport cost within any point of the study area from laterite borrow pits was Rs. 140. Hence, the maximum cost for a tractor load of laterite soil to any clay pit within the study area in 1994 market prices is Rs. 250. A tractor load of laterite soil is approximately 0.75 cubes. Therefore, the cost of laterite soil to refill the sample pit is Rs. 3,630,000 in 1994 market prices. Assuming a 10% contingency on price and quantity fluctuations, the total cost to refill the sample pit with laterite soil is Rs. 3,993,000 in 1994 market prices. The recommended conversion factor for road transport in Sri Lanka is 0.81418, which means that the cost to refill the sample pit in economic prices is lower than the cost of refilling at market prices. Nevertheless, for the benefit cost analysis, the cost at economic prices will be assumed to equal the cost at market prices to obtain a more conservative estimate for replacement cost of the sample clay pit. Then in 1994 prices, the replacement cost of a sample pit of 20 acre feet should be at least Rs. 4,000,000.

2.3 Net Private Benefits of the Refilled Land

The Dankotuwa Divisional Secretariat area is approximately ten miles from the Colombo International Airport and the Free Trade Zone (FTZ) surrounding it. The value of land around the FTZ and its suburbs have been appreciating considerably. There is considerable demand for small blocks of land in the study area for housing. Therefore, it is assumed that if the refilled land is sold immediately after refilling, it will be sold in small blocks for housing. Then, the private benefit of the refilled land would be Rs. 400,000 per acre in 1994 prices, by selling it for housing.

The private benefits from a refilled land if it is not sold for housing, will be from agriculture. The agricultural crops in the study area can be classified as traditional and cash crops. The traditional crops being coconuts and rice, while the main cash crops being banana, ginger, saffron, betel, pineapple and papaw. Discussions with the farmers and the agricultural officers revealed that one would get an higher annual income from cash crops.

A summary of the survey of annual income and expenditure data on different combinations of cash crops that can be grown on an acre of land in the study area obtained from different farmers are given in Table 1. The study of the data in Table 1, reveal that growing betel leaves for export is the most profitable in terms of economic prices. It must be noted that betel is susceptible to a viral disease which can wipe out all the vines within a few months. However, given the current data on cash crops, betel is assumed as the agricultural crop that will give the maximum net annual benefit in the study area. Since we do not know the actual future benefits of a refilled land, it is reasonable, albeit optimistic, to assume the maximum benefits from currently available information as future benefits from the refilled land for the benefit cost analysis.

Table 1.
Benefit per Acre from Cash Crops in 1993 Economic Prices17.

Cash Corps	Benefits/Acre/Year(Rs)
Ginger and Papaya	81,900
Pineapple and Papaya	75,000
Betel Leaves	404,000

2.4 Opportunity Cost of a Refilled Land

Since higher private benefits can be obtained from agriculture, the opportunity cost of a refilled land, the cost for the next best use, will be from housing. Therefore, the opportunity cost of an acre of refilled land in the study area can be considered as Rs. 400,000 in 1994 prices.

The appreciation of land value in the study area is assumed to be same as the discount rate in real terms (i.e without inflation). While this assumption might underestimate the future appreciation of land in the study area given the recent trend, other values can cause theoretical inconsistencies. For example, if the appreciation rate is lower than the discount rate then the present value of the land sold in the future is lower than the value of land today. If the appreciation rate is higher than the discount rate then the present value of the land sold in the future is greater than the value of land today. Therefore, the opportunity cost of the refilled land one year from the start of mining, when refilling is complete, is Rs. 424,000. This makes the opportunity cost of refilled land as Rs. 400,000 in 1994 prices.

2.5 Net Social Benefits of the Refilled Land

The survey of land owners around the clay pits to estimate the productivity loss due to clay mining have shown that there is a considerable impact on the paddy fields, with all paddy fields adjoining clay pits being abandoned and most within two miles being affected. It can therefore be assumed that refilling of clay pits will increase the productivity of adjoining paddy fields and coconut lands to that similar to prior to clay mining.

The survey on productivity loss also identified that there was a loss in productivity due to the draw down of the levels of water wells in homesteads during the dry months. This resulted in the villagers having to deepen their wells, obtain water from neighbors' wells, spend more time in finding water for their daily requirements, and abandon economic activities like home gardening which required the use of well water. It is believed that the draw down of the level of water wells is due to the water levels in clay pits being below the level of the Maha Oya River, the traditional determinant of the ground water level during the dry season. Refilling the clay pits will slower the draw down of the water level and the river will once again become the determinant of ground water level during the dry months. Thereby, increase the productivity of activities dependent on level of water wells to that similar to prior to clay mining.

