II. LITERATURE REVIEW

2.1. Smallholder Rubber

Rubber cultivation fits farmer’s basis resource satiation reasonably since it only requires minimal cash expenditure for relatively inexpensive items as seeds and hand tools (Barlow, 1990). Furthermore, commercial rubber production on a small scale was cleverly adapted to the indigenous institution of traditional land systems, under which chief output of land could be acquired almost without cost. In due course, farmers are able to exploit the growing demand for rubber to an extent permitted by their basic resources and market links. This attracted many other small farmers who are convinced by significance of continuous cash income from rubber in supplementing their subsistence.

Introduction of rubber to the local people opened up opportunities for utilizing land more economically instead of leaving the land fallow after one or two years of food crop farming small farmers intercropped with rubber. After 8 to 10 years, with negligible labor input for up keeping young trees, the land became valuable rubber garden and generated continuous income as supplement to their subsistence. Profits secured from rubber during the price boom encouraged many farmers to shift to rubber cultivation as source of livelihood. But to varying degrees, they continued to produce subsistence crops, which later proved valuable when rubber markets were so depressed. According to Knorr (1945), in the 1920’s Indonesia smallholders were less dependent on rubber than their Malaysia counterparts. Their diversified farming made them less vulnerable to the dramatic price decline during the 1930’s of great
depression. Judging from the continuously increasing planted area of smallholder rubber, it may be inferred that the relative importance of rubber in smallholders must be increased too.

Rubber is one of the Indonesia’s major resources: a major source of household income for over eight million people, and among the country’s list, it’s the largest agricultural generator of foreign exchange (Barlow, 1990). This makes Indonesia to be among the world’s largest rubber producers. Rubber that is produced on large plantations or estates employs modern agricultural technologies, heavy capital investments, and a wage labor force. But the bulk of Indonesia’s rubber, 75% at the most count in 1990 by Colin Barlow, produced in tiny gardens of hectare by smallholder agroforesters Barlow and Muharminto (1982) who produce rubber with household labor to meet certain part typically not the major part of their household’s income requirements. Rubber is ideally suited to this purpose, in the words of Barlow (1990), it offers “flexible management… limited reliance on skill… easy disposal of output … and a good cash potential”.

Colin Barlow in 1996 classified the period of rubber growth in three phases; (1) Subsistent economic phase indicated by traditional farming i.e. selling and buying process, shifting cultivation and little involvement of the government; (2) early transformation of farming indicated by the dominancy of commercialized agriculture rubber marketing including international marketing, the beginning of the implementation of rubber cultivation technology, and (3) the development of agriculture in which the agricultural sector was dominant but both industrial and service sectors developed. Villages market improved, labor and land value also
increased, transportation costs decreased, innovation of planting materials improved and government roles started to increase as well. In the current state, Indonesian rubber sector is in the third phase.

2.1.1. Rubber Agroforestry System

Agroforestry is a new name for a very old farming system and to get a picture of its concept, ICRAF (World Agroforestry Centre) defines agroforestry as a collective name for land use systems and practices in which woody perennials are deliberately integrated with crops and or animals on the same land management unit. The integration can be either in a spatial mixture or in a temporal sequence with both ecological and economic interactions between woody and non-woody components.

In 1994, the World Agroforestry Centre (ICRAF), in collaboration with CIRAD-France and the Indonesian Rubber Research Institute, established a network of improved Rubber Agroforestry Systems (RAS) on-farm demonstration plots in Jambi, West Sumatra and West Kalimantan. These RAS (Box 1) are less intensive than intensive monoculture systems but more appropriate for smallholder farmers.

In Jambi agroforestry is very important for the farmers and ranges from 20 to 60% of the cultivated land (Kabai and Dässman, 1997). Looking at rubber agroforestry, it is particularly interesting for two reasons. Firstly, it is relatively unprofitable and secondly, it is entirely smallholder-oriented. One of the best ideas with rubber agroforestry is that the smallholders are able to generate income from different crops or species and during the whole year. The Ministry of Forestry is encouraging
farmers to plant trees on production forest land and this is to create important buffer zones around protected areas.

Box 1: Rubber Agroforestry Systems (RAS) best for smallholder farmers

The first system, RAS-1, is similar to the traditional jungle rubber system, but recommended clones are used instead of unselected rubber seedlings. The clones must be able to compete with the natural secondary forest growth. Various planting densities (550 and 750 trees/ha) and weeding protocols were tested to ascertain the minimum management necessary for optimum production. Intensive weeding is limited to the two-meter strip of rubber rows; the space between rubber rows is less intensively weeded. This is important for smallholder farmers who need to maintain or increase labour productivity. The system is very much in line with the fallow enrichment concept and suits a large number of smallholders because of its simplicity.

