THE CONTRIBUTION OF THE SMALL TRACTOR IN AGRICULTURAL PRODUCTION IN KENYA

BY

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<td>10</td>
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P.M. KININA, AMBIM, MInstSM
INTRODUCTION

Kenya had an average food production growth rate of 3.7 during the period of 1974-78 and currently a population of 14.8 million which grew at an average rate of 3.5 over the same time period. The total agriculture production rate is expected to fall to 3.1 by 1983. The ratio, food produced : population, is decreasing as the total agriculture production growth rate becomes smaller and population growth rate larger.

The overall problem which confronts the agricultural sector of the Government of Kenya is how to increase agricultural production to a level which will feed the people adequately. There are many factors affecting agricultural production yield, I have chosen to investigate the methods of cultivation used in Kenya and their relationship to production yield. I have restricted myself to small-scale farms, 10-200 acres, this being 85% of the farms in Kenya. In terms of cost and production yield, it is my thesis that the use of small tractors can increase the agricultural production in Kenya by at least two folds.

I have carried out my investigation by interviewing farmers in Kericho, Bungoma, Kisii and Nakuru Districts, from March to April, 1979.

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1 - Ministry of Agriculture Working Paper

"Population Growth and the Employment problem and the future of the large farm sector in Kenyan Agriculture (1978) Page 1
At an average growth of 3.5, Kenya will double its 14.8 million people in less than 20 years. By the year 2000, there will be more than 30 million people to feed and house. (This rate of 3.5 is a conservative figure, recent unpublished surveys have estimated the present rate of growth to be as high as 3.9)

As more people are added to the population, large holdings are divided up to accommodate the growing demand for land ownership. Over 800,000 hectares of land have been settled on these small scale farms since independence. During the next Planned Period, several new settlement schemes are planned in Machakos, Kilifi and Lamu. However, the present emphasis will be to further develop the existing schemes so that they become self-sustaining.

In 1965 Kenya had over 0.75 hectares of high potential land per person. By the year 2000, it will be less than 0.2 hectares. "Policies and Programmes dealing with access to land and its use are therefore critically important in determining employment, welfare and income distribution in the rural areas. At independence the basic question was the transfer of land from foreign to Kenyan hands. Now the basic question is the best use of the land for production to assure equity of access among the citizens."

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It has been noted that there are population movements from high potential areas to marginal areas. Some marginal areas are estimated to be increasing at the rate of 30%. Families are leaving the high potential areas due to unavailability of land.

Arid and semi-arid lands constitute 80% of the total land surface of Kenya. It is estimated that 20% of the nation's population and 50% of its livestock live in those areas. The increasing population presence on this fragile ecology has resulted in significant income degradation and limited income opportunities.

Table 1 gives figures on the population by districts where large farms are located as can be seen, some districts are densely populated, while others are not, due to large land holdings.

**TABLE 1**

Projected population - In and Around the Main large Farm Areas in Kenya by District, for 1975, 1980 and 1990.
<table>
<thead>
<tr>
<th>YEAR</th>
<th>DISTRICT</th>
<th>1975 TOTAL POP. ('000)</th>
<th>1975 DENSITY</th>
<th>1980 TOTAL POP. ('000)</th>
<th>1980 DENSITY</th>
<th>1990 TOTAL POP. ('000)</th>
<th>1990 DENSITY</th>
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<tr>
<td></td>
<td>Total Pop. for</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kenya (Series B)</td>
<td>13,413</td>
<td>-</td>
<td>15,677</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Trans Nzoia</td>
<td>166</td>
<td>67</td>
<td>209</td>
<td>84</td>
<td>318</td>
<td>127</td>
</tr>
<tr>
<td></td>
<td>Uasin Gishu</td>
<td>249</td>
<td>66</td>
<td>308</td>
<td>81</td>
<td>455</td>
<td>120</td>
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<td></td>
<td>Nakuru</td>
<td>360</td>
<td>49</td>
<td>430</td>
<td>59</td>
<td>597</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>Kericho</td>
<td>628</td>
<td>127</td>
<td>783</td>
<td>158</td>
<td>1,174</td>
<td>237</td>
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<tr>
<td></td>
<td>Nandi</td>
<td>253</td>
<td>91</td>
<td>297</td>
<td>106</td>
<td>397</td>
<td>142</td>
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<tr>
<td></td>
<td>West Pokot</td>
<td>93</td>
<td>18</td>
<td>102</td>
<td>19</td>
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<td></td>
<td>Elgeyo Marakwet</td>
<td>184</td>
<td>65</td>
<td>205</td>
<td>73</td>
<td>249</td>
<td>89</td>
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<tr>
<td></td>
<td>Baringo</td>
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<td>172</td>
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<tr>
<td></td>
<td>Narok</td>
<td>153</td>
<td>8</td>
<td>186</td>
<td>10</td>
<td>276</td>
<td>15</td>
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<tr>
<td></td>
<td>Kakamega</td>
<td>979</td>
<td>275</td>
<td>1,173</td>
<td>331</td>
<td>1,657</td>
<td>466</td>
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<tr>
<td></td>
<td>Bungoma</td>
<td>450</td>
<td>148</td>
<td>558</td>
<td>183</td>
<td>827</td>
<td>271</td>
</tr>
<tr>
<td></td>
<td>Kisumu</td>
<td>508</td>
<td>244</td>
<td>619</td>
<td>297</td>
<td>890</td>
<td>427</td>
</tr>
<tr>
<td></td>
<td>Nyandarua</td>
<td>218</td>
<td>166</td>
<td>243</td>
<td>76</td>
<td>313</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Kiambu</td>
<td>570</td>
<td>221</td>
<td>676</td>
<td>262</td>
<td>921</td>
<td>357</td>
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<tr>
<td></td>
<td>Muranga</td>
<td>534</td>
<td>211</td>
<td>623</td>
<td>246</td>
<td>824</td>
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<td>Kirinyaga</td>
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<td>205</td>
<td>400</td>
<td>268</td>
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<td></td>
<td>Nyeri</td>
<td>444</td>
<td>132</td>
<td>524</td>
<td>156</td>
<td>711</td>
<td>212</td>
</tr>
<tr>
<td></td>
<td>Laikipia</td>
<td>72</td>
<td>7</td>
<td>73</td>
<td>8</td>
<td>76</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Meru</td>
<td>724</td>
<td>76</td>
<td>851</td>
<td>89</td>
<td>1,140</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>Embu</td>
<td>227</td>
<td>79</td>
<td>277</td>
<td>96</td>
<td>398</td>
<td>139</td>
</tr>
<tr>
<td></td>
<td>Machakos</td>
<td>846</td>
<td>60</td>
<td>980</td>
<td>69</td>
<td>1,277</td>
<td>90</td>
</tr>
</tbody>
</table>