2.6 Analysis

The condition for future land use for clay mining with estimated values is depicted in Figure 3. The sample clay pit15 is again used for this analysis and it assumes that the sample clay pit will be mined within the first six months of obtaining a permit and will be restored within six months of completing mining. In other words, this analysis assumes that the excavator will complete mining and restoration within one year of obtaining the permit to mine. The social benefits of refilling were not quantified. However, when they are quantified it will increase the net benefits of this condition.

It is seen from Figure 3 that only environmental costs due transportation of clay are included. The annual environmental costs such as annual health cost due to Malaria and annual productivity loss of paddy and coconuts, are not included. The reason is that if the clay pits are refilled, then diseases like Malaria which are caused as a result of clay pits will not occur and the productivity of adjoining lands will be back to a state similar to that prior to clay mining. In other words, we assume that there are no long term impacts on the environment if the clay pits are refilled.

It is assumed that by the middle of year three (year and a half after cultivation), betel will be in full production and the start up costs are recovered from the income during that period and that the estimated net annual economic benefit will be achieved throughout the study period after the end of second year of production (end of third year) as shown in Figure 3. The justification for these assumptions is that this analysis should estimate net present value of the refilled land using maximum net annual benefits of the refilled land from currently available information. It is implicit in this analysis that the net economic benefits obtained from excavating the laterite hills to the road level are equal to or greater than the environmental costs caused by that excavation. In other words, excavation of laterite hills is socially profitable. However, if one wants to assume that environmental costs are greater than the economic benefits, then the present value of that component should be included as a negative value. Also, it is assumed that the values in 1993 prices for betel are the same in 1994 prices.

The net present value of this condition as shown in Figure 3 can be written as,

$$NPV = CCL + \frac{NPBc}{(1+i)^{0.25}} - \frac{ECT}{(1+i)^{0.5}} - \frac{RC}{(1+i)^{0.75}} - \frac{OCL}{(1+i)} + \frac{A}{(i+i)^{3}} * \frac{(1+i)^{n-3}-1}{i\,(1+i)^{n-3}}$$

Assuming January 1, 1994 as time zero, the net benefit at time zero, when the discount rate is 6%, is Rs. 1,857,597. The benefit cost ratio is 1.29.

Table 2 shows a comparison of three conditions, private feasibility of clay mining, social feasibility of clay mining, and future land use for clay mining, as depicted in Figures 1, 2 and 3. The private feasibility condition has the highest benefit cost ratio. Hence, an excavator could argue that the clay pit need not be refilled as that condition has the highest benefit cost ratio from the economic view point. However, the future land use condition has the highest net present value of net benefits, showing that from an incremental analysis the optimal economic condition. Hence, in the future, clay mining in the study area should only proceed if there is refilling.

Table 2.
Comparison of the Three Conditions.

Condition	B/C Ratio	Net Present Value in 1994.
1. Private Feasibility	1.78	Rs. 1,271,991
2. Social Feasibility	1.38	Rs. 798,660
3. Future Land Use	1.29	Rs. 1,857,597

Current practice for clay mining in Sri Lanka, where clay pits are left open after mining, is a sub optimal situation. In addition, externally affected property right owners of adjacent lands do not have effective legal recourse. Even though the estimated values are for the study area, there are no substitute sources of supply without equivalent social and environmental costs. Therefore, it is essential that when the authorities issue a permit to mine clay in the future they have to ensure that the excavated clay pit is refilled.

3.0 Mine Restoration Bond

According to the new Mines and Minerals Act No. 33 of 1992, an important requirement in obtaining the industrial mining license to excavate clay is the posting of a "Mine Restoration Bond" (Form 10 of the Mines and Minerals Act No. 33 of 1992). The legal interpretation of a "Mine Restoration Bond" is that the excavator has a legal obligation to restore the pit after mining to a state similar to that prior to mining. Even though the legal requirement implies a command and control situation for the Mine Restoration Bond, as shown previously the command enforcement is difficult and or doubtful.