The second system, RAS-2, is a more complex agroforestry system. Rubber trees are planted at normal density (550 stems/ha) along with perennial timber and fruit trees (92 to 270 trees/ha) after slashing and burning. Annual crops, mainly upland rice, are intercropped for the first two or three years, under various rates of fertilization. Planting densities of selected species were tested according to pre-established tree typology. Tree species such as rambutan, durian and petai were included. Natural regeneration is allowed in between rubber rows and farmers decide which naturally regenerating species to maintain.

In RAS-3, annual crops, mainly rice, are grown in the first year only, with legume crops such as Mucuna, Pueraaria and Flemingia planted immediately after the rice harvest. Fast growing multipurpose trees (such as Paraserianthes falcataria, Acacia mangium and Gmelina arborea) can also be used. These trees can shade Imperata in the early years of rubber establishment while after seven to eight years; these can be harvested and sold to the pulp industry to provide farmers with extra income.

Source: Joshi et al. 2006

In many cases, where communities have an economic incentive to implement agroforestry systems, many of which are environmentally benign, these systems frequently appear to be financially more attractive (as well as environmentally sound, compared with alternative uses of forests). For example, research by IPB in 2002
West Lampung shows a substantial financial advantage of the complex agroforestry systems practiced by customary communities over rubber or oil palm monocultures.

2.1.2. Rubber Monoculture System

This comprises a single crop i.e. rubber rather than multiple of crop species. In most cases monoculture is a response to the intensification of farming and an drive to increase yields.

Many projects have been implemented in Indonesia in recent decades to improve rubber productivity by introducing more intensive monoculture systems. These include the Nucleus Estate and Smallholder project; the Rehabilitation and Replanting for Export Commodities project; the Smallholder Rubber Development Project (SRDP), the Tree Crops Smallholder Development project and the Tree Crops Smallholder Sector project. Outside government project areas, most smallholders cannot use recommended technologies because they are limited because they are both financially and resourcefully incapacitated.

Between 1980’s and 1990’s the Indonesian government policy for the development of clonal rubber plantations for smallholders at the national scale resulted in the introduction of “clones”¹, mainly in the form of rubber monoculture.

This particular cropping system, which is quite different from the traditional one, was based on a technological package involving a high level of inputs (fertilizers, pesticides and herbicides, cover crops etc.). The project started with 15 % of smallholder rubber producers in Indonesia (350 000 ha) with clonal planting material which allows threefold multiplication of rubber yields (i.e. 1500 kg/ha/year with grafted improved rubber planting material.)
clones). The disadvantage of monoculture lies in the fact that it is not easily reproducible by smallholders due to lack of capital, credit, availability of planting material and technical information.

Because rubber does not yield a return on investments for 6 to 7 years, which is a serious disadvantage, monoculture requires a relatively high starting capital to purchase the necessary inputs for the first three years in order to get quick returns. The cost of clonal planting material is high as well as the quality and availability leaving a lot to be desired and emerging network of private nurseries is not yet sufficiently advanced.

2.2. Policies Affecting Agriculture

Policies influencing the agricultural sector in Indonesia fall into two categories; i.e. agricultural price policies and macro-economic policies. Agricultural price policies are commodity specific. Each price policy targets only one commodity (e.g., rubber) at a time. Price policies also can influence agricultural inputs. Macroeconomic policies are nation-wide in coverage. Macro policies thus affect all commodities simultaneously.

2.2.1. Agricultural Price Policy Instruments

All agricultural price policy instruments create transfers either to or from the producers or consumers of the affected commodity and the government budget. Some price policies affect only two of these three groups, whereas other instruments affect all three groups. In all instances, at least one group loses and at least one other group benefits. Policy analysts need to consider three categories of agricultural policy
Instruments e.g. taxes and subsidies, international trade restrictions, and direct controls.

Taxes and subsidies on agricultural commodities result in transfers between the public budget and producers and consumers. Taxes transfer resources to the government, whereas subsidies transfer resources away from the government. For example, a direct production subsidy transfers resources from the government budget to agricultural producers.

International trade restrictions are taxes or quotas that limit either imports or exports. By restricting trade, these price policy instruments change domestic price levels. Import restrictions raise domestic prices above comparable world prices, whereas export restrictions lower domestic prices beneath comparable world prices.

Direct controls are government regulations of prices, marketing margins or cropping choices. Typically, direct controls must be accompanied by trade restrictions or taxes/subsidies to be effective. Otherwise, “black markets” of illegal trade render the direct controls ineffective. Occasionally, some governments have sufficient police power to enforce direct controls in the absence of accompanying trade regulations. Direct controls of cropping choices can be enforced, for example, if the government allocates irrigation water or purchased inputs.