**Source:** Central Bureau of Statistics, Ministry of Finance and Planning.
Land of good quality is scarce in Kenya. Most of the high and medium potential land is concentrated in the Central Highlands and Western Kenya. This is less than 17% of the total land area. Here one will find some of the most advanced daily products, tea, coffee, and pyrethrum in the world. On the other hand, one will find wooded steppe and bushed grassland in the drier parts of the country. Kenya's total arable land is estimated at 17.5% or 98,463 square kilometres. The total area of Kenya is 582,646 square kilometres. Of this, 14,000 square kilometres are under water and swamp, as stated above, Kenya arid lands are estimated to be 80% total land area.

The country's altitude ranges from sea level at the Indian Ocean to 5,200 above sea level; 38% is less than 500 metres above sea level, 34.5% is between 500 metres and 1,000 above sea level, 26% is between 1,000 and 2,500 metres above sea level and 1.5% is more than 2,500 metres above sea level. Much of the land between 150 metres and 1,000 above sea level is semi-arid and arid.

The seasons vary very little in terms of temperature in most of Kenya. These are though, four fairly well-defined periods; January, February and March are the warmest and driest months in the eastern half of the country, including Nairobi and the Highlands; April, May and early June are usually the months of heavy rainfall, commonly called the 'long rains', late June, July and August constitute the cool period. September and October are sunny and dry;
November and December are the months of the 'short rains'.

Inspite of the 'rain seasons' Kenya has a rainfall of 510 millimetres or less. This deficiency in water supply impedes agricultural production greatly.

Inspite of the small ariable land and the deficient rainfall Kenya is basically an agricultural economy, 37% of foreign exchange was earned by agricultural exports during 1976. Ideally, there are two planting seasons, one in time for the 'long rains' and one in time for the 'short rains'. The type of crop planted at what time depends on the water requirements of that crop.

2.1 FARM SIZE

Farm sizes range from less than one acre to thousands of acres, from a family trying to dig a subsistance existence, to large plantations owned by Europeans, a few Kenyans and co-operative societies.

Many of the large farms formally owned by Europeans are being bought by the Government, sub-divided, and sold to the people. In this way, more families will have use of the land.

As can be seen from Table 1, if the very large farms are kept intact, many people in the densely populated areas would continue to be landless.
"The intense large hunger in these areas outside the large farm areas is indicated by the growing numbers of landless families, the extensive migration to unemployed poverty in urban slums, and the movements of population into the lower potential rural areas where agriculture is extremely risky and famine endemic. Under such circumstances, it is extremely difficult to justify maintaining large areas of high potential land under low population densities."  

The argument given in the past is that these large farms high productivity would be undermined if they were subdivided.

This argument no longer holds. It has been demonstrated that the commercialised small scale farms are more efficient than the large scale farms. This however, is mainly due to the lack of peoples management of the large farms. Owners are less interested in the production yield then in the assets value of the land.

With the high population growth rates along with many other disturbing factors as discussed earlier, the nation cannot afford this great under-utilization of high potential land.

However it is not enough to sub-divide the land and content with the increase in crop yield gained from the division.

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This in itself will not increase production yield to an acceptable, not to mention, desirable level. There is a need for additional input in order to realize the potential of the land. Specifically, there is a need to develop innovatory farming systems that will fit in with the resource constraints of small holdings and will allow their intensifications. There is also a need to make readily available non-farm produced complementary inputs such as fertilizer, new seed varieties and insecticides which increase the productivity and intensity of land use.

The large farms use large tractors and complimentary implements to till the soil. The mere size alone makes this equipment to incorporate for use on the small farmer. Even if they were used in spite of their size, the cost would be too great. The initial investment of a large tractor is around Shs. 104,000. The maintenance of this machine is an ongoing expense.

The small-scale farmer cannot afford to purchase the farming equipment that was used previously, before the farm was sub-divided.

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4 - This is the current price of a M.F. 165 with 62 H.P.
2.2. **GROWING FOOD DEMANDS**

The demand for more food is increasing at a fantastic rate. It is predicted that the demand will increase by 3.9% to 7.5% for different commodities from 1978 to 1985. These estimates were prepared by the World Bank based on current predictions of population and income growth. Table 2 gives a breakdown of demand increase for 1972-1978, and 1978-1985, for basic food-stuff. As the table shows, the increase in demand is high. This in itself does not mean much, but when compared to the total agriculture production growth rate, which is expected to fall to 3.1% by 1983, one can appreciate the problem better.
### Table 2