If the selected economic instrument motivates the excavators to achieve the environmental goal then it is successful from both policy and administrative points of view6, 10, 14. The Mine Restoration Bond should therefore be implemented in a way that the excavators are motivated to refill the clay pits after removing the clay. For example, most people who rent their houses request a security deposit. The objective of the security deposit is to ensure that the house is returned in a state similar to that prior to renting. Similarly, if the analysis shows that restoration is required, the Mine Restoration Bond for clay mining should be a deposit-refund type of non-tax economic instrument, where the deposit is refunded when the clay pit is restored. In other words, Mine Restoration Bond is the security deposit to ensure that if required restoration of the clay land will happen.

It is therefore suggested that the Mine Restoration Bond be a deposit-refund type of non-tax economic instrument, where the deposit is refunded when the clay pit is restored. The value of the Mine Restoration Bond has to be at least equal to the replacement cost, so that if necessary the authorities can refill the clay pit. It was estimated previously that in 1994 market prices the replacement cost of a clay pit of 20 acre feet should be at least Rs. 4,000,000. Therefore, it is suggested that the Mine Restoration Bond should be at least Rs. 4 million in 1994 prices per acre to be excavated down to twenty feet.

If the excavators are required to deposit a Mine Restoration Bond of Rs 4 million in 1994 prices per acre in full to obtain an industrial mining license, then it is unlikely that most excavators will be willing to or are capable of fulfilling such a requirement. Also, given the socio-economic impact of such a policy, the political will to approve or implement such a recommendation will be lacking. Instead, a bank guarantee equivalent to the Mine Restoration Bond value is recommended as a requirement to obtaining an industrial mining license. When the clay pit is refilled the licensing authority will release the bank guarantee of the excavator. If an excavator does not refill the clay pit, Geological Survey and Mining Bureau of Sri Lanka, the licensing authority can call the bank guarantee and use that money to refill the clay pit.

While excavators will not tie up capital unnecessarily in providing the bank guarantee, it will be sufficient to motivate them to refill the clay pit after excavation. According to bank officials, annual charge on such a guarantee will not exceed 5%. The exact charge is not known as yet because the commercial banks at present do not have a policy to approve a Mine Restoration Bond for clay mining. However, banks have the mechanism to provide bank guarantees in general, and according to the officials, they will not find it difficult to implement such a guarantee if required by the license issuing authority for clay mining.

The excavators knowing that they have to refill the clay pit after mining, will include amount equivalent to the Mine Restoration Bond in their selling price of a cube of clay at the pit head. While the price of clay at the pit head will increase, the clay mining industry will become a 'clean' industry as opposed to the current industry that is causing a lot of long term impacts to the environment.

The immediate impact of the Mine Restoration Bond will be an increase in market prices of clay, clay bricks and clay roof tiles. In reality, the consumers of clay building materials have received a subsidy from the people living in the areas where clay was excavated as they have not paid the social costs for the benefit they receive in using clay bricks and roof tiles. All they have paid as the marginal opportunity cost is the marginal production cost and the marginal user cost19. The people in the area suffer the consequences of clay mining so that consumers, or the construction industry, can purchase the clay bricks and roof tiles at a cheaper price. Conceptually, the cost of restoration of the clay pit and the Mine Restoration Bond will add the marginal restoration cost of clay mining to the marginal opportunity cost of clay bricks and roof tiles.

4.0 Conclusions and Recommendations

The following conclusions and recommendations can be arrived at as a result of this study. These conclusions are directly applicable to the study area. However, with a few modifications they can be generalized to clay mining in Sri Lanka.

1. The net benefits of clay mining including net benefits of refilling and allowing for any reductions in the residual environmental costs of clay mining that are avoided through refilling, are positive. The benefit cost ratio is 1.29. This condition has the highest net present value of benefits. Therefore, in the future clay mining should be permitted on clay lands in the study area only if there is refilling.

2. Even though the benefit cost ratio for the private feasibility condition for clay mining is the highest, the current practice to mine for clay and leave the clay pit open is a sub optimal option. From the incremental analysis we can conclude that the best option is to mine for clay and restore the pit.

3. The policy instrument to ensure refilling (restoration) of clay pits by excavators should be one that could motivate excavators. Therefore, a deposit-refund type of non-tax economic instrument is suggested as the Mine Restoration Bond which is required to mine for clay.

4. The Mine Restoration Bond of Rs. 4 million in 1994 prices, approximately equal to the replacement cost of the sample clay pit of 20 acre feet is suggested. In its implementation a bank guarantee equal to the proposed Bond value would be the most advantageous to excavators.

5. Most of the increase in prices of clay bricks and roof tiles should and will be passed on to the consumers. This is not unreasonable as the consumers of clay bricks and roof tiles have been receiving a subsidy from the people living in the areas where clay is mined as they do not pay the social costs for the benefit they receive.