### 2.2.2. Macro-economic Policies Affecting Agriculture.

Agricultural producers and consumers are heavily influenced by macro-economic policies even though they often have little influence over the setting of these nation-wide policies. Three categories of macroeconomic policies monetary and
fiscal policies, foreign exchange rate policies, and factor price, natural resource, and

Monetary and fiscal policies are the core of macro-economic policy because
together they influence the level of economic activity and the rate of price inflation in
the national economy, as measured by increases in indexes of consumer or producer
prices. Monetary policies refer to controls over the rate of increase in the country’s
supply of money and hence the aggregate demand in the economy. If the supply of
money is increased faster than the growth of aggregate goods and services,
inflationary pressure ensues. Fiscal policies refer to the balance between the
government taxing policies that raise government revenue and the public expenditure
policies that use that revenue. When government spending exceeds revenue, the
government runs a fiscal deficit. That result creates inflation if the government covers
the deficit by expanding the money supply.

Foreign exchange rate policies directly affect agricultural prices and costs.
The foreign exchange rate is the conversion ratio at which domestic currency
exchanges for foreign currency. Most agricultural commodities are traded
internationally, and most countries either import or export a portion of their
agricultural demand or supply. For internationally tradable commodities, the world
price sets the domestic price in the absence of trade restrictions. The exchange rate
thus directly influences the price of an agricultural commodity because the domestic
price (in local currency) of a tradable commodity is equal to the world price (in
foreign currency) times the exchange rate (the ratio of domestic to foreign currency).
Factor price policies directly affect agricultural costs of production. The primary factors of production are land, labor, and capital. Land and labor costs typically make up a substantial portion of the costs of producing most agricultural commodities in developing countries. Governments often enact macro policies that affect land rental rates, wage rates, or interest rates throughout the economy. Other factor price policies, such as minimum wage floors or interest rate ceilings, influence some sectors more than others. Some governments introduce special policies to attempt to control land uses or to govern the exploitation of natural resources, such as minerals or water. These macro policies can also influence the costs of agricultural production.

2.3. Smallholder Export Crop Production

The rural economy of many developing countries is based on export crop production. Export crops are grown for international markets. Most of them share some common characteristics.

Firstly, they are high value commodities handled through reasonably concentrated marketing systems. Secondly, their production relies on the use of some purchased inputs. Finally, they are also internationally tradable, such that their domestic price is closely linked to a world market price mediated through the domestic exchange rate (Dorward et. al., 1998).

The World Bank (2005) recognized a number of contributions that export crops could make to agricultural development at the household level. Export crops are the nucleus around which extension services, input supply and marketing are built. Food crops often benefit from residual fertilizers in the soil when they follow export crops
in rotation. Export crops also allow the purchase of productivity enhancing equipment and accumulation of capital for other investments.

It should be noted that critical issues facing export crop production under market liberalization are somewhat different from those facing food crops. Many staple food crops in Indonesia are essentially non-tradable internationally, as low value-to-weight ratios preclude profitable trade and/or because they are not widely consumed outside the country. Even where international trade might exist (as for example with rice and maize), intra-country transport costs might inflate prices within producing regions, thus hindering goods movements into the world market. Some of the core requirements of the reform policies, including real exchange rate depreciation coupled with the removal of subsidies on purchased inputs, have dramatically reduced profitability of input use of most major food crops. Indeed, such cases of reduced profitability have been reported in Jambi (Hawassi et al 2003).

Changes in relative input-output price ratios have been less adverse for export crops than for food crops. In general therefore, the use of purchased inputs remains profitable for export crops as compared to food crops.

Crumb rubber factories were introduced by the government; most of them were private and depended only on the raw material from smallholder rubber growers. State owned crumb rubber factories were integrated with the private owned estates but the number was limited (Gapkindo 2004).

In 1968, crumb rubber processing technology was introduced and commercially applied in Indonesia. Success and popularity of this crumb rubber industry was shown by the fast growth of crumb rubber factories from 65 in 1969 to
135 in 1974 (Gapkindo, 2002). This number decreased to 87 in 1984 but increased again significantly in 1994 to 115 factories.

In 1984 the number of crumb rubber factories decreased due to the decreased capacity of raw rubber raw material. There was tight competition among factories to get raw rubber and since the factories could not compete, they ended up stopping their operation.