**Projected Food Demands, 1978 and 1985**

<table>
<thead>
<tr>
<th>Produce</th>
<th>Thousand Tonnes</th>
<th>Annual Growth %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1972</td>
<td>1978</td>
</tr>
<tr>
<td>Wheat</td>
<td>160.8</td>
<td>217.6</td>
</tr>
<tr>
<td>Rice</td>
<td>22.8</td>
<td>29.6</td>
</tr>
<tr>
<td>Maize</td>
<td>1522.9</td>
<td>1917.4</td>
</tr>
<tr>
<td>Sorghum and millet</td>
<td>87.6</td>
<td>112.5</td>
</tr>
<tr>
<td>Pulses</td>
<td>240.0</td>
<td>321.3</td>
</tr>
<tr>
<td>Starchy roots</td>
<td>1394.5</td>
<td>1061.1</td>
</tr>
<tr>
<td>Sugar</td>
<td>159.6</td>
<td>235.4</td>
</tr>
<tr>
<td>Veg., Oil &amp; fats</td>
<td>31.2</td>
<td>45.9</td>
</tr>
<tr>
<td>Animal fats</td>
<td>4.8</td>
<td>7.4</td>
</tr>
<tr>
<td>Meat, Fish and poultry</td>
<td>224.8</td>
<td>346.5</td>
</tr>
<tr>
<td>Eggs</td>
<td>6.0</td>
<td>8.9</td>
</tr>
<tr>
<td>Milk, &amp; Milk Products</td>
<td>944.5</td>
<td>1350.3</td>
</tr>
</tbody>
</table>

**Source:** Ministry of Agriculture Working Paper

"Population Growth, Employment Problem, and Future of Large Farm Sector in Kenyan Agriculture".

- 10 -
The increasing gap between the growth in supply and growth in demand implies that an increasing proportion of total agricultural resource will have to be allocated to domestic food production which in turn implies a decreasing proportion available for the production of exports and industrial inputs, the major bases of overall non-agricultural growth in the Kenyan economy.

This process will undermind any attempt at development unless means are developed to intensify agricultural productions. Increasing population pressure is expected both to increase the opportunity cost value of subsistence output, and the market value of food crops. Unless the returns from non-food crops production increase at the same rate there could be substantial reallocation of food production at farm land. This emphasises that subsistence production makes no less a significant contribution to the national economy than commercial production. The increasing difficulties of maintaining food supplies for the growing population means that food production level, whether for farm family subsistence or for sale, become critical determinants of economic progress.

Now, let us review the problems before us.

1. Kenya has a food production growth rate of 3.7%, which is expected to fall to 3.1% by 1983, and a population growth rate of 3.5% and rising.
2. Only about 17% of the land is suited for agriculture production.

3. There are population movements from high potential areas to marginal potential areas where farming is extremely risky.

4. Kenya has a deficient rainfall.

5. Due to population pressure more food will be used simply to feed the people, leaving less for export.

6. With less food for export, less money is earned for investments.
CHAPTER 3

PRODUCING MORE FOOD

The problems are great and are of the sort that need immediate solution. However, the answers are not immediately obvious. Not only is the country suffering from a low food production growth rate, the natural factors which could contribute to higher yield are in effect contributors to the low food growth rate; water supply and arable land. In fact 15 million people are feeding from 98,500 square kilometres of land. This is a density of about 152 persons per square kilometre. This figure becomes larger when we take into consideration the crops raised for exports.

The immediate problem before us, that is the problem which must be solved before we can adequately deal with the others, is how to increase food production. Taking into consideration the constraints outlined above, "How can Kenya increase its production yield?"

Much research has gone into crop yield. Among other findings one of the most important factors contributing to high crop yield is proper preparation of the soil before planting. Bad tillage lead to unnecessary soil
and water loss. The seed-bed should be prepared with minimum disturbance of the soil, which means that deep ploughing and trash burial are undesirable. This is especially important in Kenya where 80% of the land is arid and semi-arid.

**PREPARING THE SOIL**

Over the years, various farm implements have been designed and developed to till the soil in a manner to get maximum returns. These implements were designed and are being continuously imposed upon with two objectives in mind:

1. To prepare the seed-bed for the soil properly, and
2. To prepare the seed-bed in accordance with the type of soil. With these developments, different types of soil will not be subjected to the same implements. This avoids shallow top soil from being ploughed too deep, or deep top soil from being ploughed too shallowly. Light dry soil will not be unduly disturbed, and so forth.

In a country where 17% of the land is arable and 80% is semi-arid and arid, it would be a suicidal act to till these two very different types of soil in the same manner. The semi-arid land cannot withstand the same treatment as the arable land.
Preparation of the land for planting can be divided into two stages; Primary tillage and Secondary tillage.

**PRIMARY TILLAGE**

Primary tillage is the most important operation carried out on the farm. It is during this operation when the depth of disturbance of the soil is determined. This operation is carried out with the use of the mould board plough or chisel plough, depending on the type of soil.

But before ploughing begins, the farmer should stubble clean his field. This consists of cultivating the land to a depth of two or three inches and may be carried out with a cultivator or rotavator; the purpose being to produce quickly a shallow seed-bed for weed seeds to germinate in, so that when the land is subsequently ploughed, growing weeds, not dormant weed seeds are buried.

In some soils, repeated cultivation at the same depth form a hard crust known as a "Plough Pan" and if allowed to persist will result in the long term reduction in yield. The "Plough Pan" limit the water holding capacity of the soil as moisture cannot percolate through this serious flooding could result.
To break up this pan, the farmer should use the subsoiler. The operation should be carried out every three to four years. It should be done when the land is as dry as possible so that full advantage can be taken of the soil's shattering effect.

As stated above, the mouldboard is one of the ploughs used to carry out the primary tillage. There are two types of mouldboard ploughs, the conventional and the reversible. Whichever plough is used, the effects and advantages are the same; a rectangular strip of soil is cut, lifted and inserted, a fresh layer of soil is exposed. This permits a balance of air and moisture within the soil itself.

There are several bases available for use with the mouldboard plough. The one used by the farmer will depend on the soil and crop to be planted.

The Lea Base
Has a gentle action as it passes through the soil, and leaves an unbroken furrow, well set up.

The Semi-digger Base
is shorter than the lea base and has a concave mouldboard. Work produced can be altered by forward speed, thus travelling fairly slowly produces an almost unbroken furrow slice, whilst speeding up results in a greater
soil shattering effect. This soil shatter is essential if one is producing an immediate seed-bed, as it helps to reduce the cost of secondary tillage. Maximum depth of work is $\frac{3}{4}$ of furrow width, i.e. 12" base = 9" depth.