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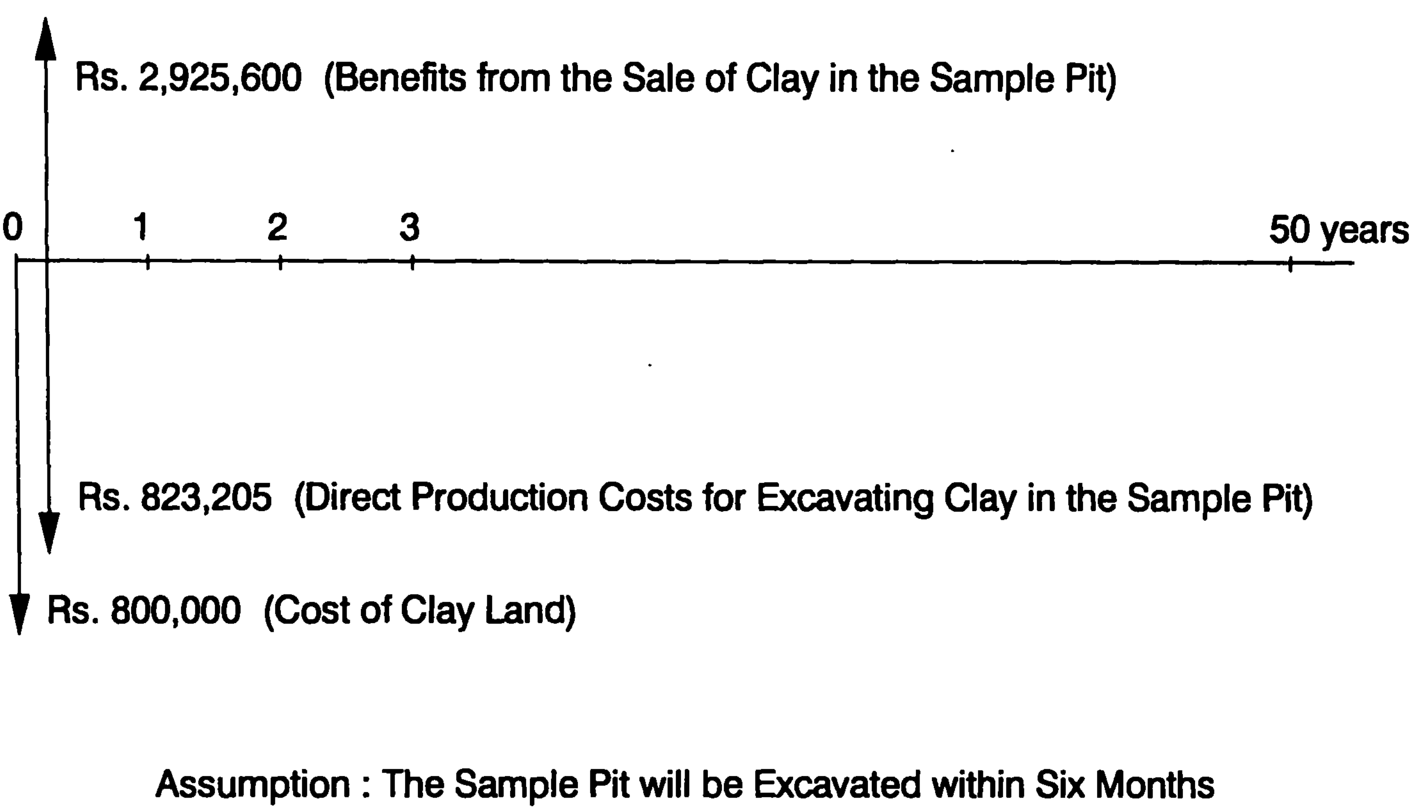
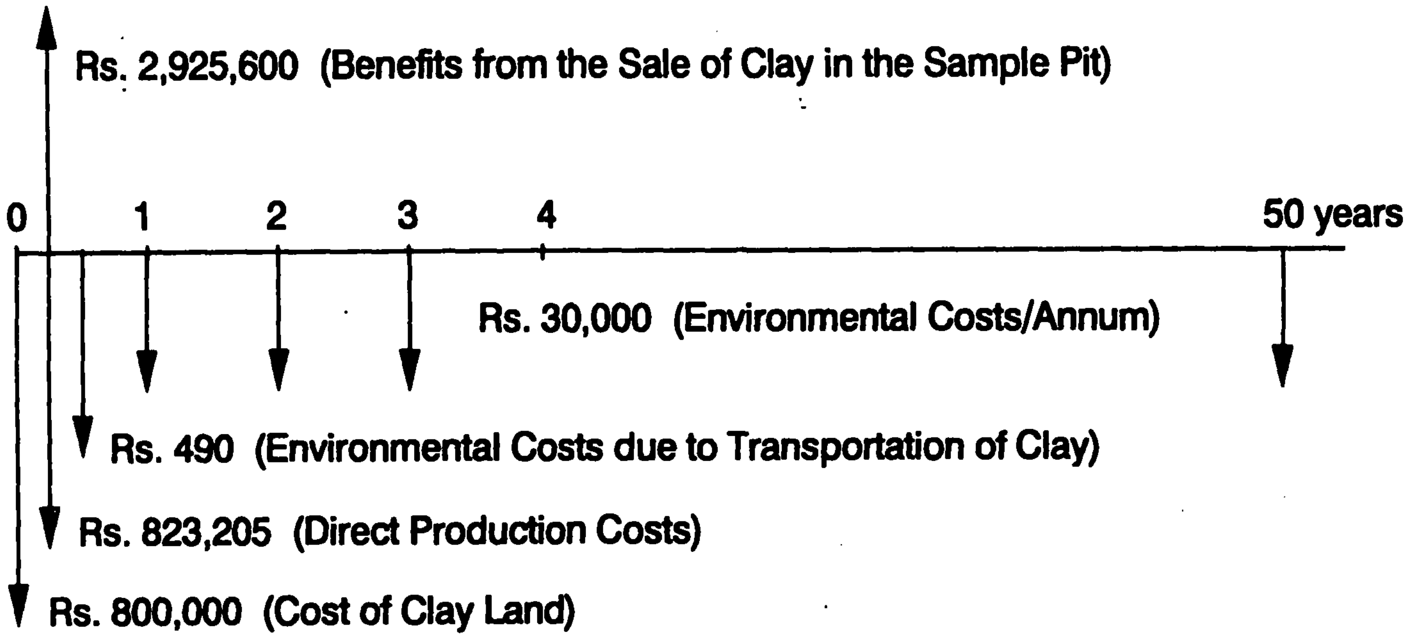
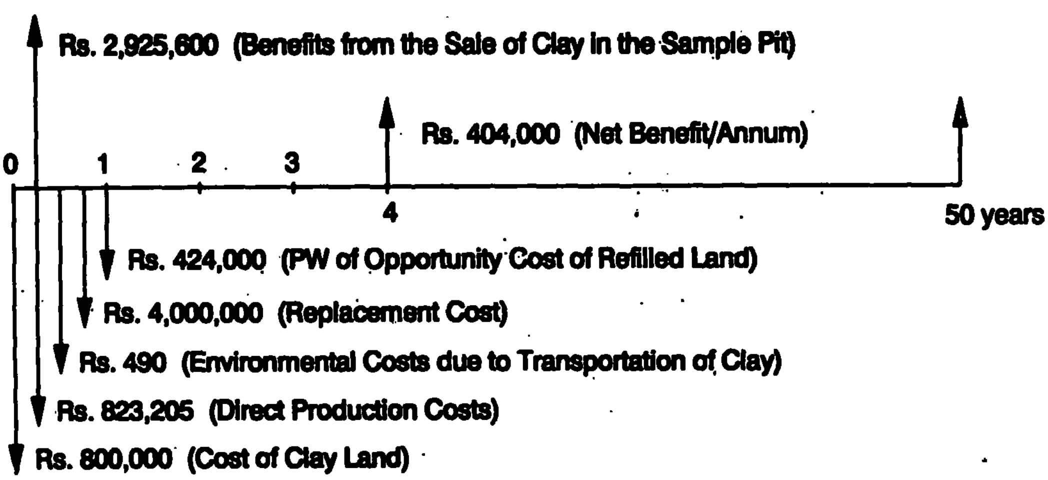


Figure 1. Condition for Private Feasibility of Clay Mining with Estimated Values



Assumption : The Sample Pit will be Excavated within Six Months

Figure 2. Condition for Social Feasibility of Clay Mining with Estimated Values



Assumption : The Sample Pit will be Excavated within 6 months and Refilled within the next 6 months.

Figure 3. Condition for Future Land Use for Clay Mining with Estimated Values