The sustainability of crumb rubber industry depends strongly on the supply of raw rubber material from smallholder rubber farmers. The balance between factory capacity and the raw rubber material production should be maintained. Poor geographical positions cause macro inefficiency especially in transportation.
Table 3. Capacity and Production of Crumb Rubber Factories Based on Provinces from 2002 to 2004

<table>
<thead>
<tr>
<th>NO</th>
<th>Province</th>
<th>Capacity 1</th>
<th>Production 2</th>
<th>Deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nangroe Aceh Darussalam</td>
<td>0</td>
<td>47 097</td>
<td>47 097</td>
</tr>
<tr>
<td>2</td>
<td>North Sumatera</td>
<td>422 600</td>
<td>197 087</td>
<td>225 513</td>
</tr>
<tr>
<td>3</td>
<td>Riau</td>
<td>127 600</td>
<td>197 424</td>
<td>69 824</td>
</tr>
<tr>
<td>4</td>
<td>West Sumatera</td>
<td>163 000</td>
<td>64 288</td>
<td>98 712</td>
</tr>
<tr>
<td>5</td>
<td>Jambi</td>
<td>162 200</td>
<td>183 610</td>
<td>21 410</td>
</tr>
<tr>
<td>6</td>
<td>Bengkulu</td>
<td>44 000</td>
<td>33 563</td>
<td>10 437</td>
</tr>
<tr>
<td>7</td>
<td>South Sumatera</td>
<td>629 400</td>
<td>291 666</td>
<td>337 734</td>
</tr>
<tr>
<td>8</td>
<td>Lampung</td>
<td>24 000</td>
<td>25 097</td>
<td>1 097</td>
</tr>
<tr>
<td>9</td>
<td>West Kalimantan</td>
<td>160 000</td>
<td>173 165</td>
<td>13 165</td>
</tr>
<tr>
<td>10</td>
<td>Central Kalimantan</td>
<td>55 800</td>
<td>137 921</td>
<td>82 121</td>
</tr>
<tr>
<td>11</td>
<td>South Kalimantan</td>
<td>128 000</td>
<td>54 181</td>
<td>73 819</td>
</tr>
<tr>
<td>12</td>
<td>East Kalimantan</td>
<td>0</td>
<td>14 617</td>
<td>14 617</td>
</tr>
<tr>
<td>13</td>
<td>Others</td>
<td>16 800</td>
<td>21 751</td>
<td>4 951</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>1 933 400</strong></td>
<td><strong>1 441 467</strong></td>
<td><strong>491 933</strong></td>
</tr>
</tbody>
</table>

Source: ¹ Gapkindo, 2004 ² Ditjenbun 2004

Totally there was a difference of 491 933 tons (Table 3). This number reflects a deficit in raw rubber material. The largest number was in the largest raw rubber producing provinces i.e. North and South Sumatera. This condition is caused by; a relatively tight competition in the raw rubber material marketing system. Another influence caused by the shortage of raw rubber material is the irrational traffic of raw rubber viewed from the transportation side.
According to Table 3, the largest rubber producing provinces are North Sumatera and South Sumatera. The reasons could be due to relatively tight competition in the raw rubber material and the irrational traffic of raw rubber viewed from the transportation side. Indonesian natural rubber export destination countries (Table 6) are United States, Western European Countries, Japan, China, Singapore and South Korea. The export to the U.S decreased to -3.5% from 1996 to 2001 due to the slowdown in economics and automobile industries in the U.S. Export to the Asian countries increased by 23.3% annually, China increased by 33.4% annually due to the fast growth of economics at an average rate of 10% annually. Export to western European countries also increased to 8.5% annually (Table 6).

According to the Indonesian Rubber Association (Gabungan Perusahaan Karet Indonesia, Gapkindo) in 2002 there were 91 crumb rubber Standard Indonesian Rubber (SIR) factories, with 21,560 workers and 89 Ribbed Smoked Sheet (RSS) factories all around Indonesia, in Java, Sumatera, and Kalimantan Islands and concentrated latex or crepe factories. Most of the crumb rubber factories belonged to private companies, smoked sheet factories to government-owned estates. In 2003 total capacity of the factories that belonged to Gapkindo members were 2.2 million tons, 20% more than the raw rubber material produced, which meant that factories should be more aggressive in buying raw rubber material. The Gapkindo members were government-owned estates, private companies, processors, exporters, traders, and buyers.
Table 4. Export Volume of Indonesian Natural Rubber Based Product from 1969 to 2002

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Volume (000 tons)</td>
<td>(%)</td>
<td>Volume (000 tons)</td>
<td>(%)</td>
</tr>
<tr>
<td>RSS</td>
<td>388</td>
<td>59</td>
<td>192</td>
<td>20</td>
</tr>
<tr>
<td>SIR</td>
<td>4</td>
<td>1</td>
<td>658</td>
<td>67</td>
</tr>
<tr>
<td>Crepe</td>
<td>79</td>
<td>12</td>
<td>81</td>
<td>8</td>
</tr>
<tr>
<td>Latex</td>
<td>34</td>
<td>5</td>
<td>44</td>
<td>4</td>
</tr>
<tr>
<td>Others</td>
<td>153</td>
<td>23</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>657</strong></td>
<td><strong>100</strong></td>
<td><strong>976</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>


In 1969 Indonesian Natural Rubber (NR) export was dominated by Ribbed Smoked Sheet (RSS), but ten years later by technically specified rubber (Standard Indonesian Rubber SIR) and in 2002 SIR dominated, 96% of the total export. The growth of Indonesian NR export based on the type of product during 1969-2002 is shown in Table 4. Based on its value, the Indonesian NR export fluctuated (Table 5), export price was very much influenced by the international rubber price, supply and demand, and competitiveness of Indonesian NR export compared to export from other exporting countries such as Malaysia.