**The Digger-base**

is abrupt, deep and steeply concave, and produces a high degree of soil shatter. It is used for deep ploughing in preparing the soil for root crops etc. Maximum depth is 2" less than width i.e. 12" base = 10" depth.

**The Deep Digger Base**

is the largest mouldboard available and is capable of completely inverting a square furrow. It is used in land reclamation.

**The Chisel Plough**

In recent years there has been a great increase in the use of the chisel plough as a primary tillage implement. The chisel plough has a ruggedly constructed open frame, with heavy duty lines attached to it. It is used mainly in free draining high and medium tamped soils. The advantages of the chisel ploughs are: the speed with which they can be operated, and the way in which they maintain the soil strata. This is particularly important in shallow top soil areas. The usual procedure is to
chemically control weed growth prior to chisel ploughing. After this two diagonal passes are sufficient to produce a suitable tilt.

Having completed the mouldboard ploughing of a field, the condition of the soil is still far from ideal for plant growth. In light soils the seedbed will be too "fluffy" and will require consolidating to remove excess air. In heavier soils there will be large air pockets, and the average clod size will be too large. To deal with breaking down of clods to a desirable size and consolidation of the seedbed, we move on to secondary tillage.

**Secondary Tillage**

The **disc harrow** is an excellent implement for breaking down clods and consolidating the seedbed without dragging buried trash to surface. As with secondary tillage implements, it should be operated at a fairly fast forward speed to obtain adequate soil shattering effect. It is usual to find scalloped discs on the front gauge of disc harrows. These are more aggressive in their treatment of large clods than plain discs.

The **Rigid Tine Cultivator** is used in preparation of a deep seedbed for such crops as potatoes, roots, etc. It breaks down sub-surface clods to the desirable size as well as
ensure uniform consolidation of the seedbed.

The Spring Tine Cultivator is equipped with light tines that vibrate as the implement is drawn through the ground. Operated at high speed, around three inches deep, they add the tine much more effective in breaking down clogs than its rigid tine counterpart which tends to deflect the clod until little breakdown. Fairly recently the heavy duty spring tine cultivator has been introduced which combines the advantages of being able to operate fairly deep with vibrating tines.

Proper timing of the foregoing operation is extremely important if one is going to take advantage of the optimum germinating period, and growing period of the subsequent crop.

Proper cultivation of the soil include conservation of the soil. Kenya has precious little good soil. Our objective of producing more food must be integrated with soil conservation.

Soil erosion is the loss of suitable soil for plant growth by wind and/or rain. As the foregoing discussion has demonstrated proper tilling of the soil enhances does include soil conservation, steps are taken to remove the "Plough Pan" if it has developed.
Also different implements are used on different types of soil.

Erosion caused by wind and water are inter-related in that both are often caused by the land's inability to hold all the water that falls on it. By increasing the water holding capacity of the soil, not only will the surface run-off be reduced, but the overall moisture content of the soil is increased thus decreasing wind and water erosion. With more moisture in the soil, an increase in yield can be expected.
Farming methods used in Kenya

The large scale farmer performed the foregoing tasks more or less. The question which now arises is, to what extent are the small-scale farmers tilling their fields in the proper manner? To get the information, I interviewed farmers in Nakuru, Kericho, Bungoma, and Kisii Districts. The following was found:

In Litein, Kericho District, I interviewed 40 small scale farmers who owned tractors. 38 out of these small-scale farmers owned small tractors of 30 H.P. Two of them owned large tractors of 60 H.P. The 38 who owned small tractors were doing well. They were tilling their soil properly and making impressive profit from their yields. Unfortunately, the two big tractor owners were not so well off due to expensive maintenance of the large tractors. Also the tractors were too large to handle with ease on the small farm. Thus the profits were not as impressive as the others.

From a survey I took in Kericho, Bungoma and Kisii, I found that out of the 100 farmers I talked to, 40 used oxen to do their ploughing. I was told by the farmers that immediately they plant their seeds without just harrowing, no means of harrowing is available for oxen. Thus this farmers get very low returns from their crops.
I talked to five farmers who used hoes and pangas to cultivate their land. These farmers had between 1 - 10 acres of land. Because their acreages were so small they had not been able to accumulate enough capital to hire even oxen. So they were left with no choice but to use hoes.

Tilling the land by hoe is very difficult and slow. Of course it goes without saying that the land is badly prepared. It is simply dug up with the hoe, no other implements are used. The yield is very poor. A maximum of 8 bags of maize per acre.

Results of the different farming methods

A closer look at individual cases will shed more light on the situation.

CASE A

In Nakuru District at Ngwataniro farm, a small-scale farmer owns 20 acres of land. 15 acres are under cultivation. This farmer tills his land with hired labourers using hoes.

He hired 10 labourers per day, working from 8 a.m. to 4.30 p.m., a total of 8 working hours per day. Each labourer was paid Shs. 10 per day, 6 days per week. Th labourers were able to dig $\frac{1}{2}$ acre per day. Each day the farmer paid out Shs. 100 to the labourers for preparing $\frac{1}{2}$ acre of land.
It took the labourers 30 days, 240 men hours to finish digging the 15 acres. The farmer paid a total of Shs.3,000 to the labourers. The following was observed:

1. The land was badly prepared.
2. The farmer was late in planting.
3. At the time of harvesting he only got 120 bags of maize from his 15 acres, an average of 8 bags per acre.
4. After selling his maize, he got a net profit of Shs.1,500.

**CASE B**

In Rare Settlement Scheme in Nakuru District, a small-scale farmer wanted to cultivate his 15 acres of land with the use of an ox. He hired the ox from 8 a.m. to 4.30 p.m. for Shs. 90. The ox could only plough \( \frac{3}{4} \) acre per day. The ploughing took 30 days to finish, 240 hours. The farmer paid a total of Shs.2,700 for the use of the ox.