Since the economic crisis which was triggered by the monetary crisis in middle 1997 in several South East Asian countries, the economic growth was negative and the inflation rate also increased. This condition influenced the world rubber demand.
as well as the supply. This was shown by the negative growth and a drastic decrease in exchange rate of the main natural rubber producing countries.

Table 5. Volume, Value and Average Price of Indonesian Exported Natural Rubber from 1969 to 2002

<table>
<thead>
<tr>
<th>Year</th>
<th>Volume (000 US $)</th>
<th>Export value (000 US $)</th>
<th>Average price (US $/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1969</td>
<td>657</td>
<td>171 750</td>
<td>0.26</td>
</tr>
<tr>
<td>1980</td>
<td>976</td>
<td>1 165 321</td>
<td>1.19</td>
</tr>
<tr>
<td>1990</td>
<td>1 077</td>
<td>846 876</td>
<td>0.79</td>
</tr>
<tr>
<td>2000</td>
<td>1 380</td>
<td>888 623</td>
<td>0.64</td>
</tr>
<tr>
<td>2002</td>
<td>1 496</td>
<td>1 037 562</td>
<td>0.69</td>
</tr>
</tbody>
</table>


According to Burger and Smit (2001), between 1997 and 2000 the world rubber market experienced a turbulence development, as well as serious shock from 11th September 2001 tragedy (The World Trade Center attack). In this respect, the price for natural rubber went down to its lowest point.
Table 6. Indonesian Rubber Export Based on Destination from 1996 – 2001

<table>
<thead>
<tr>
<th>Destination</th>
<th>1996</th>
<th>2001</th>
<th>Growth / year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Volume (000 ton)</td>
<td>(%)</td>
<td>Volume (000 ton)</td>
</tr>
<tr>
<td>Asia &amp; Africa</td>
<td>433</td>
<td>30</td>
<td>488</td>
</tr>
<tr>
<td>Japan</td>
<td>106</td>
<td>7</td>
<td>151</td>
</tr>
<tr>
<td>Korea</td>
<td>48</td>
<td>3</td>
<td>60</td>
</tr>
<tr>
<td>China</td>
<td>51</td>
<td>4</td>
<td>137</td>
</tr>
<tr>
<td>Singapore</td>
<td>130</td>
<td>9</td>
<td>78</td>
</tr>
<tr>
<td>Others</td>
<td>97</td>
<td>7</td>
<td>62</td>
</tr>
<tr>
<td>America</td>
<td>783</td>
<td>55</td>
<td>690</td>
</tr>
<tr>
<td>United States of America</td>
<td>628</td>
<td>44</td>
<td>517</td>
</tr>
<tr>
<td>Others</td>
<td>155</td>
<td>11</td>
<td>173</td>
</tr>
<tr>
<td>Europe</td>
<td>198</td>
<td>14</td>
<td>258</td>
</tr>
<tr>
<td>West Europe</td>
<td>151</td>
<td>11</td>
<td>215</td>
</tr>
<tr>
<td>East Europe</td>
<td>47</td>
<td>3</td>
<td>425</td>
</tr>
<tr>
<td>Australia &amp; New Zealand</td>
<td>199</td>
<td>1</td>
<td>161</td>
</tr>
<tr>
<td>Total</td>
<td>1434</td>
<td>100</td>
<td>1453</td>
</tr>
</tbody>
</table>

Source: Gapkindo, 2002.
2.4. Review on Measuring of Efficiency

It thus appears that the amount of output from a currently known way of production is determined not only by levels of inputs but also the existing organizational arrangements i.e. institutions. An institutional factor is entered into the production calculus in terms of its influence on the efficiency resource use. The conventional perception is that institutions may have great influence on the ability and willingness of a producer to correctly allocate resources at hand subject to his objective e.g. output maximization, profit or revenue maximization, cost minimization etc.