The following was observed:

1. The land was not done well
2. The farmer was late in planting
3. After harvesting, the farmer got 150 bags of maize from his 15 acres, an average of 10 bags of maize per acre.
4. The farmer got a net income of Shs.3,500
CASE C

In Nakuru District on Kiamunyi farm, a farmer owns a small scale farm of 20 acres. He has 15 acres under cultivation. This farmer owns a small tractor of 30 H.P.

The farmer ploughs 8 hours a day. He is able to plough 5 acres per day, consuming Shs.100 of fuel daily. The farmer finishes ploughing in three days, 24 hours. He spends a total of Shs.300 on fuel for ploughing 15 acres.

The following was observed:
1. The farmer prepares his land properly.
2. He takes a short time to prepare his land, thus planting in plenty of time.
3. He spends little money.
4. Because the land is properly prepared, he harvest 375 bags of maize from his 15 acres, an average of 25 bags per acre.
5. After selling his maize, he got a net profit of Shs.20,000.

The advantage of properly preparing the land can be easily appreciated. But as we see, few small-scale farmers are doing this. Out of 100 interviewed, only 40 were making use of the tractor pulled implements. The others used oxen and hoes.

Although our main concern here is with increasing food yield, we must take into consideration the initial cost of the tractor and implements. The selling price of a small tractor is between Shs.16,000 and Shs.50,000. If a farmer buys a tractor for Shs.16,000 and plants 15 acres of maize, he can
expect to recover his investment after only one harvest. If he purchases the most expensive one for Shs.50,000, he can expect to recover the investment after three harvests of 15 acres of maize. The implements are much cheaper and the capital invested in them is much less and can be recovered quickly. Maintenance cost is relatively low, much lower than the cost of feeding an ox.

Now that it is quite evident that the use of tractor pulled implements have a positive relationship to food production yield, we got to the next step of looking for means of getting the small tractor to the small-scale farmer.

One way to deal with this is for a few farmers, say 2 - 4, to come together and buy one tractor and the necessary implements. This machinery will be used among the farmers. As the farmers’ crops yield increase, each one, in turn can purchase his own equipment. One of them could purchase the tractor and implements owned by the group.

The main advantage in owning one’s own tractor is that it is at your disposal whenever you need it. Thus maximizing the use of the land. This can be illustrated in the following cases:

I talked to two farmers in Njoro. Both owned 25 acres of land. One farmer owns a 29 H.P. tractor. Last season he planted peas in five acres, potatoes in five acres and maize in ten
acres. After harvesting, the farmer made a net income of over Shs.30,000. He then ploughed and harrowed his land immediately and rotated his crops. He obtained almost the same net income.

The other farmer hired a tractor and ploughed about 20 acres, planting peas, potatoes and maize also. Because the land was prepared hurriedly, the farmer earned a net income of Shs.20,000 only. He did not plant again because he did not have means to prepare his soil. On the other hand if he had owned a tractor he could have started preparing his land in time to allow for proper cultivation and after harvest he could have rotated his crops and planted again.

However, for the very small farms, 10 acres or less, it will be economical if two or more farmers invest in one small tractor jointly. With 10 or less acres, the physical size will simply not be large enough to get maximum use of the tractor. I suggest that they form a co-operative, buy one or two tractors depending on the total number of acres to be cultivated. The number of farmers in each co-operative should be kept down to a size where maximum use will be made of the equipment without causing undue inconvenience to anyone farmer.

There are further advantages of owning a tractor. Apart from pulling implements used in cultivating the land, the
tractor can be used on the farm to perform the following jobs:

1. Transporting farm produce to the market
2. Spraying coffee or wheat
3. Doing all trailer work on the farm
4. Logging

As compared to preparing the above jobs using labourers or oxen, it is time saving and cost less.

Another question which needed answering is "Do the small-scale farmers want small tractors?".

I interviewed 400 small-scale farmers in Nakuru, Njoro, Molo and T.Falle. Out of the 400, 380 would like to own small tractors, 20 were interested in large tractors.

The reasons given for their preference for small tractors are:

1. The cost is low, Shs.16,000 - Shs.50,000
2. They are inexpensive to maintain and operate
3. Their size are suited for the small farm.
4. They can do most of the jobs on the small farm.
5. They will help increase the crop yield so that more money will be realized.
6. Due to their size, they will plough well on hilly farms.

Infact if more small tractors were available in Kenya, more small-scale farmers would have them. There are a
total of about 9,000 tractors in Kenya and only about 500 of these are small tractors and are being operated by small-scale farmers and co-operatives.
Overall Benefits of the Small Tractor

The small-scale farmers using a small tractor can increase his crop yield from $2\frac{1}{2}$ - 3 times his crop yield when using the hoe or ox. If 85% of Kenyan farmers, or even 50% doubled their production yield, Kenya certainly would not have a domestic food problem. As a matter of fact, there would be a large surplus. This is desirable. This 'surplus' can be exported to earn foreign exchange.

Now that the farmer is guaranteed a high yield, he can plant less for domestic consumption and enlarge his field of crops for export. In other words, now that the basic problem, food for the population, is taken care of, one can invest some of his time and energy elsewhere, in this case producing crops for export.

With a larger quantity of agricultural products for export, more foreign exchange is earned. This capital can be invested in other sectors of the economy.

As stated earlier, Kenya has an agricultural economy. The growth of the country originates from the soil. The amount of foreign exchange earned by agricultural products determines the degree of development made elsewhere. One of the crops which brings in a considerable amount of foreign exchange is coffee.
In 1976, Kenyan coffee earned £70 million and in 1977, £80 million.

Although the cost of farm input are rising, just as other inputs in all other sectors are, world market prices are high enough to cover these costs and still leave the farmers with a reasonable profit.

By using tractors to cultivate the land, small-scale farmers will not only be able to feed the nation but will also produce a large surplus for export. That is, the tractor will enable the farmer to go beyond the mere stage of keeping the growing population fed. Their use will in fact help to create jobs for the large number of unemployed.

How can this be done, when in fact the tractor reduces the labour required on the farm considerable?

The unemployment rate in Kenya is high. About 9.4% of the labour force is unemployed. If small farmers mechanized on a large scale, the unemployment rate will become even greater. As was demonstrated earlier, a small tractor can do the same job as labourers much more efficiently. A man with a tractor working 15 acres of land can till it in three days. On the other hand, it will take 10 labourers, 30 days to dig 15 acres. With the use of a tractor one labourer can replace 100 labourers. So for every day a
tractor is used, 99 labourers are being replaced. As compared to using the ox, for everyday a tractor is used a labourer loses a day's work.

This being the case, can we truly justify the use of small tractors on a large-scale basis in a country suffering from a high unemployment rate?

Let us back us a bit. Our biggest problem was to produce enough food to keep pace with the growing population. We saw that this could be accomplished by introducing modern tractors drawn implements to the small-scale farmer. Infact we would produce a large surplus. So our most immediate problem was solved. Kenyans will continue to be well fed.

The farmer can produce more for export. The predicted growth rate for total agricultural out-put for the Planned period is 4.7%. This is the growth rate expected if the growth trend changes, that is if the Plan is carried out as outlined. The predicted growth rate of 3.1% by 1983 is probably more realistic. Be as it may, this figure, 4.7%, is dependent on production development and not higher producer prices, as prices for Kenya's main exports crops, coffee, tea and sisal, are expected to remain constant or to decline during the coming five years.

The foreign exchange earned from the agricultural exports
can be used to invest in other sectors of the economy. Capital can be invested into new industries, and the expansion of existing industries. The expansion of the industrial sector will automatically cause the creation of new jobs. These jobs will pay a higher wage than the farm labour, thus the worker will have more purchasing power. His purchasing will stimulate the economy in other areas.

The manufacturing sector is the second largest sector in the economy. Manufacturing has grown very rapidly since independence. It is expected to continue to grow at an average annual rate of 9% during the Planned Period. By 1983, the manufacturing sector is expected to contribute 15.8% to Government Development Plan. In 1976, this sector contributed 13.3%. According to the Plan, an additional 40,000 jobs will be created in the modern manufacturing sector. Presently, 118,000 people are employed in manufacturing. With a greater investment in manufacturing, the number of jobs can be greatly increased.

There will be capital for investment in housing projects, schools, office buildings, etc. Construction of buildings calls for labourers.

More capital will be invested in better communication and transportation systems. These investments create jobs. The list continues.
As new industries are created, Kenya will depend less and less on imported goods. That is, more and more products will be manufactured locally. It is usual that with heavy machinery, the first stage in localizing the product is to import the parts and assemble them locally. This is happening with Pick-up trucks. General Motors is assembling trucks locally. With the opening of the assembly plant many jobs were created.

We can thus assume that if farmers use tractors on a large scale that it will be very profitable to invest in an assembly plant for implements. These plants could be located in the rural areas, thus helping to avoid crowded living conditions in the cities. In fact the jobs taken over by the use of tractors can now be partly replaced by the production of tractors and other farm implements.

With Kenya's economy well on its way, and the country enjoying the benefit afforded by agricultural exports and industrial export, the economy can invest in the development of its semi-arid and arid lands. This of course is costly and should be approached cautiously. However, the development of these lands would open up many new possibilities for Kenya.

The development of arid and semi-arid land has become a matter of high priority for the Plan Period. During this five year period, 1979 - 1983, an integrated approach will be developed combining dry land mixed farming of annual
crops, perennial crops and livestock. The objective is to develop farming systems for medium-low and low-potential areas, which allows reliable production in household needs and market sales for the increasing population in arid and semi-arid areas. By doing this, the people of the arid and semi-arid areas will be more or less self-supporting. The development of these lands will reduce the erosion caused by the misuse of the land, create jobs to alleviate the population pressure on the arable land.

It also follows that with a sound economy, adequate food, facilities and services for the people, the health of the population will improve. Maternal and infant mortality will decrease to a level close to that of the general population.

Kenya has a national family planning programme. It is intercepted with Maternal and Child Health, MCH/FP. The objective of this programme are dual; to improve the health of mothers and children under the age of 5 years thereby reducing mobility and mortality rate for these two groups, and to reduce the population growth rate by motivating parents to practice family planning.

A new cadre of civil servants was created to teach and motivate the population on proper nutrition, hygiene, preventive medicines, (immunization, etc) and family planning. This new cadre Family Health Field Educators. They go to the homes of the people and talk to them.
This enables them to see what the actual problems are so that they can advise the parents on the specific problems that affect them.

One of the basic assumptions made by the planner of this programme is that once the health of the people, especially the mothers and children has been improved, they will be more receptive to family planning.

Studies have shown that educational levels and infant mortality rate in a society, a decline in fertility will occur. The two variables, education and infant mortality are inter-related.

One of the objectives in the Fourth Development Plan is to wipe out adult illiteracy by 1983. The Plan also calls for increased enrollment in primary schools to the university level. This being the case, we can assume that in the very near future, Kenya will experience a natural fertility decline brought on faster by the increase in food production which is responsible for the better equipped schools and qualified teachers and low infant mortality rate.

Tables 3 and 4 show the predicted increase in student enrolments from 1979 to 1983, and the increase in recurrent costs of education for the same periods.
Table 3

Growth of Student Enrollments, 1978-1983

YEAR


Source: A short version of The Fourth Development Plan, 1979-1983, P. 52
Table 4
Growth in Recurrent costs of Education

- Primary
- Secondary
- Technical Education
- Teacher Education
- Special Education

A Polytechnic and Post-secondary
B University
C Administration, Planning & Miscellaneous

Source:
A Short Version of The Fourth Development Plan, 1979-1983
P. 53
CHAPTER 6

Conclusion

"Over 85% of the nation's population lives in rural areas, and most of them make their living from agriculture. The rapidly growing urban sector depends on the growth of purchasing power in rural areas. Improved growth and welfare in agriculture are therefore basic determinants of the pace of economic and social progress in the nation."