In deriving testable hypotheses of producer behavior, efficient production is usually taken for granted. The standard assumption is that markets and information are perfect, allowing equilibrium prices to clear any excess demand for and supply inputs and output. This leads to a production situation with zero profit, which ensures that inefficient producers may exist in the short run only and will eventually be driven out of the industry during the transition towards long run equilibrium. Such equilibrium is simply a conceptualization of a pareto-optimal state of production and consumption with a somewhat dynamic property. In reality, an economy or industry may experience a continuous transition from one state of equilibrium to another, during which some inefficient producers may survive regardless of competitive pressures. More importantly, inefficiency often perpetuates over a long period, mostly as a result of imperfect information concerning the methods of input application as well as prices. In addition to this the ability to discern available information may
differ significantly from one producer to another, leading to a production situation characterized by markedly different efficiency.

In its early application, the concept of efficiency deals with output variation by considering one input at the time. In this way, input use efficiency is shown in terms of productivity of an input under consideration. Later development of the concept makes it possible to measure the efficiency if input application for more than one by some index of input use. However there is a problem in providing a satisfactory index of input use, as different inputs may only be measured in different units Farrel, (1957); Griliches, (1987). Some economists have tried to get round this problem by suggesting cost comparisons as a measure of production efficiency but such a measure can only be meaningful if all producers face the same input and output prices.

Farrell (1957) suggested one method for measuring efficiency of input use through estimation of ‘production frontiers’, from which a deviation of observed output, at a given level of inputs technology is measured to give the degree of system efficiency of that particular production. When factor prices are taken into account, measurements of efficiency at observed level of output give ‘price efficiency’ or, as it is often called, allocative efficiency. The combination of system and price inefficiencies then gives ‘overall efficiency’, which is also called economic efficiency.

Farrell’s approach is considered a sensitive way to simultaneously measure the efficiency of all relevant inputs applied in a production process. But more satisfactory applications of this approach had been delayed for some time due to
absence of computational techniques for estimating a production frontier. Understandably, the applications of Farrell’s approach are simply confined to efficiency measurements, which are obtained by comparing output of individual producers to an average output of the industry. Lau and Yotopoulos (1971), for example used the approach in comparing efficiency of a production unit relative to another. By fitting an average production function for each production separately, they then compared the constant terms to give relative efficiency measurements. Although their method (i.e. unit-output-price profit function) can get round the problem of model specification for physical input – output relationships, it does not measure the efficiency of a particular unit (e.g. farm or firm) from the maximum possible output under actual circumstances of production. In addition, this method becomes impractical when comparing the efficiency of more than two production units. Further, this method fails to specifically distinguish the source of differences in the performance of production units considered, in a sense, it does not show the relative importance of two components of ‘efficiency parameter’ (i.e. efficiency related error terms and white noise). In other words, a difference in the efficiency of two production units may be statistically significant, but it cannot be ascertained whether the difference is due to efficiency –related error terms (i.e. methods of input application) or random errors. Unless these two error terms can be decomposed, there is a possibility for making an incorrect conclusion about efficiency differentials. For example, production units under investigation may be equally (in) efficient, but considered as being different because their efficiency parameters are statistically different due to white noise.
With the advent of more sophisticated econometric techniques, production possibility frontiers with decomposed error terms can be estimated with great ease. A parametric representation of production with decomposed error terms was first and independently suggested by Aigner, Lovell and Schmidt (1977), Meeusen and Broeck (1977), Battesse and Cora, (1977). As noted by Bauer (1990), Econometric techniques for the estimation of production function basically remain unchanged. The only advancement is found in the specification of error terms, which consists of two parts. There is statistical noise with a normal distribution and inefficiency with a one-sided distribution.

2.4.1. Smallholders Production Efficiency

A fair amount of attention has been directed at assessing the relative efficiency of smallholders. However as Carr (2003) points out, many smallholders are not trying to maximize production but to take a risk-free strategy given the policy constraints. Higher smallholder productivity would be possible if these constraints were removed. He argues that unlike food crops, which are grown everywhere, export crops are only grown in areas well suited for their growth. There are few ecological constraints and many well developed technologies available for the smallholders.

However, unlike food production export production is very sensitive to government policies on agriculture, exchange rates and retailing. Technical matters require further research but to a great extent production increases will be achieved more by policies which remove the constraints on smallholders using technology.

The accumulated evidence suggests that smallholders are not as efficient if judged only by yield per hectare. However economic efficiency is not only a matter
of returns to land. Smallholders can adopt a low-input and low-output strategy and continue making a profit at prices that would not be economically viable for estates. ‘Such flexibility offers the possibility of efficient resource allocation in response to the diversification of economic opportunities in the developing economies, as well as being a form of insurance against the uncertainties inherent in world markets (Tiffen and Mortimore, 1990). Furthermore, the political case for smallholder rubber agroforestry farming rests not only on efficiency, but also on equity considerations in the distribution of land and in the regional knock-on effects that smallholdings would generate.

2.4.2. Adopted Model on Measuring Efficiency

The Policy Analysis Matrix (PAM), developed by Monke and Person (1989), provides an organizational framework, which identifies patterns of incentives for economic sectors at each level of the commodity chain, and analyses the impact of direct policy on these patterns at each level as well as their effects on different production technologies, Staal and Shapiro, (1994). The impact of specific commodity and macro-economic policies is gauged by comparing results in the presence and absence of the policy Scarborough and Kydd, (1992). According to Shapiro and Staal (1995), policy in the context of marketing of agricultural commodities is defined as those government decisions (market interventions) which alter the prices economic agents (such as farmers, traders, processors, wholesalers, retailers and consumers) face and which affect their incomes and welfare.

The PAM is a matrix of information about agricultural and natural resource policies and market imperfections that is created by comparing multi-year land use
system budget calculated at private and social prices (Monke and Pearson, 1995). Private prices are the prices that farm households are facing (local or domestic market price of input and output). Therefore, profitability or NPV valued at private prices, so called private profitability, is an indicator for production incentive Tomich et al, (1998). Social prices are the economic prices that remove the impact of policy distortion (taxes, subsidy and other local levies) and market imperfections. Usually it is derived from export or import parity prices of particular inputs or outputs. Profitability measured at social prices, so called social profitability, is an indicator of potential profitability.

In brief, the Domestic Resource Cost (DRC) approach uses social profitability to measure efficiency; the greater the profitability, the stronger the efficiency (Monke and Pearson, 1989). Specifically, systems efficiency can be measured by a DRC ratio:

$$DRC = \frac{\text{Value of domestic factors at economic prices per unit of output}}{\text{Value added at economic prices per unit of output}}$$

In addition to computing profitability, the PAM is used to compute protection coefficients such as DRC, EPC, ERP, NPC and NRP of which DRC is the most important. For this study DRC is computed to determine the production efficiency of the rubber smallholders under agroforestry and monoculture systems respectively.

DRC is a summary measure of the efficiency of domestic production and is interpreted as the costs required for earning a unit of foreign exchange. DRC is also used in comparing relative efficiency among agricultural commodities and is defined as the shadow value of non-tradable factor input used in an activity per unit of
tradable value added. In other words DRC indicates whether the use of domestic factors is socially profitable or not.

Commodities are ranked according to DRC value, and this ranking can then be taken as an indication of competitive advantage or disadvantage.

It should be noted that social profitability needs to be gauged under “shadow” instead of market prices. As opposed to observable market prices, shadow prices are “social” prices reflecting the value of social benefits or costs. For example, agroforestry high profitability in rubber may not reflect efficient resource utilization, but could result from direct or indirect government interventions artificially lowering the production costs or raising the output prices. Therefore, using distorted market prices to measure profitability tends to result in a “false” indication of efficiency; and shadow prices, which measure the true or social value of production costs and revenues, should be used in calculating DRC ratios for efficiency assessment.

Empirical DRC analyses are often conducted based on the “Policy Analysis Matrix” (PAM), which is a standard apparatus for policy decision-makings (Monke and Pearson, 1989) and used widely in efficiency analysis of related to agriculture commodities.

2.5. Measuring Distortions

2.5.1. Distortions in Agricultural Commodity Markets

More efforts have been put in place recently in measuring distortions in the agricultural sector. Several studies have sought to evaluate the costs of such trade distortions. In the late 1970’s and early 1980’s several less developed countries raised
producer prices for cereals relative to other competing opportunities, thus increasing incentives for food production. A good example is shown in the study in Kenya by Jabara (1985). The study revealed that producer prices (output prices deflated by input prices) for food and other crops increased substantially from 1979 to the early 1980s and these increases in prices were associated with the increase in marketed agricultural production. In another major study on pricing policy in developing countries, the United Nations Food and Agriculture Organization (FAO) (1985) noted that, while international cereal prices fell to 18 per cent between years 1978 and 1982, developing countries domestic producer prices rose on average by 5 per cent over the same period.

The study by Byerlee and Sain (1986) found no consistent evidence of price disincentives for agricultural commodity producers in less developed countries. Although the countries kept prices low to consumers, according to the Byerlee and Sain study, the countries did so using policies that did not directly tax producers. It is clear that government taxation of the exportable commodities, which is embraced in the controlled prices set by the government, is a policy considered unfavorable.

Westlake (1987) draws attention to the policy distortions that existed in developing countries major agricultural subsectors and tried to visualize the empirical method to estimate distortions on national levels.

2.5.2. Adopted Model

Standard ratios reflecting the degree of price divergences or distortions are normally calculated to compare profitability and efficiency of different crops. These ratios facilitate comparisons among activities, particularly when the production
process and outputs are dissimilar. A number of protection coefficients are calculated in a standard PAM. The most commonly used protection coefficients are Nominal Protection Coefficients (NPC) and Effective Protection Coefficient (EPC).