Agriculture is the 'back bone' of the Kenyan economy. It is a spring board for other economic ventures. Thus it is extremely important that agricultural output be maximized so that Kenyans will not only enjoy the direct benefit of agriculture yield, i.e. enough food for domestic consumption, but also, so that the indirect benefit can be enjoyed, i.e. better housing etc.

There are several factors which make the task of a high agricultural yield difficult; shortage of arable land, inadequate rainfall, high population growth rate and poverty among the farmers themselves. The combination of natural and social problems make the task almost impossible.

The integrated Rural Survey in 1977 showed that over 40% of small holder farming families had incomes that were scarcely sufficient to provide the basic necessities of life

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5 Planning for Progress: Our Fourth Development Plan, 1979-1983, P.27
The population was estimated to have increased on an average annually by 3.5% between 1975 and 1979. This growth rate is increasing rapidly, some estimates put it around 3.9% by 1980.

The average food production growth rate for the same period was estimated at 3.7% and falling. By 1983, it is estimated to be around 3.1, if the present trend continues.

The Fourth Development Plan outline in detail a strategy for dealing with this problem. However, I am of the opinion that the Plan make use of conservative estimates in terms of population growth and very liberal estimates in terms of expected agricultural production growth rates.

With this in mind, I believe that initially every effort should be made to increase the agricultural production yield as much as possible and as quickly as possible. It cannot be emphasised enough, agriculture is the foundation of the Kenyan economy. It is the nation's chief foreign exchange earner.

Therefore, Kenya cannot afford to sacrifice high agricultural production yield to alleviate other social problems immediately.

Kenya's foremost and immediate concern should be to increase it's agricultural production. As shown earlier in this paper, if this is done the other problems can be dealt with much more effectively.
Just what are the factors affecting high agricultural production? One of the most important factors is the proper tillage and care of the land. This calls for a more from the traditional cultivation methods to a modern technology on a large scale by small-scale farmers. The modern machinery not only allow the farmer to prepare his soil properly for the seedbed, but their proper use also aid in prevention of soil erosion. This is an important point since Kenya has only about 98,500 square kilometres of arable land. Kenyans simply cannot afford to abuse their land.

It has been shown that with the use of the proper machinery Kenya can more than double it's agricultural production. Thus the amount for export purposes increases, bringing in more foreign exchange.

There is a limit to what any soil can produce, no matter what inputs are made. Considering Kenya's population growth rate, we can say that we will reach a point in the future when production growth will lag behind population growth.

On the other hand if high food production is given priority now, this trend, in population growth rate can be changed greatly.

It is generally accepted that there is a correlation between fertility and social economic factors. Infact mortality
inacting with education have a tremendous effect on fertility levels. Though this is not always in a circular pattern. Recent studies have shown that only after a certain reduction in infant mortality has been experienced, interacting with a certain achieved educational level.

Reduced infant mortality rates in a society are brought about by improved health facilities and services. The capital for investment in health facilities and services, as detailed earlier, comes from agricultural production. The achievement of higher educational level is also brought about by the yields of agriculture.

With the reduction in the population growth rate, the pressure to produce more and more food for domestic consumption will be reduced greatly, thus pressure on the land will be reduced.

As non-agricultural production increases and earns a larger proportion of foreign exchange, agricultural production can slowly start levelling off.

This process will take time, but if agricultural production is not increased greatly, it will take even longer.

We can conclude that with the use of the small tractor on a large-scale basis, several things are achieved:

1. Increase in food production
2. Increase in foreign exchange

3. Increase in rate of development in other sectors of the economy.

4. Better health and overall higher standard of living.

5. Reduction in the fertility rate

6. Reduction in pressure on the land

With the foregoing argument, I recommend that the Kenyan Government make small tractors available to the small-scale farmer, both by importing more tractors or allowing for more to be imported and by helping the farmers with financial arrangements to purchase them. In turn the farmer will be able to increase his yield for the benefit of the nation.

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APPENDIX A

IMPLEMENTS NEEDED FOR PROPER TILLAGE

1. Primary Tillage
   Subsoiler
   Disc Plough
   Chisel Plough
   Paly Disc Cultivator

2. Secondary Tillage
   Disc Harrow
   Rapid Tine Cultivator
   Spring Tine Cultivator
   Spring Release Tine Cultivator
APPENDIX B

PREVENTIVE MAINTENANCE OF TRACTORS FOR MAXIMUM PERFORMANCE

10 HOURS OR DAILY

(1) Check engine oil level

(2) Check and clean air cleaner bowl/air cleaner element.

(3) Fuel lift pump sediment bowl

(4) Check primary fuel filter element bowl

(5) Check water in radiator - 1½" from top

(6) Grease front axle spindles and steering drag links front and rear grease points.

(7) Grease levelling lever box.

(8) Check battery electrolyte level

(9) Check tyre pressure

(10) Grease brake pedal bearing assembly.

100 HOURS OR WEEKLY

(1) Carry out 10 hours service
(2) Fan belt - ¼" deflection between fan pulley and crankshaft pulley.

(3) Check transmission oil

(4) Check the clutch pedal free travel

(5) Wheel nuts (a) Front 55-60 lb/ft  
      (b) Rear 190-120 lb/ft

(6) Check oil level in power steering. Fill until oil level ½"

**200 HOURS**

(1) Carry out 100 hours service

(2) (a) Clean and grease battery terminals  
      (b) Top the battery if necessary with distilled water.

(3) Grease steering column top bearing

(4) Change engine oil, if dusty conditions or extensive light or heavy running fit new filter element.