Many studies have quantified the distortions of input prices to be caused by policies (Repetto, 1985; Tjornhom, 1995; Lee and Espinosa, 1997), and there are a few techniques to evaluate the degree of protection or subsidy. Most of the techniques that have used methods in which the distortion is observed by the comparison of world price, or border price, and the prevailing market price, which allows the use of the conceptual framework constructed.

2.5.3. Subsidy on Inputs

The method used by Repetto (1995), Lee and Espinosa (1997) compared the subsidy on pesticides and fertilizers against that on other inputs. Conceptually, their subsidized prices were the same as the private prices in most other analyses. However, a difference was that the subsidized prices were estimated by adding up costs of importation, transportation, and sale with current subsidies.

The unsubsidized prices set as benchmark prices are different from the social costs in several studies. These are calculated as if fertilizers and pesticides are treated as any other production input. “(t) his approach compares the specific sources of fertilizer and pesticide subsidies (currency overvaluation, favorable tariff treatment, tax exemptions, etc.) against a counterfactual which measures the “standard” social costs of inputs and goods (particularly imported goods) in an economy.” Lee, Espinosa (2000).
The series of studies summarized by Krueger, Schiff, and Valdes (2001), and applied to a pesticide case by Tjornhom (2005), use the nominal and effective rates of protection for their analysis. The nominal protection coefficient (NPC) and the nominal protection rate (NPR) are measures of the protection of domestic producers or consumers from imports or exports. NPC is calculated as the ratio between the domestic price and the border price, and NPR is the percent difference between the domestic and border prices. A positive NPR represents a protection on the producer and dis-protection on the consumer, while a negative one means dis-protection of the producer and protection of the consumer.

Strength of these measures is that they may be applied to measure price distortion at any level in the production-consumption chain Tsakok, (2000). However, the drawback of that strength is that these indexes only consider output or input prices, so their scope tends to be narrow when compared to the effective coefficient and rate of protection.

The effective protection coefficient (EPC) and the effective protection rates (EPR) are different from their corresponding nominal measures, because they indicate the degree of protection on production structures. The EPC, for example, calculates the value added in domestic prices over the value added in border prices for a commodity. The value added is defined as the difference between the output value and the tradable input value. Because of that definition, the value added can also be interpreted as the return on non-tradable domestic factors of production such as land, labor and capital (Tsakok, 2000). The EPR is the percent difference between the value added in domestic prices and border prices.
EPC greater than 1 means that, producers receive a greater return with the policy intervention. Any positive EPC implies incentive to producers, but Tsakok, (2000) explains that the incentive is only potential and not actual. This happens because the difference in price levels does not result in concrete resource reallocation. A negative EPC indicates that there is a flaw in the decision to undergo the production process under existing productivity and cost conditions.

2.4. Market Failures

Price formation through market mechanisms in decentralized economies frequently fail to arrive at equilibrium levels. The answer lies in non-competitive behavior, asymmetric information, severely segmented input and output markets, and the presence of externalities are among the causes of market failure, signaling wrong input and output prices. This is a situation that is commonly found in developing economies Myint (2005).

Distortions express themselves to markets through a complex web of economic activity interactions. One possible net outcome takes the form of wrong input prices. For example as a result of market distortions the capital price may appear low relative to wages despite abundant labor. This may lead to development of capital using technology. The implications of such technical change are particularly important to smallholder producers whose cash situation does not permit them to adopt new technology. Their problem of technology adoption is also exacerbated by an imbalance access to formal capital markets. As a result, these involuntary non-adopters are excluded from the partition of income generated.
2.5.5. Government Interventions

Institutional changes induced by economic forces may not always progress along socially optimal path of economic development. The presence of social-private divergences in resource use and income distribution resulted from such changes in a legitimate justification for “deliberate exogenous efforts” undertaken by governments, which are specifically aimed at narrowing the gap by planning and stimulating changes in relevant institutions.

It is interesting to note that many economists support ‘intervention approach’. Johnston and Kilby (2003), for example maintained that Laissez-faire is certainly not the best alternative for government policies in product, factor and money markets in late developing countries, even though interventions may impede healthy developments of some sectors. This is particularly true in backward economies such as those of the 19th century e.g. Germany and Russia, where necessary prerequisites for economic growth have not developed (Gerschenkron, 2002). Therefore, a more powerful stimulus than pecuniary incentives is needed to stimulate economic growth.

In preventing distortions governments often intervene. Policy measures for such intervention may range from modest discouragement to complete banning of the development and adoption of undesirable technology. Policy measures are usually coupled with fuller support to reach activities in labor using technology development. Encouragement usually comes in form of patent and license granted to private interventions. Along with those, budget subsidies may be allocated to public education and research institutes advancing natural science and engineering. Such encouragement is basically justified for research that has substantial payback.