(5) Check brakes

(6) Check the front hubs for tightness

(7) Check epicyclic units oil level
300 HOURS

(1) Carry out 100 hour service
(2) Change engine oil
(3) Change engine oil filter

500 HOURS

(1) Carry out 100 hours service
(2) Change transmission oil - drain ram cylinder
(3) Check steering box oil level
(4) Clean gauze element in fuel lift pump sediment bowl.
(5) Renew primary fuel filter
(6) Drain, clean and flush radiator
(7) Change oil in epicyclic hubs
(8) Change power steering filter
(9) Change auxiliary hydraulic oil filter element

1000 HOURS

(1) Check rubber sleeves on gear sticks
(2) Renew secondary fuel filter

(3) Repack rear wheel bearings

(4) Drain, remove and clean fuel tank

(5) Inspect commutator and brushes of dynamo

(6) Replace dry air cleaner element

Surely, with past experience, a farmer carrying out all the above service, will have no problems with his tractor, but will gain more from it.
APPENDIX C

SOIL CONSERVATION PRACTICES

1. METHODS OF CONSERVING SOIL

CONTOUR RIDGING WITH TIES

Whenever the crop permits, it should be grown on contour ridges, as this is not only a first-class method of preventing the movement of water, but permits maximum absorption by the soil. The ideal is to tie the ridges every 5-12 feet (1.5 - 3.7m) according to the slope. The ties are constructed by dragging a disc along in front of it. Then at the required distance the operator pulls a rope which raises the discs and leaves a tie between the ridges, he then drops the discs again and resumes the cycle. The purpose of the tie is to ensure that there is no movement of water round the contour.

SLIT MULCHING

An idea started in America in the growing of citrus crops, it has gained favour in many other countries growing fruit trees. The system is based on the ideal of minimum soil disturbance and in fact only the tree rows are cultivated. Natural vegetation in the inter row is left, and then gradually brought under control as the tree crop becomes established. This control normally takes the form of selective poisoning of the more noxious growths.
TRASH BUNDS

When clearing new areas, it is now an established practice in many parts of Africa, to heap the slashed vegetation into contour bunds. This is an elementary, and cheap method of preventing the movement of soil.

STRIP CROPPING

On gentle slopes general farming can be done. Strip cropping should be carried out to help conserve the soil. It consists of laying out contour strips 100-200 feet, (30-60m) wide depending on the slope and careful planning of the rotation cycle. Four strips taken at random may look something like this:

- Strip 1 Maize or cotton - inter row tillage
- Strip 2 Clover or grass - no tillage
- Strip 3 Groundnuts - little tillage
- Strip 4 Fallow

Very often each contour has a buffer strip approximately 10 feet, (3m) wide at it's edge, which is permanently grassed.

WHEEL TRACK PLANTING

Still not fully exploited, this is a convenient method of conserving soil and controlling weed growth. After ploughing for example, a farmer may wish to plant maize on a 30" (.25m) row spacing. The tractor wheels are set at 60" (1.5m) with a
planter unit running in the middle of each rear wheel. The rear wheels break down the soil and consolidate it, and the inter row is left in a really rough and cloddy state.

The first run down the field will give a row spacing of 60" (1.5m), by steering down the middle on the return trip the designed 30" (.75m) row spacing will be achieved.

**GREEN MANURES**

It is good husbandry in areas with soils of low humus content to grow green manures for ploughing in. Such crops as Napier grass, sun hemp or lupines are very often used. They are also aids in preventing erosion.

2. **ENGINEERING SYSTEMS**

When constructing control structures across slopes it is usual to provide a slight gradient to allow excessive water to run off into natural or specially constructed drainage areas. The Gradient prevents collected water from breaking away from the terrace or ditch and causing gully erosion, as shown on Page 52.
Hillside Ditch

This is normally used on steep 20% to 40% slopes and normally hand made.

30" (76.2cm)

Permanent grass or shrubs to prevent silt flowing into ditch

24" (60.96cm)

Grass cover on ridge
These are 4' - 12' (1.2 - 3.6m) wide and 1' - 2' (0.3 - 0.61m) high according to slope which may be 10% - 20%. Vertical distance between ridges, which are permanently covered with grass or cover crops, is 5' (1.2 - 1.5m). A channel must not be left on the lower side of the ridge as this will collect water which may flood out at a low point and cause erosion.

Permanent cover crop on ridge

This Channel must be filled in by cultivation
BROAD BASED OR NICHOLS TERRACE - "WORKOVER TERRACE"

This type of terrace should be 10' - 40' (3 - 12m) wide and is designed to be cultivated and planted. It is normally constructed with a plough, starting in the middle and working out several times to build up the centre around 2' (.6m) high.
To cultivate the vertical distance between broad based terraces use these formulas:

Slopes less than 5%:
\[
\frac{\%\text{Slope} + 2}{2} = \text{Vertical distance in feet}
\]

Slopes more than 5%:
\[
\frac{\%\text{Slope} + 6}{3} = \text{Vertical distance in feet}
\]

**MODIFIED BENCH TERRACE**

Tie across terrace every 60' (18m).

Permanent cover growing on better (vertical face)
BENCH TERRACE

This terrace is similar to those shown above but does not have ties. Suitable for cultivated crops the width may be from 3' to 20' (1 - 6m) depending on slope and cultivation equipment used.

WINDBREAKS

These are not ideal methods of controlling wind erosion as they take up valuable land, and moisture loss through evapotranspiration (use of water by the tree or bush) can be very high. Land area protected is normally 20 - 25 times tree height (H).
PHYSICAL SURVEYS OF NEW CLEARINGS

When planning the cropping systems and conservation methods for a new clearing, it is important that an accurate physical survey of the area be carried out. On completion of the survey, the land can be graded using the:

**VERNON TABLE**

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<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
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<td>5 - 10%</td>
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<td>Over 30%</td>
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<td>Extremely Severe</td>
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</table>

**LAND CAPABILITY CLASS**

i. A and B slopes of good soil

ii. Mainly C slopes of good soil


iv. Mainly E slopes, some D.

v. Mainly E and F slopes

vi. Mainly steep rocky ground, or dry climate

vii. Rock outcrops and eroded areas.

**MOST INTENSIVE SUITABLE USE**

Suitable for cultivation with almost no limitations
Suitable for cultivation with strong limitations
Suitable for cultivation with strong limitations.
Suitable for tree crops, grasses and very limited cultivations.
Not suitable for cultivations. Forest tree crops and grasses.
Poor forest

No productive use.